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Foreign Direct Investment and Technology Spillovers: Evidence from The Indian Manufacturing Sector

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Subash Sasidharan[1]

Abstract

During the recent period, we observe that many countries compete with each other to attract foreign investment. When MNCs invest in a host country, it is assumed that a part of their technology spills to the host country firms. But the empirical studies on spillover effects of FDI have failed to find robust empirical results about the possibility of positive spillover effects. This study is an attempt to empirically examine the spillover effects from the entry of foreign firms using firm level data of Indian manufacturing industries for the period 1994-2002. We consider both the horizontal and vertical spillover effects of FDI. Consistent with the findings of the previous studies, we find no evidence of significant horizontal spillover effects. In contrast, we find negative vertical spillover effects, although it is not statistically significant.

Keywords: Foreign Direct Investment, Horizontal Spillover, Vertical Spillover, Panel Data
JEL Code: F2, O1, O3

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Introduction

Since 1980s foreign direct investment (FDI)[†] has been a dominant form of technology transfer from developed countries to developing countries. It is based on the fact that multinational enterprises and its affiliates are an important source of international capital and technology. Foreign direct investment bring with it equipment, technical know how, management marketing and other skills (Lall 1997). It is presumed that domestic firms benefit from the externalities associated with the foreign investment through productivity improvement, exports and international integration (Costa and de Queiroz 2002). Therefore, many countries offer various kinds of incentives like tax holidays, subsidies and low tax rates to attract foreign investors.

However, the results of the studies on the positive externalities by FDI are largely inconclusive. The lack of significant horizontal spillover (within industry) effects of FDI has made the researchers to look at the possibility of vertical spillover effects. The main objective of the present study is to empirically examine the horizontal and vertical spillover effects of FDI in the Indian manufacturing sector. The study of India is of particular interest due to the surge in the foreign direct investment inflows witnessed since the onset of large scale economic restructuring in the 90s.

This paper is organised as follows. Section 2 provides an overview of the Foreign Direct Invest regime in India. The theoretical framework and empirical evidence from previous studies are presented in Section 3. Section 4 discusses the data source and methodology. Section 5 presents the empirical results. Finally, Section 6 concludes the study.

2. Foreign Direct Investment Regime in India

The process of transition from a closed to an open economy in the Indian case was a very gradual phenomenon. This is true in the case of the FDI policies also. Kumar (1994) classifies the FDI policy in India into four distinct phases. Phase one (1948-1967) was characterised by gradual liberalisation. This period is marked by a cautious approach concerning the foreign capital. Even though the policy makers were aware of importance

[†] We use the term foreign direct investment and multinational enterprises interchangeably

of foreign capital, it was felt that foreign capital need to be regulated in order to safeguard national interests. However, until 1956, there was no regulation on foreign capital. The industrial policy resolution passed in 1956 emphasised reservation of certain industries to the public sector. The foreign exchange crisis in 1958-59 made the government to rethink its stand on foreign capital. The government tried to offer concessions in the form of tax incentives to foreign investors. The outcome was, many MNCs started showing interest in investing in India.

Restrictive Phase (1968-79) is marked by the regulation of foreign capital and streamlining of procedures in the approval of foreign collaborations. During this period, a Foreign Investment Promotion board was set up to monitor approval of foreign collaborations exceeding 40 percent of equity. Three new enactments passed during this phase clearly underline the apathy of the policy makers to the foreign capital. The Monopolies and Trade Restrictive Act (MRTP) of 1969 required the scrutiny of the all projects involving large firms' capacity expansion. The Indian Patents Act of 1970 was an attempt to remove the monopolistic advantages enjoyed by the multinational corporations. The act was enacted with the intention of avoiding the crowding out of domestic firms. The Foreign Exchange Regulation Act (FERA) (see Kumar 1994 for details) of 1973 required the dilution of all foreign equity to 40 percent. As a result, those multinational companies, which refused to comply with the new regulation, left the market (for example Cocoa Cola and IBM).

Third Phase (1980-1990), witnessed easing of regulation on the foreign capital. The industrial policy resolution of 1980 and 1982 announced certain liberal policy rules like delicensing of selected industries and exemption of foreign equity restriction on fully export-oriented units. Along with the adoption of liberal trade policies, government also took certain measure to allow the import of capital goods and technology. A significant consequence of the policy regime during this period is the shift in the sectoral composition of FDI from plantations, minerals and petroleum to manufacturing sector. The manufacturing sector accounted for the 85 percent of total stock of FDI by the end of 80s (Balasubramanyam and Mahambre 2003).

During the early nineties, India faced severe foreign exchange and balance of payments crisis. The policy makers realised that the solution is to adopt a liberal policy regime. The New Industrial Policy (NIP) resolution passed in 1991 abolished industrial licensing. NIP provides for automatic approval of FDI up to 51% of equity in a list of 34 specified high-priority, capital intensive, hi-technology industries. The prime motive of the policy makers in the adoption of the NIP has been to attract foreign direct investment in various sectors.

Table 1. FDI Inflows to India

Year	FDI Inflows‡ (Millions of Dollars)
1990	237
1991	75
1992	252
1993	532
1994	974
1995	2151
1996	2525
1997	3619
1998	2633
1999	2168
2000	2319
2001	3403
2002	3449
2003	4269
2004	5335

Source: World Investment Report (various issues)

Due to the liberalisation policies adopted by the Indian government since the beginning of the 90s, the foreign direct investment flows have increased steadily from 237 million dollars in 1992 to 5335 million dollars in 2004 (see Table 1). The growing presence of

‡ **Notes:** FDI inflows comprise capital provided (either directly or through other related enterprises) by a foreign direct investor to a FDI enterprise, or capital received by a foreign direct investor from a FDI enterprise. FDI includes the three following components: equity capital, reinvested earnings and intra-company loans.

foreign firms may be attributed to the liberalization, deregulation and macroeconomic stabilization policies adopted by the Indian government. Therefore, the role of foreign investment in the form of technology transfer has come to the center stage in India's industrial development. It has been claimed that the foreign subsidiaries poses a challenge to the domestic firms through its superior technology and other firm specific advantages. At the same time domestic firms can benefit from the externalities. The domestic Indian firms will have to develop technological capability in order to compete as well as co-operate with the foreign firms. Hence, it is important to empirically examine whether the entry of foreign firms is beneficial or detrimental to the domestic Indian firms.

3. Theoretical Framework

The empirical studies on spillover effects of FDI are based on the notion that MNCs possess superior organisational and production techniques compared to the domestic firms (Hymer 1976). MNCs can transfer technology through various means like licensing, trade, FDI, subcontracting, franchising and strategic alliances. Nevertheless, the preferred mode of technology transfer is through foreign direct investment since it can internalise the transfer of superior technological assets at little or no extra cost (Caves 1996). In addition, FDI is considered as the best means to keep control over the technological knowledge. Since the technology has the characteristic of a public good, a part of the technology spills from the MNC subsidiaries to the domestic firms. The spillovers can be in the form of improvement in the productivity of the domestic firms. This is neo-classical view on spillover effects[§]. The spillover effects from the FDI can be broadly classified as horizontal (sectoral) and vertical (inter-sectoral) spillover. The commonly identified channels of spillover from MNCs are illustrated in the figure below. We examine both horizontal and vertical spillovers in detail below.

[§] This is in line with the "externalities" being "spillovers", according to neo-classical theory, an externality in general is a positive one

Horizontal Spillovers

The entry of foreign firms may lead to an increase in the productivity of the domestic firms in the same industry through various means. First**,** *demonstration effects* refer to the copying or the imitation of foreign firms' technology and organisational practices by the domestic firms. Second, *labour turnover* arises from the mobility of the skilled and trained workers from MNCs to domestic firms. These workers are carriers of MNC's technology. Multinationals can prevent the flow of labour by paying higher wages. On the other hand, there is a possibility of reverse labour turnover. The employees of domestic firms can move to foreign firms. Third, *competition effects* refers to a situation in which entry of foreign firm forces the domestic firms to increase their efficiency by improving the existing methods of production or adopt new ones. For example, MNCs usually enter markets, which are highly concentrated. The main characteristic feature of such markets is the high entry barrier created by few domestic firms. In such a scenario, the entry of foreign firm forces the domestic firms to become more efficient thereby a reduction in the market concentration. At the same time, competition from foreign firms can lead to crowding out of domestic firms. Those firms, which are unable to compete with the foreign firms, are forced to make an exit. Aitken and Harrison (1999) attribute such an effect as "market stealing effect". In the most widely cited study about Venezuelan firms, Aitken and Harrison show that foreign firms actually divert demand from the domestic firms. Therefore in the short run, the productivity of the domestic firms decline. From the point of view of the customer, competition effects are certainly beneficial due to availability of the improved quality of products. Competition is considered as a driver of innovation also. The argument about positive competition effects hold only if domestic firms are not far below the technological frontier. On the other hand, in an industry characterised by weak firms, the entry of foreign firms may eventually lead to an exit of the weak domestic firms.

Vertical (Inter-Industry) Spillovers

The phenomenon of spillovers is not just confined within industries. It can arise as a result of interaction across industries. The inter industry spillover arises mainly by the customer-supplier relationship between foreign firms and domestic firms. According to Dunning (1993, p.456), "*the presence of FDI has helped to raise the productivity of many domestic suppliers, and this has often had beneficial spillover effects on the rest of their operations*". It is believed that spillovers are more likely in the case of inter-industry than with in the same industry. The reason behind such a belief is that, MNCs can prevent the leakage of technology to its competitors, while it has no incentive to prevent the technology diffusion to its suppliers and clients (Javorick 2004).

Vertical spillover mechanism operates both at the upstream and downstream sector. MNCs usually source their raw materials and components from domestic suppliers. The incentive for the MNC to source from the domestic market arises in the case of high transportation costs between the home and host country as well certain regulations imposed by the host country government like local content requirements. The MNCs usually assists the local suppliers to achieve technical and organisational competence by providing technological assistance as well as training programmes for employees of local supplier firms (Lall 1978). MNCs follow stringent quality requirements regarding their inputs supplied by local firms. As a result, the domestic supplier firms improve their quality of products and patterns of production process. The entry of foreign firms may increase the demand for intermediate inputs by local firms. Therefore through backward linkage mechanism, productivity of domestic firms may improve.

On the other hand, if the MNCs prefer to source from their international supplier, the domestic firms will have to upgrade in order to meet the global and follow sourcing [**]. Those supplying firms failing to meet the requirements of the MNCs or unable to meet the import competition will be forced to exit from the market. As a result a negative vertical spillover can arise in such an eventuality. Markusen and Venables (1999) in a

[**] The international suppliers follow the MNCs to the host countries

theoretical model show that as a result of the contact with the multinational firms, local input suppliers can emerge strong in the long run make the MNCs to leave the market.

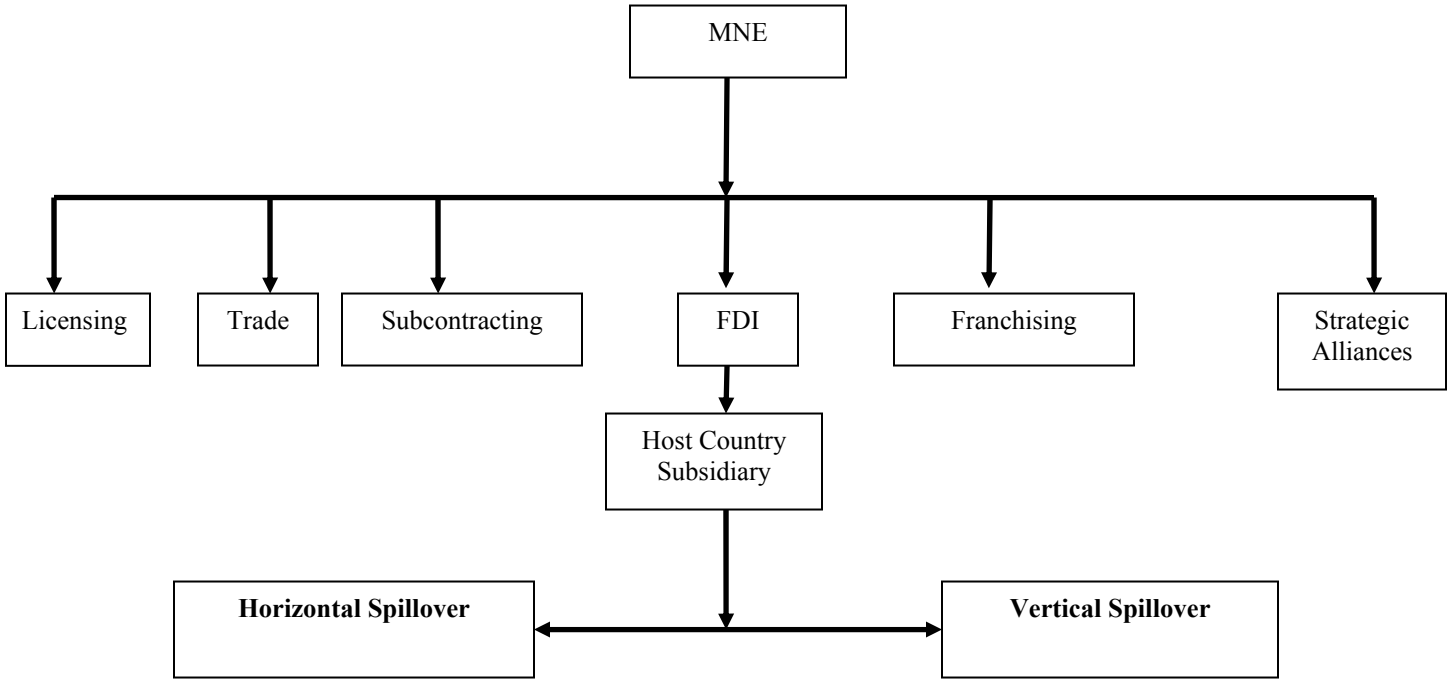

Figure1: Channels of Technology Transfer and Spillover from Foreign Direct Investment

The occurance of vertical spillover is based on certain set of conditions. The foremost factor is the extent of the vertical integration between foreign firms and its domestic suppliers. MNCs focussing on the domestic market have the incentive to source from the domestic suppliers. While, an export oriented MNC subsidiary might prefer the international supplier of the parent company in order to meet the international quality standards in the export markets. This is true in the case where MNCs are unable to find the domestic supplier meeting its stringent quality requirements. Based on the above discussion, we can conclude that the net effects of horizontal and vertical spillover can be either positive or negative.

Large number of studies has appeared in the recent years on the impact of FDI on host country firm productivity growth through spillovers[††]. The studies pertain to developed, developing and transition economies using both cross sectional and panel data. The pioneering studies (Caves 1974; Globerman 1979; Blomstrom and Persson 1986) using cross-sectional data mostly found evidence of positive effects. However, these studies were criticised for the reason that they were unable to take into consideration the industry and time effects. The evidence of positive spillover from foreign subsidiaries may be due to the possibility that MNCs tend to invest in high productivity industries. The availability of panel data has enabled the researchers to rectify the shortcomings of using cross-sectional data. Studies undertaken with the panel data reveal negative or insignificant effects (Aitken and Harrison 1999, Djankov and Hoekman 2000; Konings 2001). Some of the studies based on panel data show positive effect, but depending on certain factors like the absorptive capacity (Kinoshita 2001; Girma 2005) and the extent of the technology gap between domestic and foreign firms (Kokko 1994; Castellani and Zanfei 2003). Panel data also enables the researchers to take into account the time lag involved in the absorption of spillovers by domestic firms. In an extensive review of studies on spillover effects of FDI, Gorg and Strobl (2001) conclude that "*the results of productivity spillover studies do not seem to be affected by whether the studies use sector*

[††] See Blomstrom and Kokko (1998) and Gorg and Greenaway (2004) for an extensive survey of the literature.

or firm level data, but that it is important whether the data used are cross-sectional or panel data".

The lack of positive spillover effects within industries using panel data has made researchers to search for the possibility of FDI spillover across industries. These studies are based on the belief that domestic firms in downstream and upstream sectors may be benefiting from the linkage with the foreign firms. Vertical spillover variables are constructed using input-output tables. Some of the recent studies focussing on inter-industry spillovers have found positive effects through backward and forward linkages with the foreign subsidiaries (Schoors and van der Tol (2002) for Hungary; Javorick (2004) for Lithuania; Blalock (2002) for Indonesia). However, some other studies on the linkage effects illustrate mixed results. For example, Yudeva et al (2003) study on Russian manufacturing firms find negative forward and backward linkage effects. Similarly, Merlevede and Schoors (2005) focus on the inter-sectoral effects of spillovers in Romanian firms. They find evidence of positive forward spillovers but backward spillover is found only in the case of export-oriented sectors.

Table 2. Studies on Intra-Industry and Inter-Industry Spillovers of FDI

Authors	**Data**	**Year**	**Level of Aggregation**	**Country**	**HS**	**F**	**B**
Blomstrom and Persson (1983)	c.s	1970/1975	ind	Mexico	+		
Blomstrom and Wolf (1986)	c.s	1970/1975	ind	Mexico	+		
Kokko (1994)	c.s	1970	ind	Mexico	+		
Blomstrom and Sjoholm (1999)	c.s	1991	micro	Indonesia	+		
Sjoholm (1999)	c.s	1980/1991	micro	Indonesia	+		
Aitken and Harrison (1999)	panel	1976-89	micro	Venezuela	-		
Haddad and Harrison (1993)	panel	1985-89	micro	Morocco	?		
Djankov and Hoekman (2000)	panel	1993-96	micro	Czech Rep.	-		
Konings (2001)	panel	1993-97 1994-97 1993-97	micro	Bulgaria, Poland, Romania	- ?		
Zukowska and Gagelmann (2000)	panel	1993-97	Micro	Poland	-		
Kugler (2001)	panel	1974-98	ind	Colombia	?		
Kathuria (2001,	panel	1976-89	micro	India	?		

2002)		1990-97					
Siddharthan and Lal (2004)	panel	1993-2000	micro	India	+		
Narula and Marin (2005)	panel	1992-2001	micro	Argentina	?		
Yudeva et al. (2003)	panel	1993-97	micro	Russia	+	-	-
Blalock and Gertler (2004)	panel	1988-96	micro	Indonesia	?		+
Javorick (2004)	panel	1996-2000	micro	Lithuania	?	-/?	+
Javorick and Spatareanu (2004)	panel	1998-2000	micro	Romania	- +		+/-
Schoors and van der Tol (2002)	c.s	1997/1998	micro	Hungary	+	+	-
Merlevede and Schoors (2005)	panel	1996-2001	micro	Romania	-	+	-/+
Blyde et al.	panel	1995-2000	micro	Venezuela	-	-	+/?

c.s.: cross sectional data
ind: industry
Micro include both plant and firm level data
HS: Horizontal spillover
F: Forward Linkages
B: Backward Linkages
?: insignificant effects

Table 2 provides a summary of the selected studies carried out on productivity spillovers based on cross-sectional or panel data from developing and transition economies[‡‡]. It is clear from the table that cross-sectional studies report positive horizontal spillover effects while majority of the panel data studies report either negative or insignificant spillovers. Therefore, from the results of the previous studies, we can safely conclude that evidence on positive spillovers is weak.

3. Data Source and Methodology

The data for our study is obtained from the PROWESS database provided by the Center for Monitoring Indian Economy (CMIE). We also use the input-output table for the year 1998-99 provided by the Central Statistical Organisation (2005). The PROWESS database contains information of about 9800 firms registered with the Bombay Stock Exchange. For our study, we have drawn data for the manufacturing sector firms (Sector 15-36 in the NIC classification), resulting in a sample of 4900 manufacturing firms. The

[‡‡] For Developed countries see to Gorg and Greenaway (2004).

data covers the period from 1994-2002. Firms are categorized according to the NIC 1998 code. PROWESS database provided information on foreign equity, value of output, sales, exports, imports, wages, materials costs and fixed assets.

Table. 3 Classification of Firms by Industry in the Year 2002

NIC Code	Industry Classification	Domestic Firms	FDI* Firms	All Firms	2/3*100
15	Food Products and Beverages	280	26	306	8.5
16	Tobacco Products	3	3	6	50.0
17	Textiles	305	14	319	4.4
18	Wearing Apparel	43	2	45	4.4
19	Leather and Leather Products	22	1	23	4.3
20	Wood and of Products of Wood and Cork, Except Furniture;	14	0	14	0.0
21	Paper and Paper Products	74	8	82	9.8
22	Publishing, Printing and Reproduction of Recorded Media	18	1	19	5.3
23	Coke, Refined Petroleum Products and Nuclear Fuel	30	4	34	11.8
24	Chemicals and Chemical, Products	541	63	604	10.4
25	Rubber and Plastic Products	153	18	171	10.5
26	Other Non-Metallic Mineral Products	97	14	111	12.6
27	Basic Metals	256	16	272	5.9
28	Fabricated Metal Products	70	7	77	9.1
29	Machinery and equipment	139	40	179	22.3
30	Office machinery and Computing Machinery	19	2	21	9.5
31	Electrical Machinery and Apparatus	92	12	104	11.5
32	Radio, Television and Communication Equipment	62	11	73	15.1
33	Medical, Precision and Optical Instruments, Watches and Clocks	35	7	42	16.7
34	Motor Vehicles	96	26	122	21.3
35	Other Transport Equipment	31	3	34	8.8
36	Furniture; Manufacturing N.E.C.	36	2	38	5.3
	Total	2416	280	2696	10.4

Based on Authors Calculations from the PROWESS database

*FDI firms are those firms with foreign equity of 10 percent or more

For the purpose of our study, we have used an unbalanced panel data. The use of an unbalanced panel selection can be justified on the grounds that very few firms exit from the data set. Those firms, which report zero value added, and those firms, which re-enter the database after a gap, are excluded for analysis. The final sample varies 2696 and 2720 firms. The sectoral composition of the firms is given in the Table 3 above. From table 3 we can see that during the year 2002, 10% of the firms have foreign ownership. The foreign presence is highest in the Tobacco industry followed by machinery and equipment, non-metallic mineral products. It can be observed that in the wood and wood products industry has no foreign owned firm.

For the present study all those firms having foreign equity greater that 10%[§§] of the total equity are classified as foreign firms. In addition to the variable representing the ownership, we also construct two spillover indicators i.e., horizontal and vertical. The horizontal spillover indicator captures the spillover effects from the multinational in the same industry. Vertical spillover indicator captures the effect of foreign subsidiary from the industries to which it supplies. The details of the input variables (Capital, Labour and Materials) construction used in the production function estimation are explained in detail in Appendix I. We explain in detail below about the construction of horizontal and vertical spillover indicators.

Horizontal Spillover: Previous studies have used different measures to proxy spillovers. Most of the studies use either the share of employment or output of the foreign firm. Following Blalock (2002) and Kathuria (2002), we can represent it as: share of foreign firms output to total industry output.

Vertical Spillover: Vertical Spillover variable is used as measure to capture productivity spillovers to those domestic firms, which supply inputs to multinationals. The indicator has been constructed as follows.

$$Vertical_j = \sum_{i \neq j} \alpha_{ij} horizontal_j$$

[§§] This is the commonly used threshold level in most of the studies

We proxy the share of a firm's output sold to foreign firm by the share of an industry output sold to foreign firms in different downstream industries. We can construct this variable using an input-output table. Input-Output table provides details about the amount supplied by an industry to downstream industries. We use an input output table for the year 1998-99 provided by the Central Statistical Organisation (2005) for the same. From the firm level data we can obtain the share of foreign firms output in each industry. Where α_{ij} is the proportion of output of sector *i* supplied to sector *j* from the 1998-99 input output matrix[***]. We exclude the inputs sold within the sector since this effect is captured by the horizontal spillover variable.

3.1 Performance of Domestic and Foreign Firms

In this section we make a comparison between foreign and domestic performance based on certain key variables like exports, technology imports and R&D (Table 4).

Table. 4 Comparison of Domestic and Foreign Firms

	Domestic Firms (%)		Foreign Firms (%)	
	1994	**2002**	**1994**	**2002**
R&D Intensity	0.2	0.5	0.3	0.7
Export Intensity	8.4	13.2	10.1	13.8
Technology Imports Intensity	3	1.3	4.4	2.2

*Based on Author's own calculations from PROWESS Database
R&D Intensity is the share of R&D Expenditure to the total sales. Export Intensity is the share of total exports to the total sales. Technology Imports is the share of the capital goods imports plus the remittances on royalties and licence fees to the total sales.

R&D Intensity: It can be observed from the table that the expenditure on R&D is found to be very negligible in the Indian manufacturing sector. It is not even one percent of the total sales. During the period 1994-2002, it can be seen that there has been a marginal increase in the R&D spending by both the domestic and foreign oriented firms. From the data we can observe that foreign firms are more R&D intensive than the local firms.

[***] The details of the construction of the input-output coefficient and concordance table are given in appendix II.

Export Intensity: It is normally assumed that the foreign firms are more export intensive compared to the domestic firms. But, it is indeed a surprise to find from our data that the domestic firms are as export intensive as the foreign firms. Even though the foreign firms had an edge in the initial years, we can clearly observe a trend of domestic firms catching up with the foreign firms. We find that the export intensity of both the domestic and foreign firms is almost the same in the year 2002. The possible explanation might be the depreciation of the rupee during the nineties and the liberalisation policy adopted in the nineties might have enhanced the incentive for the domestic firms to export. This is clearly a positive sign, and reveals an improvement in the competitiveness of the domestic firms.

Technology Imports**:** Technology Imports is one of the important determinants of the productivity growth of the firms. Firms usually import technology as a means to upgrade their existing technology. In addition, the imported technology may enable the firms to obtain monopolistic rents by using the foreign technology previously not available in the country. Technology imports can be broadly classified as both embodied technology consisting of capital goods and disembodied technology in the form of blueprints and licence fees. We observe from the sample firms that the technology imports has declined in both the local and foreign firms**.** The decline in the technology imports can be explained by the fact that licensing or technology collaboration is not longer considered by firms as a favourite means to obtain foreign technology. This is especially true in the context of a liberalised regime, in which the firms have the option to start a joint venture or strategic alliances with foreign firms**.**

3.2 Comparison of the Total Factor Productivity between Foreign firms and Domestic Firms

We follow the model proposed by Aitken and Harrison (1999) to examine whether the foreign firms are more productive. They use an augmented production function to examine the effect of foreign ownership on firm productivity within a region or an industry. We use a log-linear production function to verify whether foreign ownership has a positive association with increased productivity.

$$lnY_{ijt} = \alpha + \beta_1 lnK_{ijt} + \beta_2 lnL_{ijt} + \beta_3 lnM_{ijt} + \beta_4 FS\_Firm_{ijt} + \varepsilon_{ijt} \quad (1)$$

The log of output is regressed on a vector of inputs and a share of foreign ownership. The variable FS_Firm_{ijt} is refers to the ownership variable. This variable takes the value 1 for those firms whose share of foreign capital exceed 10 per cent or zero otherwise. We expect the coefficient of FS_Firm_{ijt} to be positive and significant. Inputs consists of materials M_{ijt}, labour L_{ijt} measured by number of employees and capital stock $K_{ijt.}$ The above equation is estimated using the OLS method. We also included an annual time dummy as well as industry dummy to control for differences in time and industry effects. The estimated results are presented in the Table 5. As expected the coefficient of the variable FS_Firm_{ijt} is positive and significant. This result clearly corroborates with our notion that those firms with foreign participation in its equity are more productive than the domestic firms.

Table 5 TFP Comparison between FDI firms and Non-FDI firms

Dependent variable	**ln Output**
FS_Firm_{ijt}	0.13***
	(0.022)
lnK	0.29***
	(.007)
lnL	0.40***
	(0.008)
lnM	0.30***
	(0.007)
Constant	-0.91***
	(0.022)
Industry Dummies	Yes
Year Dummies	Yes
R^2	0.68
No. of Observations	12176
Time Period	1994-2002

Notes: The figures in the brackets are standard errors adjusted for heteroscedasticity

*** Shows significance at 1% level

Empirical Model

We follow the model employed by the previous studies on spillover effects of FDI by estimating a log linear augmented Cobb-Douglas production function. The production function is augmented of foreign presence apart from the regular input variables. The basic model can be represented as follows.

$$lnY_{ijt} = \alpha + \beta_1 lnK_{ijt} + \beta_2 lnL_{ijt} + \beta_3 lnM_{ijt} + \beta_4 Horizontal_{jt} + \beta_5 Vertical_{jt} + \varepsilon_{ijt} \quad (2)$$

where, Y_{ijt} the output by firm i in the jth industry at the time period t. The log of value added is regressed on a vector of inputs and a measure of foreign presence. The variable *horizontal* represents the share of foreign firms output in industry j at time period t. *Vertical* captures the effect of multinationals on the domestic input suppliers. Inputs consists of materials M_{ijt}, labour L_{ijt} measured by number of employees and capital stock $K_{ijt.}$

The above model can be estimated using Ordinary Least Squares Method (OLS). However, the estimation based on OLS poses the problem of consistency. The estimation of above model requires the strict assumption of exogenity of the variables. But the recent debates on production function estimation suggested that the exogenity assumption is will be violated in the case of OLS estimation of production function (Griliches and Mairesse 1998). The firms respond to productivity shock by using more amounts of inputs. Therefore, both labour and material variable is endogenous (Capital is generally considered as a fixed factor). As a result, there might be a correlation between the unobserved productivity shock and the inputs. Hence, OLS estimates will be biased. Griliches and Mairesse (1998) suggest that by using a first difference form of the model specification, the bias arising from the endogenity can be controlled.

While estimating the production augmented of foreign presence, there is a need to control for the industry specific effects. It is found that foreign firms tend to invest in productive firms in the host country. Therefore, if the industry effects are not controlled for, the estimated results tend to be biased and inconsistent. Often it is found that OLS estimates tend to give positive and significant results about the spillover effects. The earlier strand

of work on FDI and spillover using cross-sectional data, which did not control for industry and time effects often found positive results. This positive correlation may be attributed to the fact that foreign investment is often attracted to productive industries. Thus if the industry effects are not controlled for, the positive results arising seems to be a spurious one.

We use a first difference model to eliminate the differences in productivity level across industries. First differencing procedure enables us to eliminate the time invariant firm specific productivity effects. Along with the first difference model, we also include a group of industry and time dummy to get rid of the omitted variable bias and time invariant factor. By including the dummies, we can control for the differences in industry and regional effects such as long-term strategies of the firm, infrastructure and technological opportunities (Marin and Bell 2004). Therefore the equation 2 can be written as

$$ln\Delta Y_{ijt} = \alpha + \beta_1 ln\Delta K_{ijt} + \beta_2 ln\Delta L_{ijt} + \beta_3 ln\Delta M_{ijt} + \beta_4 \Delta Horizontal_{jt} + \beta_5 \Delta Vertical_{jt} + \alpha_j + \alpha_t + \varepsilon_{ijt} \quad (3)$$

where, represent M_{ijt}, L_{ijt} and K_{ijt} represent material expenses, labour and capital respectively. The variables *Horizontal* and *Vertical* are same as defined above. α_j and α_t are dummy variables representing industry and time effects**.**

Results and Discussion

In this section we discuss about the results of the spillover effects based on different model specifications. Model 1(equation 2) was estimated using a pooled OLS method. As expected we find that the spillover variable Vertical is positive and significant (Table 6). The positive and significant result may be due to the fact that it did not control for the industry and time effects. We can observe that horizontal variable is negative and is not statistically significant.

Table. 6 OLS Estimation of Equation 2

Dependent Variable	lnY
Constant	0.875*** (0.020)
lnK	0.17*** (0.007)
lnL	0.27*** (0.008)
lnM	0.49*** (0.007)
Horizontal (Output)	-0.03 (0.063)
Vertical (Output)	0.35*** (0.041)
Observations	16191
R-Sq	0.72
Time Period	1994-2002

Notes: The figures in the brackets are standard errors adjusted for heteroscedasticity
*** Shows significance at 1% level

In the second stage, in order to strengthen the results we estimate the first difference model. Estimation results are given below. The estimation results for the all firms and domestic firms separately are given below in the Table 7 below.

Column 1 in the table reports the results of the spillover effects for all the firms. We can observe from the table that the coefficient of the horizontal spillover variable is positive but not significant. But the vertical spillover variable loses the significance and it becomes negative. We ran the same model consisting of the domestic firms. The results are similar compared to the estimates based on all firms. The horizontal spillover variable is not statistically significant even though the coefficient is positive. The sign of the backward spillover variable is negative and insignificant.

Our results about the lack of horizontal spillover are in concordance with the recent studies finding either negative or insignificant results (Aitken and Harrison 1999; Smarynska 2004, Kathuria 2001). The lack of horizontal spillovers can be due to the fact that foreign firms can prevent the leakage of technology to its competitors in the same industry. We find the vertical spillovers are negative and not significant in both the specifications. The recent debate that spillovers occur across industries than within

industries cannot be validated from our results. We find that those domestic firms supplying to the multinational firms are not able to reap any productivity improvements in the upstream sectors.

Table 7 OLS Estimates of the First Difference Model

	All Firms	Domestic Firms
Δ Horizontal	0.464 (0.302)	0.055 (0.362)
Δ Vertical	-0.437 (0.529)	-0.585 (0.565)
Δ lnK	0.196*** (0.010)	0.134*** (0.021)
Δ lnL	0.299*** (0.010)	0.145*** (0.018)
Δ lnM	0.464*** (0.011)	0.349*** (0..034)
Industry Dummies	Yes	Yes
Year Dummies	Yes	Yes
R^2	0.734	0.732
No. of Observations	10226	8914

Notes: The figures in the brackets are standard errors adjusted for heteroscedasticity. ***, **, * Shows significance at 1%, 5% and 10% respectively

Conclusion

During the nineties, India has attempted major changes in its economic policy by adopting a liberalised industrial and trade regime. It was undertaken with a view to improve efficiency and productivity as well as to improve the competitiveness of Indian industries. The policy makers have undertaken several measures to attract foreign direct investment to the country. From the data we have observed that during the last fifteen years, the foreign direct investment inflows have increased by almost ten fold.

In this study we have attempted to examine the spillover effects of foreign direct investment in Indian manufacturing industries. We use a firm level data of Indian manufacturing industries during the period 1994-2002 for this purpose. We investigate both the horizontal and vertical spillover effects associated with the FDI. The results of the study indicate a positive spillover for those domestic firms supplying to foreign subsidiaries. However, the lack of significance of the horizontal spillover is in congruence with the results of the other studies carried out for India (Kathuria 2001, 2002) as well as other developing and transition economies (Aitken and Harrison 1999; Djakov and Hoekman 2000; Konings 2001; Narula and Marin 2005).

Recent studies on spillover effects of FDI have looked into the possibility of finding positive effects of veritical spillovers. Following the standard methodology, (Smarynska Javorick 2004; Blalock 2002; Schoors and Vander tool 2001), we also attempted to capture the vertical spillover effects. We find that the local suppliers are not getting benefits from the contacts with the foreign firms. The negative results indicate the possibility of lack of local sourcing by the multinationals. The evidence of negative vertical spillover can be explained by the fact the foreign firms investing in India may not be sourcing inputs from domestic suppliers. It may be due to the fact that foreign firms are unable to find local suppliers, which satisfy their quality requirements. Another possibility might be a policy of "cherry picking" (Javorick and Spatareanu 2005) by the foreign firms. It means that multinational firms source inputs only from the productive local firms. As a result, domestic firms in the upstream sector may not experience any productivity improvement.

Since, there are no previous studies, which looked in to the vertical spillover effects of FDI in Indian manufacturing; we are unable to compare our results. But a recent study on vertical spillover in Indian Pharmaceutical industry report existence of negative spillovers of FDI in the upstream sector (Thangavelu and Pattnayak 2005). But our results about the negative vertical spillover effects are similar to the recent findings of negative horizontal and vertical spillover effects of FDI with the existence of negative vertical spillover

effects in some of the transition economies (Yudeva et al. 2003 for Russia; Merlevede & Schoors 2005 for Romania).

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Appendix I

Construction of Variables

Output

PROWESS data contains information on value of total output total by each firm belonging to particular industry group. This was deflated using industry specific wholesale price index. The wholesale price index is obtained from the "Index of Wholesale Prices in India with base year as 1994=100", provided by www.circonindia.com.

Capital

The difficult task faced by the researcher while estimating total factor productivity is the correct measurement of the capital stock variable. For this purpose we closely follow the methodology provided by Srivastava (1996) and Balakrishnan et al (2000). They use Perpetual Inventory Method, which correct for the fact that capital involve historical cost. Therefore, the straightforward application of the perpetual inventory method is not possible. The capital stock has to be converted into an asset value at replacement cost. For this purpose, we measure the capital stock at its replacement cost for the base year (we assume to be 1994-95). We follow Balakrishnan et al (2000) to arrive at a revaluation factor. The revaluation factor is constructed assuming that life of the machinery and equipment is 20 years and the growth of the investment is constant throughout this period. We also assume constant rate of change for the prices of the capital stock. The revaluation factor obtained is used to convert the capital in the base year into capital at the replacement cost at current prices. We then deflate these values to arrive at the values of capital stock in constant prices for the base year. The deflator used for the purpose in constructed from the series on gross capital formation. Subsequent years' capital stock is arrived by using the sum of investment using the perpetual inventory method.

Labour

The PROWESS database provides information on wages and salaries. No information on the number of employees is available. Therefore, we need to use this information to arrive at the mandays of work for each firm. Mandays at the firm level is arrived by

dividing the salaries and wages at the firm level by the average wage rate of the industry to which each firm belongs. It is arrived using the following formula

Number of mandays per firm = **Salaries and Wages/Average Wage Rate**

In order to arrive at the average wage rate, we make use of the Annual Survey of Industries (ASI) data. ASI contains information on Total Emoluments as well as Total Mandays for relevant industry groups. At the time of this study, ASI data was available only till 2001, and we have extrapolated the values for the year 2002. We obtain average wage rate by diving total emoluments by total mandays. It can be represented by:

Average Wage Rate = **Total Emoluments/Total Mandays**

Materials

We follow Balakrishnan et al. (2000) methodology to construct the materials variable. The materials bill was inflated by a material input-output price index. The input-output coefficients for the year 1997 have been used as the weights to combine the wholesale prices of relevant materials. The input-output weights were obtained from the CSO's input-output table for 1997-1998 and the relevant whole sale price index is obtained from the "Index of Wholesale Prices in India with base year as 1994=100", provided by www.circonindia.com.

Appendix II

The latest Input-Output table available for India pertains to the year 1998-99. The input-output table is provided by the Central Statistical Organisation (http://mospi.nic.in). The input-output table consists of two matrices: absorption matrix (***commodity* x *industry***) and makemat (***industry* x *commodity***). For the purpose of our study, we need to create an ***industry* x *industry*** matrix. The procedure for constructing an ***industry* x *industry*** matrix is explained in detail below.

The absorption matrix consists of values of commodities supplied to different industries for final use as well as intermediate inputs. The make matrix represent the values of output produced by different industries. As mentioned above our purpose is to construct an *industry* x *industry* matrix. Therefore as a first step, we need to aggregate the input-

output table for the manufacturing sector to two-digit level. Secondly, a matrix of coefficient (we call it matrix X) has been created by dividing each row of the absorption matrix by the total output of the commodity. We create another matrix Y (using the make matrix) by dividing the each row by the total output produced by the respective industry. As a final step, we create a new matrix Z=YX. The new matrix Z is nothing but an *industry* x *industry* matrix. Each row of the matrix Z represents the total industry output delivered to different industries in the economy.

Industry Classification	IOTT Sector No.
Food Products and Beverages	33-39
Tobacco Products	40
Textiles	41-46
Wearing Apparel; Dressing and Dyeing of Fur	47-49
Tanning and Dressing of Leather; Manufacture of Luggage, Handbags Saddlery, Harness and Footwear	54-55
Wood and of Products of Wood and Cork, Except Furniture; Manufacture of Articles of Straw and Plating Materials	51
Paper and Paper Products	52
Publishing, Printing and Reproduction of Recorded Media	53
Coke, Refined Petroleum Products and Nuclear Fuel	58-59
Chemicals and Chemical, Products	60-68
Rubber and Plastic Products	56-57
Other Non-Metallic Mineral Products	69-71
Basic Metals	72-75
Fabricated Metal Products, Except Machinery and Equipments	76-77
Machinery and Equipment N.E.C.	78,79,80,81,83
Office, Accounting and Computing Machinery	82
Electrical Machinery and Apparatus N.E.C.	84-87,89
Manufacture of Radio, Television and Communication Equipment and Apparatus	88,90
Medical, Precision and Optical Instruments, Watches and Clocks	97
Motor Vehicles Travelers and Semi-Trailers	93-95
Other Transport Equipment	91,92,96
Furniture; Manufacturing N.E.C.	50,98

I-O Sector Classification

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