# Effect of Foreign firms and their Linkages on Domestic Firms in the Indian Manufacturing Industry: Evidence from 1989-2004

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# 1 Introduction

A developing country can move up the technological ladder is by inviting Multi National Enterprises or Enterprises in developed countries that are at the frontiers of their fields to invest in their countries through the foreign direct investment (FDI) channel. Liberal policies on the part of the developing country attract FDI, try to increase exports in areas where the country is on the technological frontier, i.e. they basically try to allocate factors to their most productive use, allow for rapid factor accumulation and wider consumer choice.

Foreign Direct Investment (FDI) has been an area that has invoked interest both among researchers and policy makers. FDI is one of those areas which has benefits both for the host country as well the home country. Home country benefits are from the new markets and low costs of production that firms are able to access and host country benefits are from the better technologies and systems that FDI brings and is an additional source of capital for the host country. FDI manifests itself in various forms, either investing firms buy equity in firms in the host country or they start affiliates in host countries.

Multi National Corporations (MNC's) use the FDI channel to set up affiliates overseas, there is an extensive literature on why MNC's prefer setting up affiliates abroad rather than exporting or licensing their product or technology. The key reasons that come out from literature are the combination of (a) MNC's desire to keep its proprietary knowledge as closed as possible and (b) Fear of market failure in protecting that knowledge. Hence MNC's internalize various processes to protect their brand, technology, and marketing expertise.

India started with an import substitution policy and used industrial

policies to protect and subsidize domestic industries, though these policies helped India to diversify its industrial structure it encouraged inefficiency in its industries. The New Industrial Policy followed by India after 1991 was aimed at increasing efficiency and growth of Indian Industries, it de-bureaucratized and allowed for greater transparency in foreign investment approvals. The Report of Steering Group on FDI of the Planning Commission (2002) recognizes the importance of FDI in developing economies. The report says that FDI flows are usually preferred over other forms of external finance because they are non-debt creating, non-volatile and their returns depend on the performance of the projects financed by the investors. FDI also facilitates international trade and transfer of knowledge, skills and technology, and their complimentary and catalytic role can be very valuable in a world of increasing competition and rapid technological change. The report also notes the crowding-out and crowding-in effects of FDI on domestic industries. The report targets an FDI in flow of US $ 7-8 billion in the first two years of the Tenth Five year plan. FDI in India on the whole has been steadily rising, a trend which can be expected to continue in the future. From the table below it is seen that Manufacturing gets a sizeable share of FDI, hence one can expect more foreign participation in the Manufacturing sector as FDI inflow in India increases.

Naturally the question that comes to one's mind is how beneficial has this new open environment been to the Indian Manufacturing Industry. Have local firms moved up the productivity ladder i.e. has FDI been helpful to productivity of local firms upstream and downstream to foreign firms in Manufacturing. In this particular chapter we try to find out the effects of foreign firms on domestic firms in the period 1989-2004 by looking out for spillovers

Table 1: Total FDI Inflow & FDI Inflow in Manufacturing (FDIM)

| Year | Total FDI Inflow | FDIM |
|---|---|---|
| 1992-93 | 280 | 205 |
| 1993-94 | 403 | 265 |
| 1994-95 | 872 | 519 |
| 1995-96 | 1419 | 702 |
| 1996-97 | 2058 | 1548 |
| 1997-98 | 2956 | 1827 |
| 1998-99 | 2000 | 1184 |
| 1999-00 | 1581 | 892 |
| 2000-01 | 1910 | 1066 |

Source: Report of Steering Group on FDI of the Planning Commission (2002) for FDI Inflow (Total FDI Inflow and FDIM in $ million)

in the Indian Manufacturing Industry. The outline of the paper is as follows, in section two we look at the analytical framework and review the literature, section three discusses the framework of the study while section four discusses the data and measurement of variables. The estimation procedure used for the study can be found in section five and results in section six. Section seven of this paper concludes the study.

# 2 Analytical Framework and Review of Literature

When a MNC sets shop in a developing country, domestic firms can improve their productivity by learning from the MNC. The channel for this learning can either be imitating their technology or hiring workers who have worked for the MNC. For domestic firms competing with the MNC, improving their efficiency and thereby reducing their cost might be a way to stay in the market. These kinds of benefits to domestic firms because of the presence of MNC's are called as spillovers. Spillovers in the literature have been defined as

Spillovers occur /exist where the production functions of producers are affected not only by their market activities, but also by the activities of other economic agents (producers or consumers).[2]

Literature has identified following kinds of spillovers, we first define spillovers with respect to Industry.

1.Intra-Industry Spillovers: Intra-Industry Spillovers occur when the activity of MNC's affect local firms in direct competition to the MNC.

2.Inter-Industry Spillovers: Inter-Industry Spillovers occur when the activity of MNC's affect local firms upstream or downstream to the MNC. Depending on the type, spillovers can be defined as follows:

(a) Productivity Spillovers: Productivity Spillovers are defined as changes in productivity of the domestic firm due to the presence of foreign firms.

[2] Stewart and Ghani (1991).

(b) Technological Spillovers: Technological Spillovers are defined as changes in technology of the domestic firm due to the presence of foreign firms. One should note that technological spillover can lead to productivity spillover but the reverse is generally not possible.

(c) R&D Spillovers: R&D Spillovers can be further classified as Rent Spillovers and Knowledge Spillovers.

i. Rent Spillovers: When new and improved goods are sold, the supplier usually would ask for a higher price; this increase in price may not be proportional to the increase in performance as market structure might constrain the innovator from in creasing price proportionately. Thus the user will enjoy a better `price-quality ratio', the stronger the competition the more the innovator will share the innovation rent with the user in form of low prices.

ii. Knowledge Spillovers: Patent documents, Scientific and Technical literature are the available sources used by innovators to codify their innovation, but these sources have public good characteristics and hence knowledge may spillover to firms in the absence of market transactions.

(d) Wage Spillovers: Foreign firms generally try to recruit the best available talent by offering wages higher than the existing market rate as a result of which domestic firms might have to increase their wages to retain their best talent.

Having defined various kinds of spillovers we now turn our attention to various channels that theory has identified through which these are transmitted.

1.Imitation: This mechanism is generally supposed to be favored for

new products and processes, firms in developing countries are believed to reverse engineer or imitate products and management practices of firms from developed countries. Thus local firms improving their productivity by imitating MNC's is a spillover benefit to the local industry when the MNC sets up a unit in the host country.

2. Skills Acquisition: It is well known that MNC's requirement of skilled labor is a notch or two greater than that of local firms and they invest in training their employees to enhance their productivity. So when such trained and better skilled labor move to local firms they generate productivity improvements in the local firms. The spillover here works through the following two ways (a) Spillover generated by complementary workers who work both in the MNC firm as well as local firms for e.g. if the MNC and the local firms have the same supplier for a key component of their process then the service staff of the supplier can give useful inputs to local firms about the practices in the MNC. (b) Knowledge carried by workers who switch from the MNC to another local firm. Few papers in literature have argued that this is the most important channel for spillovers and there are some empirical papers which support this.

3. Competition: When a MNC enters a new market the probability of it being a monopoly in the new market is very low, hence it will enter a market with few existing local firms. From the local firms perspective the entry of the MNC puts pressure on it to use its existing processes more efficiently, resulting in productivity gains for the local firms. This is true even if the local firm is unable to imitate the processes of the MNC.

4.Exports: When a local firm observes that in addition to serving the local market the MNC is using its capacity to cater the export market then the local firm also tries to enter the export market by creating logistics infrastructure, establishing distribution networks i.e. by trying to learn more about the export market. Thus exports might be a source of productivity gain as the local firm would use it existing capacity and processes more efficiently to cater both to the local and export market.

The MNC has an incentive to prevent any kind of spillover to domestic firms in the same industry since they compete with each other, whereas it would like to help its domestic suppliers in learning as ultimately the MNC would be benefited by any such learning. The channel for spillovers to local suppliers could be through the following ways (a) Transfer of know-how from MNC to the local supplier; (b) Stringent quality and time schedule set by the MNC on delivery of products by the local supplier might induce the local supplier to opt for the best technology; and (c) Economies of scale benefit for local supplier because of the entry of an MNC and hence increase in demand for its products. Domestic firms may benefit from new and improved products that a MNC brings with it when it enters a developing country market. The MNC also has a benefit in keeping its domestic buyers informed about the latest technology or equipments and processes in their industry around the world which is a benefit, local firms might not have access to when they have depend on imports. Thus one would expect spillovers to be more prevalent at the Inter-Industry level than at the Intra-Industry level since the MNC has an incentive in spillovers to local suppliers and buyers. This discussion leads us to find evidence from literature for the occurrence of Inter-Industry and Intra-Industry spillovers; however, a discussion of Inter-Industry spillover studies can only be pursued after one has touched upon various models in literature on linkages fostered by MNC.

## 2.1 Theoretical Models on Linkages

The concept of Forward and Backward Linkages was developed by Hirschman (1958). According to Hirschman (1958) backward linkage effect is a process where the setting up of an industry makes available a new expanding market for its inputs and this is true in both the cases of the initial input supply i.e. from abroad or locally as every non-primary activity according to him will induce attempts to supply the inputs needed in that activity domestically. Forward linkage effect in his words is defined as every activity that does not by its nature cater exclusively to final demands will induce attempts to utilize its outputs as inputs in some industries.

Rodriguez-Clare (1996) develops a two country model to analyze the effects of multinationals through linkages on economic development. He shows that positive benefits of MNC's linkage with upstream industries of the host economy depend on the cost of communication between headquarters and production plant. They also depend on the complexity of the production process i.e. how intermediate input intensive, the product of MNC is; and the level of development in home and host countries i.e. home and host countries should not be very different in the variety of intermediate inputs produced.

Markusen and Venables(1999) develop an analytical framework to find out the effects of an FDI project on local firms in the same industry. Multinationals affect the local firms in two opposing directions; competition in product and factor markets might reduce profits of local firms whereas linkage effects of multinationals to supplier industries might reduce input costs and there by increase profits of local firms. They show that MNC's can act as catalyst for local industrial development and the local industry can become strong enough to reduce the relative and absolute position of the MNC with time. Glass et al (2002) have very neatly summarized the theoretical and empirical literature on linkages caused by MNC's; Rodriguez-Clare (1996) (RC),

Markusen and Venables(1999) (MV) and, Matouschek and Venables(1999) (MaV) are the three theoretical models which have been covered.

Explaining each theoretical model, they set out conditions under which there can be positive linkage effect and conditions under which there can be negative linkage effect. We here highlight[3] their points on negative linkage effect. In the RC model, they explain a scenario where an MNC can have a negative linkage effect on another industry if it draws labor from that industry. In the MV model they consider two special cases where one finds negative linkage effects due to MNC's, in the first case if the MNC does not source any intermediate locally then the linkage effect will reduce the number of domestic firms both upstream and downstream which reinforces the competition effect (multinational replacing local firms in the same industry). In the second case if the intermediates are not perfect substitutes then the number of upstream firms to the MNC's may rise because of enhanced variety of intermediates which might induce entry of downstream firms and the MNC might displace the domestic downstream firms and the number of downstream domestic firms may fall. In the MaV model the overall effect is broken down into two parts: an initial production effect and a feedback effect, the initial production effect is the immediate change in local production i.e. change in the output levels of domestic firms in an industry as well as that in upstream industries due to the entry of an MNC and we know that this initial production effect can be negative on upstream firms if the MNC crowds out all local firms in that industry and imports all its inputs. The initial production effect on downstream industries can also be negative if the MNC sells all its output locally while local firms export some of their output and the MNC displaces no imports.
Kugler (2006) sets up a stochastic multi-sectoral dynamic general equilibrium model in which firm level FDI can generate spillovers both within and across sectors. He then empirically tests his model with Colombian manufacturing data and finds that MNC activities are substitutes for domestic manufacturing within their sector, but they can complement manufacturing in other sectors. He notes that without local outsourcing by MNCs, widespread FDI spillovers would not materialize. He finds evidence which points to a crowding out effect of MNC's on domestic competitors and in many cases inter-sectoral complementarity via backward linkages but not via forward linkages. Kugler also finds that when MNC's import some intermediate inputs, crowding out of local upstream suppliers occurs.

## 2.2 Inter-Industry, Intra-Industry Spillover Studies

Foreign firms have incentive to prevent technology diffusion to their competitors in the same industry but have no incentive in preventing technology diffusion to upstream and downstream firms whose improved performance might ultimately benefit foreign firms.

[3] For exact details, please refer the original paper by Glass et al (2002).

Thus we can expect more empirical support for Inter-Industry spillover than Intra-Industry spillover.

Bernstein (1988) estimates the effects of Intra and Inter-Industry R&D investment spillovers on the cost and structure of production. The study finds that Intra and Inter-Industry spillovers decrease unit costs of production. Los (1997) examines the possibility of a new measure of Inter-Industry knowledge spillover. The paper argues that existing measures are not very flexible when one has many industries and time periods to consider, the new measure uses Input-Output tables to measure knowledge spillovers. Hence in this study we use Input-Output tables to probe the existence of spillovers; following studies like Smarzynska (2004 a) and Blalock and Gertler (2004).

Hanel (2000) shows econometric evidence on the relationship between total factor productivity growth and the R&D expenditures of Canadian manufacturing industries in the presence of inter-industry and international spillovers of technology. The study assumes that the principal channel of transmission of new technology is foreign direct investment. Industry's own R&D expenditures have a positive relationship with Total Factor Productivity (TFP), domestic inter-industry spillovers of new technology have a larger effect on TFP than industry's own R&D expenditures, and international spillovers contribute to TFP growth less than domestic inter-industry spillovers and less than Industry's own R&D.

Lopez (2002) estimates total factor productivity for Mexican manufacturing firms at the plant level and studies its evolution in the face of trade and investment liberalization under the North American Free Trade Agreement. The study then distinguishes and empirically captures Intra and Inter-Industry spillovers and finds that Intra-Industry spillovers are negative but Inter-Industry spillovers are positive.

Driffield et al (2002) examine whether linkages between foreign and domestic firms affect productivity growth in domestic manufacturing industries in United Kingdom. The study works with three digit industry data, it distinguishes between backward linkage (industries from which foreign firms purchase) and forward linkage (industries to which foreign firms sell) at the Inter and Intra industry level. At the Intra-Industry level the study finds two opposing spillover effects (forward having positive and backward having negative sign) which tend to cancel and finds positive Inter-Industry spillover effects on local firms which buy from foreign firms. This implies that local firms which supply to foreign firms in the same industry might have to meet stringent conditions set by the foreign firm which lead to poorer domestic industry performances and local firms which bought from foreign firms in the same industry benefited from better products of foreign firms. They also state in the paper that whenever a domestic firm sells to /buys from a foreign firm in the same industry the degree of externality may be mediated because firms have better knowledge of one another and the potential for opportunistic behavior is limited in both parties to the transaction. This also could be one of the reasons why many Intra-Industry spillover studies; which do not take this forward and backward aspect into consideration; have reported no evidence for the existence of such spillovers.

Smarzynska (2004 a) looks for spillovers through backward linkages in Lithuania and finds positive spillover effects for local firms which act as suppliers to foreign firms. The study also finds that these spillovers are associated with projects where ownership is shared among domestic and foreign partners but not with fully owned foreign investments, which suggests that a larger extent of local sourcing is undertaken when ownership is shared. Blalock and Gertler (2004) analyze the welfare gains from foreign direct in vestment through technology transfer to local suppliers. They find evidence for productivity gains, greater competition, and lower prices amongst local firms upstream from foreign entrants. Technology transfer adds value and output increases for firms in both the supplier and buyer sectors and it also generates an externality that benefits buyers in other sectors downstream from the supply sector as well.

Smarzynska et al (2004 b) examine whether the nationality of foreign investors affect the degree of vertical spillovers from FDI in Romania. They find a positive effect between the presence of American and Asian companies in downstream sectors and the productivity of Romanian firms in the supplying industries. Presence of European firms/investors in downstream sectors has a negative effect on the productivity of Romanian firms in the supplying industries. Smarzynska and Spatareanu (2003) examine whether the degree of spillovers from foreign direct investment is affected by the foreign ownership share in investment projects in Romania, this is because from theory we know that MNC's would like to protect their proprietary knowledge or expertise. Thus the interesting question is do joint ventures with local partners have more occurrences of spillovers than fully owned foreign ventures, more particularly in an Intra-Industry set up. This study looks at both Intra as well as Inter-Industry Spillovers. The study produces evidence for positive intra-sectoral spillovers resulting from fully-owned foreign affiliates but not from projects with joint domestic and foreign ownership. The study suggests that domestic suppliers benefit from contacts with multinational customers, but, fully-owned foreign affiliates appear to have a negative effect on domestic firms in upstream industries.
Blomstrom and Sjoholm (1999) examine the effects of technology transfer and spillovers deriving from ownership sharing of foreign multinational affiliates. They find that local participation with foreign firms does not facilitate technology diffusion in the host country and find support for positive spillover effects. Takii(2005) looks at spillovers and characteristics of foreign multinational plants in Indonesian Manufacturing by regressing the production function using suitable variables to capture the spillover effects. The study finds positive spillover effects and greater presence of fully owned foreign firms reduces the magnitude of spillovers. Technological levels need to be high enough in local firms for more spillovers to take place from foreign-owned plants.

Gorg & Greenaway (2004) review possible sources of spillovers and empirical evidence for their existence in developing, developed and transitional economies. They say that although theory can identify a range of possible spillover channels, empirical support is hard to find. They note that there is an extensive empirical literature aimed at identifying intra-industry spillovers with econometric work on all three kind of economies, they find that evidence on productivity spillovers is weak across all economies with only few studies finding positive evidence, one of the reasons for this could be the canceling effect at the Intra-Industry level as found by Driffield et al (2002). They have also reviewed few studies on inter-industry spillovers. The following

table summarizes the papers on Intra-Industry Spillovers[4].

## 2.3 Studies on Indian Industry

Following are the studies we are aware of that have looked into Spillovers in the Indian Manufacturing Industry.

Basant & Fikkert (1993) studied the impact of R&D, Foreign Technology purchase and, Technological spillovers on the productivity of Indian Industry. They used panel data for Indian Manufacturing firms from 1974-75 to 198283and, international R&D and patent data for 9 countries, considering only disembodied technology purchased from foreign countries through licenses in

[4] The table is not exhaustive for a thorough summary please refer Gorg & Greenaway(2004).

Table 2: Papers on Intra-Industry Spillovers

| Author | Country | Data | Result |
|---|---|---|---|
| Blomstrom and Persson(1983) | Mexico | C-S | P |
| Blomstrom(1986) | Mexico | C-S | P |
| Blomstrom and Wolfi(1994) | Mexico | C-S | P |
| Kokko(1994) | Mexico | C-S | P |
| Kokko(1996) | Mexico | C-S | P |
| Haddad and Harrison(1993) | Morocco | Pa | M |
| Kokko et al(1996) | Uruguay | C-S | M |
| Blomstrom and Sjoholm(1999) | Indonesia | C-S | P |
| Sjholm (1999a) | Indonesia | C-S | P |
| Sjholm (1999b) | Indonesia | C-S | P |
| Chuang and Lin (1999) | Taiwan | C-S | P |
| Aitken and Harrison (1999) | Venezuela | Pa | N |
| Kathuria (2000) | India | Pa | M |
| Kokko et al (2001) | Uruguay | C-S | M |
| Kugler (2001) | Colombia | Pa | M |
| Caves (1974) | Australia | C-S | P |
| Globerman (1979) | Canada | C-S | P |
| Liu et al. (2000) | UK | Pa | P |
| Driffield (2001) | UK | C-S | P |
| Girma et al. (2001) | UK | Pa | M |
| Girma and Wakelin (2001) | UK | Pa | M |
| Girma and Wakelin (2002) | UK | Pa | M |
| Harris and Robinson (2004) | UK | Pa | M |
| Haskel et al (2002) | UK | Pa | P |
| Barry et al. (2001) | Ireland | Pa | N |
| Barrios and Strobl (2001) | Spain | Pa | M |
| Dimelis and Louri (2001) | Greece | C-S | P |
| Djankov and Hoekman (2000) | Czech Republic | Pa | N |
| Kinoshita (2001) | Czech Republic | Pa | M |
| Bosco (2001) | Hungary | Pa | M |
| Konings (2001) | Bulgaria , Poland, Romania | Pa | N, M, N |
| Damijan et al (2001) | Bulgaria, Czech, Estonia, Hungary, Romania, Slovakia | Pa | M or N, P only for Romania |
| Li et al(2001) | China | C-S | P |
| Zukowska-Gagelmann (2000) | Poland | Pa | N |

Source: Table 2 Gorg and Greenaway (2004)

where P is Positive, N is Negative , M is Mixed, C-S is Cross-sectional and Pa is Panel

the form of expenditure on foreign technical licenses (lump sum payments, technical fees, royalties etc). Perpetual inventory method was used to construct the knowledge stocks generated from technology purchase and R&D. They showed that there existed high private rates of return to both R&D and technology purchase. They also showed that for the Indian case R&D and technology purchases are substitutes for one another, international and domestic R&D spillovers increase productivity.

Kathuria (1998) uses the efficiency frontier technique and panel data to find out how Indian firms have benefited indirectly from technology transfer through FDI or Licensing. On comparison of behavior of local and foreign firms, he finds that on an average foreign firms have a larger number of skilled employees, larger stock of R& D, a higher capital goods import intensity and are closer to the most efficient frontier. He finds that domestic firms seem to have gained more from demonstration and competition rather than from technology diffusion.

Kathuria (2000) tests a spillover hypothesis for large sized firms that `Presence of foreign-owned firms and foreign technical capital stock in a sector leads to reduced dispersion in efficiency in the sector and fall in dispersion is higher for the firms that invest in R& D'. The study's result suggest that for half of the sectors studied foreign firms were at the frontier in their industry and in these sectors there exist negative spillovers though available foreign technical capital stock has a positive impact on local firms. The study also bifurcates the sample into scientific and non-scientific sub groups and finds that for the scientific sub group spillover gains for local firms depends on their investment in learning or R& D activities to understand the spilled knowledge. Spillover for non-scientific group's local firms was found to be weak. Contemporaneous spillover variables are used in this study.

Kathuria (2001) has studied knowledge spillovers to Indian Manufacturing firms from Foreign firms and Technology transfer by testing the hypothesis that `presence of foreign-owned firms and disembodied technology import in the sector leads to higher productivity growth for the domestically owned firms' using a Stochastic Frontier Analysis. He uses panel data for 368 medium and large sized firms for the period 1975-76 to 1988-89, he has looked into this hypothesis using spillover variables with a lag of an year. The study confirms the complementarity of knowledge spillovers and R&D only for those non-FDI firms in the scientific group; the study also finds negative spillovers from disembodied technology import for non-FDI firms in the non-scientific group, possible reason for which has given as the regulated policy regime that discouraged firms to import both embodied and disembodied technology to gain benefits from presence of foreign firms.

Kathuria (2002) looks for productivity spillovers i.e. whether liberalization has improved productivity of local firms and if spillovers from technology transfers have increased in the post-liberalization period. He concludes that in the pre-1991 only those firms in the scientific group which had a threshold level of R&D spending could experience knowledge spillovers whereas the presence of foreign firms had a positive impact on the productive efficiency of local firms in the non-scientific group. For the post-1991 period the study finds spillover evidence for local firms in both groups and the spillover absorption potential is magnified in firms which complement the benefits with their own R&D.

Pradhan(2002) analyses the Indian Pharmaceutical Industry for spillovers and productivity growth. He finds limited evidence for spillover and concludes that there have not been significant host country benefits from the presence of foreign firms in the Indian Pharmaceutical Industry. Frontier production function is used to estimate firm-specific productive efficiency growth.

Raut (1995) did a study for Indian firms on R&D spillovers and productivity growth. He used panel data for a sample of private manufacturing firms for the period 1975 - 1986 and estimated an extended production function that includes the firm's own R & D capital stock and the spillover effect of the industry-wide R & D capital stock as inputs, as well as physical capital and labor hours. He does get positive evidence between R&D spillovers and productivity growth.

Productivity differences is one of the sources for spillovers since the less productive firm (which generally is expected to be a domestic firm than a MNC) will use one of the

earlier discussed channels to improve its productivity levels and match or even surpass that of the leader firm (generally the MNC). Thus productivity differences between foreign firms and domestic firms are important in the context of our study as they might hint about the sign of possible spillover effects. There are many such studies internationally for e.g. Takii(2004), Doms et al (1998), few studies on Indian Industry which capture this phenomenon are mentioned below.

Anita Kumari (2001) examines Productivity Growth in Indian Engineering Industries during Pre-Reform and Post-Reform Period, and finds that productivity growth is lower in the post-reform period compared with that in pre-reform period. The study finds that domestic companies had a higher productivity growth compared to foreign owned companies in both the periods.

Banga (2003) studies the direct and indirect effect of FDI on productivity growth on Indian Manufacturing, the study also empirically compares the spillover effects of Japanese and U.S. FDI on the total factor productivity growth both at the industry and firm level. The results show that if markets expand at a slow pace there is an overall decline in productivity growth and that spillover from FDI may also depend on the home country of FDI. Goldar et al (2003) study the effect of ownership on efficiency of engineering firms in India in the 1990's, Stochastic Frontier Production function is used to estimate technical efficiency. Foreign Ownership firms, Local firms and Public Sector firms are compared, their results indicate that foreign firms in Indian engineering industry have higher technical efficiency than domestically owned firms. They find no significant difference in technical efficiency between private sector and public sector firms, they also find that domestically owned firms tend to catch up with foreign owned firms in terms of technical efficiency.

Patibandla and Sanyal (2002) analyze the direct and indirect productivity effects at firm level generated by foreign investment in the post-reform period of selected manufacturing sectors. They find that foreign investment does not directly increase firm-level productivity, and that R&D spending is more productive in firms or sectors with higher foreign investment. Local firms are benefited from foreign investment in their industries and these benefits are greater for larger firms and those that do more business domestically.

Though we have various studies on spillover in the Indian Manufacturing Industry there is no study we are aware of which looks at the spillover effects of the linkages created by MNC's. This study attempts to fill that lacuna by trying to find if foreign firms have had productivity enhancing or productivity hampering effect on local firms upstream or downstream to foreign rms. However, in this study we do not differentiate between a fully owned foreign firm and a joint venture between a local partner and a foreign firm, we consider both kinds of firms as a foreign firm in our study.

# 3 Framework of the Study

A general Cobb-Douglas Production Function can be written as

$$Y = e^{A}K^{\alpha}L^{\beta}RM^{\gamma} \quad (1)$$

where Y is the Real Output, $e^{A}$ is the Productivity Level , K is Capital, L is Labor and RM is Raw Materials.

The above equation in log form becomes

$$\log Y = A + \alpha \log K + \beta \log L + \gamma \log RM \quad (2)$$

Our aim in this study is to find the effect of linkages of local firms with foreign firms on the productivity level of local firms. From literature we know that the productivity level of any firm is affected by Firm Age, Technology, Exports, Imports and Foreign Presence. Factors which have been considered in this study are explained below:

Age : Age of the firm is a good proxy for the learning curve and it is well known that the learning curve includes the skill set of the firm, the procedures and equipments the firm has as a result of its production experience and thus the learning curve is a source of productivity gains. Old firms and not so new firms can be expected to have production experience which will benefit their efficiency positively whereas the same cannot be said about new firms. Age of the plant and machinery and the nature of the industry are the most important predictors of learning curve. For instance product and process industries exhibit different kinds of learning curve with process industries having steeper learning curves than process industries. Newer firms are more likely to adopt new technologies than old and not so new firms due to lumpiness of capital. Thus we have two effects one which increases efficiency of young firms and other which increases efficiency of old and not so new firms, thus apriori we cannot predict the sign of this variable.

Royalty : Royalty or Technical Know-how charges paid by the firm has been used here as a proxy for the kind of technology the firm uses in its production process. Better technologies will always be charged higher and for a firm paying higher royalty charges it signals the firm's willingness for improvement hence its productivity should higher. We know that technology could be important for accounting that part of output which cannot be completely explained by the growth in inputs like labor, capital and raw materials. The technology efforts of a firm are generally empirically measured by Royalty charges and R&D expenditure.

R& D: R& D expenditure of a firm generally signals the firm's in-house technology content and its willingness to be on the frontier both on the process front (Process

R&D) as well as the product front (Product R&D). For reasons cited earlier it is well known that firms in developed countries do not license frontier technologies to firms in developing countries, hence firms in developing countries invest in R&D to reach the frontier technology.

Exports: As described earlier a firm's ability to export gives one a good idea of a firm's competitiveness because when a firm caters to the export market then the firm has to face competition from a range of foreign firms, this competition would be beneficial to the firm in increasing its productivity. When the firm caters to a larger market it can reduce its production costs and increase its productivity through economies of scale.

Imports of Capital Goods: Another means of productivity improvement is import of capital goods, we know that firms in developed countries have better technologies which also implies they have better factors for production of goods. When a firm from a developing country decides to import capital goods, it increases its interaction with firms in developed countries, discussions with advanced firms helps the domestic firm learn and improve its processes. The result of the whole process also gives the firm better machines which also help the firm increase it productivity.

Foreign Presence: Presence of foreign firms will affect domestic firms either by increasing their productivity or by displacing them from the market. Foreign Presence with respect to a domestic firm can be classified as the following: Horizontal Presence, Downstream Presence, and Upstream Presence.

Following Smarzynska(2004) we also add a demand variable and an industry concentration variable, this is because in this study we are interested in the effect of Foreign Presence especially the knowledge transfer effect on productivity of local firms. Entry of an MNC increases competition in the product market which forces domestic firms to improve it efficiency; to separate this effect from the knowledge transfer effect we add the Herfindahl Index to proxy for market concentration. Also entry of an MNC in downstream sectors may increase demand for intermediate firms as a result of which local suppliers may scale up their operations. To separate this effect we include a demand variable which is calculated using the Input-Output table and is defined later.

Thus we estimate the following equation

$$\log Y_{ijt} = \alpha_1 + \beta_1 Age_{ijt} + \beta_2 Roy_{ijt} + \beta_3 RD_{ijt} + \beta_4 Ex_{ijt} + \beta_5 Imcap_{ijt} + \beta_6 Hori_{jt} + \beta_7 Bac_{jt} + \beta_8 For_{jt} + \beta_9 Dem_{jt} + \beta_{10} HHI_{jt} + \alpha \log K_{ijt} + \beta \log L_{ijt} + \gamma \log RM_{ijt} + \varepsilon_{ijt}$$

where, i:firm, j: Industry, t: Time, $\alpha_1$ is the intercept.

Age : Age of the firm, and is given by the difference between the year of observation and incorporation year of the firm.

Roy : Royalty or Technical Know-how charges paid by the firm divided by the Sales of the firm.

RD: Total R&D Expenditure of the firm divided by the Sales of the firm.

Ex: Exports by Sales of Firm

Imcap: Import of Capital Goods by Sales of Firm

Hori: Horizontal Spillover Variable, this variable is supposed to capture the horizontal presence of foreign firms and is defined in the following way

$$Hori_{jt} = [\sum_{f}^{n} Y_{ft}] / [\sum_{i}^{n} Y_{it}] \quad (3)$$

fεF , Fεj & iεj .
where F is the set of all Foreign firms in that Industry, Y is Sales of that firm.

Bac: Backward Spillover Variable, this variable tries to capture the backward or downstream presence of foreign firms and is given by

$$Bac_{jt} = \sum_{k=1;k\neq j}^{m} \alpha_{jk} Hori_{kt} \quad (4)$$

where $Hori_{kt}$ is the Horizontal spillover variable for the $k^{th}$ Industry and m is the number of Industries in the study. $\alpha_{jk}$ is the proportion of sector j output supplied to sector k taken from Input-Output Tables at the two-digit NIC level.

For: Forward Spillover Variable, this variable is meant to capture the forward or upstream presence of foreign firms and is given by

$$For_{jt} = \sum_{k=1;k\neq j}^{m} \sigma_{jk} [[\sum_{f=1}^{n} (Y_{ft} - Ex_{ft})] / [\sum_{i=1}^{n} (Y_{it} - Ex_{it})]] \quad (5)$$

where $\sigma_{jk}$ is the share of inputs purchased by industry j from industry k in total inputs sourced by sector j , m is the number of Industries, Ex is the exports of firm, Y is the sales of the firm, fεF , F εj & iεj .

Dem: Demand Variable

Demand Variable is added in order to control for increased demand for intermediate products, Demand is calculated as follows

$$Dem_{jt} = \sum_{k=1}^{m} \alpha_{jk} Y_{kt} \quad (6)$$

where m is the number of Industries, $\alpha_{jk}$ is the proportion of sector j output supplied to sector k taken from Input-Output Tables at the two-digit NIC level, and Y is the total sales of that Industry.

HHI: Herfi ndahl Index

Herfindahl Index controls for variations in Industry Concentration. The index is defined as the sum of the squared market shares of all the firms in a given industry.

L: Labour

K: Capital

RM: Raw Material

# 4 Data and Measurement of Variables

The primary source of data for the empirical exercises of this study is the PROWESS database of the Centre for Monitoring the Indian Economy (CMIE). This database contains information on about 9,000 companies, which includes companies that are public, private, cooperative, joint stock, listed or otherwise. This wide coverage encompasses almost 70 per cent of the economic activity of the organized sector, both manufacturing and non-manufacturing (our focus remains essentially on the manufacturing sector of the Indian industry). CMIE's methodological framework for data standardization, via formal validation and quality control, render inter-year, inter-industry and inter-company data comparable. The variables used in the equations of the models below have been constructed from data taken from the PROWESS database. Data from 1989-2004 for the following NIC-two digit industries have been used for the study.

National Industrial (Activity) Classification namely NIC plays a very vital role in maintaining standards of data collection, processing and presentation besides its wide range of applications in policy formulation and policy analysis. This classification is used in all types of censuses and sample surveys conducted in India. The Central Statistical Organization (CSO) in the Ministry of Statistics and Programme Implementation is the nodal authority for bringing out the National Industrial Classification in India. The first classification was NIC-62 followed by NIC-70, NIC-87 and NIC-98. Here we use NIC-98 classification for our study. A firm is defined as foreign firm if foreign equity in that firm is greater than 10%. Sales is used to proxy Real Output of Firm and hence for calculation of Horizontal, Backward, & Forward Spillover variable, Sales is used. Demand Variable is also found using Sales. Sales is deflated industry wise using the particular industry's WPI (at 1993-94 prices).

Table 3: NIC Industries used in the Study

| | | |
|---|---|---|
| NIC 15 | Manufacture | of food products and beverages (**FPB Ind**) |
| NIC 17 | Manufacture | of textiles (**Tex Ind**) |
| NIC 18 | Manufacture | of wearing apparel; dressing and dyeing of fur (**WA Ind**) |
| NIC 21 | Manufacture | of paper and paper products (**PP Ind**) |
| NIC 24 | Manufacture | of chemicals and chemical products (**Chem Ind**) |
| NIC 25 | Manufacture | of rubber and plastics products (**RP Ind**) |
| NIC 26 | Manufacture | of other non-metallic mineral products (**NMMP Ind**) |
| NIC 27 | Manufacture | of basic metals (**BM Ind**) |
| NIC 28 | Manufacture | of fabricated metal products, except machinery and equipment (**FM Ind**) |
| NIC 29 | Manufacture | of machinery and equipment n.e.c. (**Mac Ind**) |
| NIC 31 | Manufacture | of electrical machinery and apparatus n.e.c. (**EMac Ind**) |
| NIC 32 | Manufacture | of radio, television and communication equipment and apparatus (**Tel Ind**) |
| NIC 33 | Manufacture | of medical, precision and optical instruments, watches and clocks (**Opt Ind**) |
| NIC 34 | Manufacture | of motor vehicles, trailers and semi-trailers (**Mot Ind**) |
| NIC 35 | Manufacture | of other transport equipment (**Trans Ind**) |

Source:Central Statistical Organization, Ministry of Statistics and Programme Implementation, New Delhi.

Input-Output Transactions Table is published by the Central Statistical Organization, Ministry of Statistics and Programme Implementation. The first Input-Output Transactions Table (IOTT), consistent with the National Accounts Statistics (NAS) related to the year 1968-69, was published for the first time by the Central Statistical Organization (CSO) in 1978. Subsequent to its completion, the CSO then continued the work relating to the preparation of IOTT on a regular basis and publishes them once in every five years.

CSO has published IOTT for the following years 1973-74, 1978-79, 1983-84, 1989-90, 1993-94 and 1998-99. In this study 1993-94 and 1998-99 Input Output Transaction Tables(IO) are used to find out the corresponding $\alpha$'s; $\sigma$'s. The IO table's have been aggregated to the two digit NIC level from their original 115 X 115 level. 1993-94 IO table is used for all calculations till 1995 and for the remaining years it is assumed that 1998-99 IO table is the appropriate table.

Capital is measured using Perpetual Inventory Method, following Goldar et al(2003), Capital Work in Progress is deducted from Gross Fixed Assets to give us Historic Capital Stock which is then multiplied by 3,2, 1.5 and 1 if year of incorporation of firm is $\leq 1965$; $> 1965 \& < 1980$; $\geq 1980 \& < 1989$; $\geq 1989$ respectively to give us a base year capital stock. The base capital stock generated thus is added with annual deflated gross investments (using WPI (1993-94 prices) for Machinery and Machine Tools) to give our Capital Stock Series. Investment by firms is given by the change in Gross fixed Asset less Capital Work in Progress for two consecutive years. Since we use an unbalanced panel for our study, the base year for capital stock for each firm is calculated for the first year the firm has data for.

Labor is the number of employees obtained by dividing the Salaries and Wages of a firm for a given year by the Average Emolument per Employee for that year and for that industry. Average Emolument per Employee is found from Annual Survey of Industries data on Total Emoluments and Total Number of Employees for each Two digit Industry used in the study. Raw Materials data is deflated industry wise using the particular industry's WPI (at 1993-94 prices). R& D expenditure is of two types (a)R&D Expenditure on Capital Account and (b)R&D Expenditure on Current Account.

R&D Expenditure on Capital Account is defined as the expenditure incurred on R&D by the firm for future i.e. if the firm discovers something during a particular year but it would be using that discovery for the future years to come. R&D Expenditure on Current Account is defined as the expenditure incurred on R&D pertaining to that year by the firm. Thus with these we can empirically separate a firm's effort to be on the frontier in contemporary as well as future technologies. The sum of these two is taken as the total R& D expenditure of a company in the regressions.

## 4.1 Summary Statistics

Following tables give us an idea on the summary statistics of the sample used in the regressions.

Table 4: Number of Firms in Each Industry in the Sample

| NIC Code | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 32 | 34 | 41 | 55 | 78 | 136 | 185 | 214 | 191 | 193 | 233 | 238 | 247 | 233 | 215 | 135 |
| 17 | 24 | 35 | 53 | 61 | 94 | 157 | 227 | 237 | 235 | 238 | 233 | 226 | 223 | 216 | 208 | 137 |
| 18 | 0 | 1 | 1 | 2 | 2 | 5 | 11 | 19 | 29 | 33 | 28 | 36 | 33 | 36 | 34 | 18 |
| 21 | 11 | 13 | 23 | 25 | 29 | 39 | 57 | 58 | 64 | 61 | 58 | 62 | 67 | 59 | 58 | 45 |
| 24 | 77 | 93 | 124 | 149 | 196 | 299 | 428 | 438 | 437 | 437 | 456 | 466 | 425 | 422 | 419 | 332 |
| 25 | 22 | 22 | 27 | 35 | 46 | 81 | 127 | 151 | 144 | 132 | 141 | 142 | 129 | 120 | 117 | 93 |
| 26 | 36 | 39 | 56 | 63 | 64 | 91 | 98 | 92 | 89 | 78 | 91 | 84 | 90 | 88 | 77 | 59 |
| 27 | 20 | 27 | 45 | 54 | 77 | 110 | 152 | 155 | 136 | 137 | 173 | 199 | 191 | 193 | 168 | 98 |
| 28 | 9 | 9 | 12 | 16 | 20 | 30 | 42 | 46 | 47 | 48 | 60 | 62 | 60 | 69 | 62 | 40 |
| 29 | 47 | 56 | 70 | 90 | 99 | 123 | 149 | 158 | 158 | 148 | 149 | 159 | 149 | 158 | 147 | 99 |
| 31 | 22 | 26 | 31 | 35 | 37 | 61 | 80 | 84 | 80 | 67 | 67 | 72 | 76 | 79 | 76 | 53 |
| 32 | 11 | 21 | 25 | 24 | 34 | 48 | 48 | 54 | 60 | 58 | 67 | 66 | 69 | 63 | 59 | 43 |
| 33 | 1 | 2 | 10 | 10 | 14 | 19 | 26 | 29 | 27 | 29 | 28 | 30 | 29 | 29 | 35 | 22 |
| 34 | 22 | 26 | 37 | 44 | 58 | 68 | 80 | 85 | 85 | 91 | 97 | 132 | 132 | 134 | 126 | 85 |
| 35 | 17 | 16 | 21 | 19 | 23 | 27 | 32 | 36 | 35 | 30 | 30 | 31 | 26 | 27 | 19 | 14 |

We find from the tables on summary statistics of variables used in the regressions of All firms and of Foreign firms that almost 9 percent of the observations are from foreign firms. From tables on year-wise total number

Table 5: Number of Foreign Firms in Each Industry in the Sample

| NIC Code | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 5 | 4 | 7 | 8 | 11 | 11 | 19 | 19 | 17 | 18 | 18 | 25 | 22 | 18 | 15 | 11 |
| 17 | 1 | 1 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 2 | 4 | 4 | 5 | 6 | 3 |
| 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 1 |
| 21 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 2 |
| 24 | 13 | 14 | 14 | 14 | 23 | 32 | 39 | 38 | 35 | 42 | 47 | 48 | 53 | 49 | 44 | 34 |
| 25 | 3 | 1 | 1 | 1 | 2 | 4 | 6 | 7 | 8 | 7 | 8 | 9 | 8 | 8 | 8 | 4 |
| 26 | 1 | 1 | 4 | 6 | 5 | 6 | 6 | 5 | 6 | 5 | 5 | 5 | 7 | 8 | 8 | 6 |
| 27 | 1 | 4 | 3 | 4 | 4 | 2 | 7 | 7 | 7 | 6 | 7 | 6 | 3 | 5 | 6 | 5 |
| 28 | 3 | 3 | 2 | 3 | 3 | 3 | 4 | 3 | 4 | 5 | 5 | 6 | 5 | 5 | 6 | 4 |
| 29 | 10 | 11 | 16 | 22 | 24 | 26 | 32 | 34 | 33 | 31 | 30 | 32 | 32 | 32 | 33 | 25 |
| 31 | 5 | 6 | 7 | 8 | 8 | 10 | 9 | 8 | 8 | 10 | 11 | 11 | 10 | 10 | 8 | 7 |
| 32 | 0 | 1 | 3 | 3 | 4 | 3 | 3 | 4 | 5 | 8 | 9 | 9 | 9 | 9 | 8 | 7 |
| 33 | 0 | 1 | 2 | 2 | 3 | 5 | 5 | 5 | 4 | 3 | 4 | 5 | 6 | 6 | 6 | 5 |
| 34 | 3 | 3 | 4 | 4 | 4 | 5 | 5 | 4 | 5 | 7 | 8 | 14 | 13 | 11 | 10 | 8 |
| 35 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Table 6: Summary Statistics of Variables used in All firms Regressions

| Variable | Obs | Mean | Std.Dev | Min | Max |
|---|---|---|---|---|---|
| logsa | 22270 | 3.18 | 1.58 | 0 | 9.53 |
| age | 22270 | 22.68 | 18.95 | 0 | 169 |
| roy | 22270 | 0 | 0.02 | 0 | 2.62 |
| rd | 22270 | 0 | 0.08 | 0 | 7.06 |
| ex | 22270 | 0.1 | 0.25 | 0 | 18.53 |
| imcap | 22270 | 0.41 | 33.6 | 0 | 4229.63 |
| hori | 22270 | 0.14 | 0.1 | 0 | 0.39 |
| bac | 22270 | 0.06 | 0.09 | 0 | 0.38 |
| for | 22270 | 0.02 | 0.02 | 0 | 0.07 |
| dem | 22270 | 11127.38 | 12236.88 | 8.44 | 35208.09 |
| hhi | 22270 | 436.29 | 353.63 | 93.1 | 3773.99 |
| logL | 22270 | 5.81 | 1.9 | 0 | 12.75 |
| logK | 22270 | 3.21 | 1.59 | 0.11 | 10.59 |
| logRM | 22270 | 2.74 | 1.4 | 0 | 8.64 |
| salwag | 22270 | 7.92 | 48.99 | 0 | 2233.88 |

where logsa is log of Sales and salwag is Salaries and Wages.

of firms and foreign firms in each industry in the sample we find that Mac Ind has on an average the largest foreign presence which is 21.75 percent for whole sample period. FPB Ind, EMac Ind, Tel Ind and Opt Ind are the other sectors where foreign presence on an average for the sample period has been greater than 10 percent. The least foreign presence is found in WA Ind which on an average is 1.33 percent for the whole sample period.

Table 7: Summary Statistics of Variables from Foreign firms

| Variable | Obs | Mean | Std.Dev | Min | Max |
|---|---|---|---|---|---|
| logsa | 1989 | 3.84 | 1.61 | 0.01 | 8.83 |
| age | 1989 | 26.56 | 19.71 | 0 | 103 |
| roy | 1989 | 0.01 | 0.04 | 0 | 0.9 |
| rd | 1989 | 0 | 0.03 | 0 | 1.44 |
| ex | 1989 | 0.09 | 0.17 | 0 | 1 |
| imcap | 1989 | 1.36 | 59.3 | 0 | 2644.75 |
| hori | 1989 | 0.18 | 0.08 | 0 | 0.39 |
| bac | 1989 | 0.05 | 0.07 | 0 | 0.38 |
| for | 1989 | 0.02 | 0.01 | 0 | 0.07 |
| dem | 1989 | 10519.41 | 12057.39 | 23.6 | 35208.09 |
| hhi | 1989 | 459.01 | 334.86 | 93.1 | 2202.22 |
| logL | 1989 | 6.7 | 1.82 | 0 | 11.19 |
| logK | 1989 | 3.36 | 1.6 | 0.11 | 8.74 |
| logRM | 1989 | 3.25 | 1.51 | 0.54 | 8.32 |
| salwag | 1989 | 12.08 | 28.3 | 0 | 354.88 |

Table 8: Summary Statistics of Variables used in Domestic Firms Regressions

| Variable | Obs | Mean | Std.Dev | Min | Max |
|---|---|---|---|---|---|
| logsa | 20281 | 3.12 | 1.56 | 0 | 9.53 |
| age | 20281 | 22.3 | 18.83 | 0 | 169 |
| roy | 20281 | 0 | 0.02 | 0 | 2.62 |
| rd | 20281 | 0 | 0.08 | 0 | 7.06 |
| ex | 20281 | 0.1 | 0.26 | 0 | 18.53 |
| imcap | 20281 | 0.31 | 29.92 | 0 | 4229.63 |
| hori | 20281 | 0.14 | 0.1 | 0 | 0.39 |
| bac | 20281 | 0.06 | 0.09 | 0 | 0.38 |
| for | 20281 | 0.02 | 0.02 | 0 | 0.07 |
| dem | 20281 | 11187.01 | 12253.01 | 8.44 | 35208.09 |
| hhi | 20281 | 434.06 | 355.35 | 93.11 | 3773.99 |
| logL | 20281 | 5.72 | 1.89 | 0 | 12.75 |
| logK | 20281 | 3.2 | 1.59 | 0.11 | 10.59 |
| logRM | 20281 | 2.69 | 1.38 | 0 | 8.64 |
| salwag | 20281 | 7.51 | 50.54 | 0 | 2233.88 |

From the table comparing the mean of variables of All firms, Foreign firms, and Domestic firms we find that average sales, royalty charges paid, average labor used, average salaries paid, average capital used, and average raw material used by Foreign firms are greater than that of Domestic firms as well as that of All firms. Foreign firms in the sample on an average are found to be less export intensive and in less

concentrated markets than Domestic firms but they import capital goods more than Domestic firms. Average Age of Foreign firms is greater than that of Domestic firms as well as All firms implying that most of the Foreign firms in the sample are those which

have been in the country for some time and hence can be expected to know the market well. Total R&D expenditure of Foreign firms is higher than that of Domestic firms and is also on the higher side of the average of that of All firms.

Table 9: Comparison of Mean of Variables

| Variable | All Firms (AF) | Foreign Firms (FF) | Domestic Firms (DF) | FF-AF | FF-DF |
|---|---|---|---|---|---|
| logsa | 3.18 | 3.84 | 3.12 | 0.66 | 0.72 |
| age | 22.68 | 26.56 | 22.3 | 3.88 | 4.26 |
| roy | 0 | 0.01 | 0 | 0.01 | 0.01 |
| rd | 0 | 0 | 0 | 0 | 0 |
| ex | 0.1 | 0.09 | 0.1 | -0.01 | -0.02 |
| imcap | 0.41 | 1.36 | 0.31 | 0.96 | 1.05 |
| hori | 0.14 | 0.18 | 0.14 | 0.04 | 0.04 |
| bac | 0.06 | 0.05 | 0.06 | -0.01 | -0.01 |
| for | 0.02 | 0.02 | 0.02 | 0 | 0 |
| dem | 11127.38 | 10519.41 | 11187.01 | -607.97 | -667.6 |
| hhi | 436.29 | 459.01 | 434.06 | 22.72 | 24.95 |
| logL | 5.81 | 6.7 | 5.72 | 0.89 | 0.98 |
| logK | 3.21 | 3.36 | 3.2 | 0.15 | 0.17 |
| logRM | 2.74 | 3.25 | 2.69 | 0.51 | 0.56 |
| salwag | 7.92 | 12.08 | 7.51 | 4.16 | 4.57 |

# 5 Estimation

## 5.1 Hypothesis One

The main aim of our estimation is to establish that due to the presence of Foreign Firms there exist Horizontal, Backward and Forward Linkages in the Indian Manufacturing Industry which affect Domestic firms productivity. Thus the main hypothesis we are testing is the following

$$A_{ijt} = f\,(Hori_{jt};\ Bac_{jt};\ For_{jt})$$

From Gorg and Greenway (2004) paper we have seen that empirical literature on horizontal spillover gives us positive, negative as well as mixed results. Driffield et al (2002) have noted that most of the work on linkages have not distinguished the direction of linkages and have simply taken the average effect, they recognize this directional effect and report results where the mean effect of coefficients is almost zero. Glass et al (2002)in their article using theoretical models drive home the point that backward and forward linkages created by MNC's need not always be beneficial. It is well known that after independence India went for an import substitution policy because of which we have a diversified industrial structure. The data set we use in this study is large both in time as well the industry domain and hence the linkage effect due to MNC's for each industry need not be the same as it depends on the structure of that industry, the number of MNC's in that industry and, MNC's and local firms export and import orientation. This linkage effect will dictate the behavior of the spillover variable and hence behavior of spillover variables will be different for each industry. We summarize the positive and negative effects that could be captured by each spillover variable.

Horizontal Spillover Variable: Presence of foreign firm in the same product market will have a competitive effect on the domestic firm as a result of which either the productivity of the domestic firm would rise or the domestic firm would go out of the market as foreign firms due to their economies of scale bring down the average cost curve and the domestic firm may not be able to supply the product at the same cost. The horizontal variable in this study captures the effect of foreign firms in the same two digit industry on local firms, we expect that for domestic firms in the same product market as foreign firms, foreign firms might have an displacing or competitive effect whereas presence of other foreign firms in same two digit industry as discussed by Glass et al(2002) can have positive or negative effect on domestic firms as they can be upstream or downstream of domestic firms. The horizontal spillover variable captures the net of all these effects and hence can be positive or negative depending on which effect has dominated during the sample period.

Backward Spillover Variable: It is intended to capture the extent of potential contacts between domestic suppliers and multinational customers using the backward spillover variable. Lin and Saggi (2005) argue that not enough is known about the nature of the relationship between MNC's and their local suppliers though there is some evidence of positive relationship between them. One of the pull factors for an MNC to set shop in a developing country is cheap factors of production so an MNC might invest in vertical technology transfer to local firms or

help the local supplier firm in its efforts. We also know from Glass et al(2002) that downstream presence of MNC's need not be always be positive to the domestic supplier. With increasing openness in the economy we find that many domestic firms are supplying to foreign firms hence we can expect different signs for different industries.

Forward Spillover Variable: To calculate this variable we have taken sales of firms excluding exports, hence with this variable we again try to capture the extent of contacts between domestic buyers and multinational suppliers in the Indian Manufacturing Industry. Glass et al (2002)outline conditions in the theoretical models where a domestic firm present downstream to an MNC can be affected negatively because of the linkage with the MNC. Hence the sign of this variable depends on the existing scenario in each industry as a result of which it can vary from industry to industry.

The discussion above makes it clear that the three spillover effects for each of the industry under consideration can be different, hence we estimate a fixed and random effects model for each industry individually using the following equation.

$$\log Y_{ijt} = \alpha_1 + \beta_1 Age_{ijt} + \beta_2 Roy_{ijt} + \beta_3 RD_{ijt} + \beta_4 Ex_{ijt} + \beta_5 Imcap_{ijt} + \beta_6 Hori_{jt} + \beta_7 Bac_{jt} + \beta_8 For_{jt} + \beta_9 Dem_{jt} + \beta_{10} HHI_{jt} + \alpha \log K_{ijt} + \beta \log L_{ijt} + \gamma \log RM_{ijt} + \varepsilon_{ijt}$$

We use the Hausman test to decide which the appropriate model for each industry is. This regression is estimated for All firms as well as only for Domestic firms.
In order to take care of endogeneity issues due to productivity shocks seen by the firm but not by the econometrician, we apply the Levinsohn-Petrin (LP) procedure[5]. Here we adopt a two step process where we regress $\log Y_{ijt}$ on $\log K_{ijt}$, $\log L_{ijt}$ , and $\log RM_{ijt}$ using the LP procedure where RM is taken as proxy for Intermediate Inputs. LP procedure gives us Productivity estimate for each observation which is then regressed on the remaining variables . We estimate this equation for all firms as well as for domestic firms, Capital calculated by PIM and Labor represented by number of employees is used in all the above estimations[6]. Following Haskel et al (2002) to address the problem of omission of variables arising due to a host of plant, industry, time, and region specific effect we estimate the specified model in first differences which will help us in removing any fixed firm specific effect we may not have been able to capture. The results of the first difference model are similar to that of the levels result but have not been reported here. Many papers in literature expect externalities to affect firms after a lag, to take care of this aspect we estimate all the four models explained above with lagged spillover variables. Lag for these regressions have been assumed to be an year.

[5] For details please refer Levinsohn and Petrin(2003), the author is grateful to Amil Petrin for the levpet ado program.
[6] Autocorrelation and Heteroskedasticity have been controlled for in all the reported regressions.

# 6 Results

## 6.1 Results for Contemporaneous Spillover Variables

Since we have carried out our empirical analysis separately for each industry we report their results separately. Not all industries gave us results which were consistent in all the four regressions, hence we report only those industries where we have got consistent results for all the four regressions.

**WA Ind: Manufacture of wearing apparel; dressing and dyeing of fur**

Hausman test rejects random effect model only for the Domestic firms LP regression (DF LP) and random effects model is not rejected for the other three regressions i.e. All firms regression (AF), Domestic firms regression (DF) and All firms LP regression (AF LP). Forward is positive and significant in all regressions implying that firms in WA Ind have benefited from foreign supplier firms in other industries.

**Chem Ind: Manufacture of chemicals and chemical products**

Hausman test rejects random effect model for all the four regressions. We find that Horizontal is negative and significant in all the regressions implying that foreign firms in the chemical industry have affected domestic firms in the same industry.

**RP Ind: Manufacture of rubber and plastics products**

Hausman test rejects random effect model for all the four regressions. Foreign firms in other two digit industries buying from domestic firms in RP Ind are found to be beneficial to these domestic firms in all the regressions.

Table 10: Regression Results of WA Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | 0.003*** | 0.003*** | 0.004*** | 0.006 |
| roy | 16.577*** | 16.72*** | 16.467*** | 11.891 |
| rd | 6.764* | 6.538* | 4.108 | 4.850 |
| ex | 0.127*** | 0.116*** | 0.132*** | 0.034 |
| imcap | -0.073*** | -0.073*** | -0.06*** | -0.013 |
| hori | -1.997* | -1.952* | -3.399*** | -1.363 |
| bac | 538.168 | 505.318 | -322.260 | 368.498 |
| for | 26.997*** | 25.14*** | 12.24** | 15.269* |
| dem | -0.001 | -0.002 | 0.008** | -0.009 |
| hhi | 0.000 | 0.000 | 0.000 | 0.000 |
| logL | 0.115*** | 0.113*** | 0.089*** | 0.087*** |
| logK | 0.03*** | 0.03*** | 0.017 | 0.016 |
| logRM | 1.057*** | 1.058*** | 1*** | 1*** |
| Constant | -1.274*** | -1.196*** | 0.436*** | 0.535* |

**NMMP Ind: Manufacture of other non-metallic mineral products**

Hausman test rejects random effect model for AF and DF regressions and random effect model is not rejected for AF LP and DF LP regressions. Horizontal is found to be positive and significant in all the regressions implying that foreign firms in the NMMP Ind have been beneficial to domestic firms in the same industry.

Table 11: Regression Results of Chem Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | -0.014*** | -0.015*** | -0.008*** | -0.007*** |
| roy | -0.443*** | -0.433*** | -0.097*** | -0.094*** |
| rd | -0.073** | -0.065* | -0.017 | -0.013 |
| ex | 0.066*** | 0.068*** | 0.08*** | 0.075*** |
| imcap | -0.005*** | -0.005*** | -0.001 | -0.001 |
| hori | -0.71** | -0.745** | -0.545*** | -0.45** |
| bac | 0.553 | 0.666 | 0.191 | 0.152 |
| for | 7.545 | 7.125 | 4.625 | 3.558 |
| dem | 0*** | 0*** | 0** | 0* |
| hhi | 0.001 | 0.001 | 0.001* | 0.000 |
| logL | 0.192*** | 0.204*** | 0.203*** | 0.204*** |
| logK | -0.011 | -0.010 | 0.011 | 0.028 |
| logRM | 0.915*** | 0.912*** | 1*** | 1*** |
| Constant | -0.435*** | -0.488*** | 0.943*** | 0.928*** |

**BM Ind: Manufacture of basic metals**

Hausman test rejects random effects model for all the four regressions. Backward and Forward are found to be negative and significant in all the regressions implying that domestic firms in FM Ind have been affected by supplying to foreign firms in other two digit industries and buying from foreign firms in other two digit industries.

**FM Ind: Manufacture of fabricated metal products, except machinery and equipment**

Hausman test rejects random effect model for AF and DF regressions and random effect model is not rejected for AF LP and DF LP regressions. From the results we find that domestic firms in FM Ind have been affected negatively by foreign firms in the same industry.

Table 12: Regression Results of RP Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | -0.014*** | -0.015*** | -0.009*** | -0.031*** |
| roy | -1.616 | -3.446* | -1.878* | -3.585** |
| rd | -0.106*** | -0.105*** | -0.033*** | -0.064*** |
| ex | 0.225** | 0.208** | 0.069* | 0.215*** |
| imcap | -0.001*** | -0.001*** | -0.001*** | -0.003*** |
| hori | -0.098 | -0.162 | 0.195 | -0.125 |
| bac | 7.442* | 7.52* | 10.666** | 16.891*** |
| for | 1.598 | 1.426 | -0.089 | 0.609 |
| dem | 0*** | 0*** | 0* | 0*** |
| hhi | 0*** | 0*** | 0* | 0*** |
| logL | 0.164*** | 0.161*** | 0.146*** | 0.149*** |
| logK | -0.014 | -0.013 | 0.169** | 0.217** |
| logRM | 1*** | 0.992*** | 1*** | 0.647*** |
| Constant | -0.981*** | -0.939*** | 0.011 | 3.18*** |

Note: bac is significant at 10.3% and 11.1% in AF and DF regressions respectively.

**Mac Ind: Manufacture of machinery and equipment n.e.c.**

Hausman test rejects random effect model for AF and DF regressions and random effect model is not rejected for AF LP and DF LP regressions. We find that Horizontal is positive and significant whereas Backward is negative and significant in all the regressions implying that domestic firms have benefited from foreign firms in the same industry but have been affected by supplying to foreign firms in other two digit industries.

Table 13: Regression Results of NMMP Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | -0.018*** | -0.017*** | -0.001*** | -0.002*** |
| roy | -1.808 | -1.788 | 0.265 | 0.135 |
| rd | 0.006 | 0.004 | -0.020 | -0.016 |
| ex | 0.021 | 0.043 | -0.117*** | -0.134*** |
| imcap | 0.004 | 0.004 | 0.001 | 0.001 |
| hori | 2.879** | 2.794** | 0.576** | 0.529* |
| bac | -26.997 | -24.683 | -1.218 | -1.171 |
| for | 10.938 | 12.709 | -1.087 | -0.399 |
| dem | 0*** | 0*** | 0* | 0.000 |
| hhi | 0* | 0* | 0* | 0.000 |
| logL | 0.254*** | 0.254*** | 0.245*** | 0.243*** |
| logK | -0.004 | -0.002 | 0.116* | 0.112* |
| logRM | 0.868*** | 0.867*** | 0.923*** | 0.927*** |
| Constant | -1.253*** | -1.294*** | 0.4*** | 0.401*** |

**Tel Ind: Manufacture of radio, television and communication equipment and apparatus**

Hausman test rejects random effects model for all the regressions. We find Backward to be positive and significant in all the regressions indicating that domestic firms in Tel Ind have benefited from supplying to foreign firms in other two digit industries.

Table 14: Regression Results of BM Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | 0.009* | 0.008* | 0.017*** | 0.018*** |
| roy | 4.740 | 4.453 | 10.619* | 10.845* |
| rd | 2.262 | 2.493* | 0.448 | 0.462 |
| ex | -0.132*** | -0.128*** | -0.07*** | -0.063*** |
| imcap | -0.002 | -0.002* | 0.000 | 0.000 |
| hori | 1.286 | 1.336 | 0.768 | 0.677 |
| bac | -0.59** | -0.601*** | -0.456* | -0.429* |
| for | -15.07** | -16.009*** | -16.346** | -18.269** |
| dem | 0.000 | 0.000 | 0** | 0* |
| hhi | 0.000 | 0.000 | 0.000 | 0.000 |
| logL | 0.162*** | 0.156*** | 0.19*** | 0.189*** |
| logK | -0.014 | -0.013 | 0.001 | 0.000 |
| logRM | 0.893*** | 0.902*** | 0.934*** | 0.937*** |
| Constant | 0.380 | -0.653 | 0.064 | 0.012 |

**Opt Ind: Manufacture of medical, precision and optical instruments, watches and clocks**

Hausman test rejects random effects model for AF, DF and AF LP regressions and does not reject random effects model for DF LP regression. Horizontal is found to be negative and significant in all the regressions implying that domestic firms have been affected by foreign firms in the same two digit industry.

Table 15: Regression Results of FM Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | 0.016 | 0.012 | 0.000 | 0.001 |
| roy | -0.841 | -6.128 | 1.638 | 1.675 |
| rd | 2.935 | 3.156 | 0.694 | 0.246 |
| ex | 0.083 | 0.088 | 0.166** | 0.023 |
| imcap | -0.029 | 0.004 | -0.070 | -0.007 |
| hori | -1.18*** | -1.295** | -1.135*** | -0.764*** |
| bac | -33.013** | -25.392 | -1.594 | -2.563 |
| for | 7.124 | 7.142 | 3.034 | 1.499 |
| dem | 0.000 | 0.000 | 0* | 0** |
| hhi | -0.001*** | -0.001*** | -0.001*** | 0*** |
| logL | 0.285*** | 0.289*** | 0.216*** | 0.218*** |
| logK | 0.066 | 0.108** | 0.255 | 0.367* |
| logRM | 0.655*** | 0.649*** | 0.440 | 0.493** |
| Constant | 0.644* | 0.537 | 1.673*** | 1.212*** |

## 6.2 Results for Lagged Spillover Variables

Of the fifteen industries we started with we find that only nine industries gave us results in the contemporaneous spillover analysis. As mentioned earlier there are papers in literature which suggest that spillovers affect with a lag. In this section we report results of our empirical analysis with lagged spillovers separately for each industry. It is assumed that spillovers take an year's time to affect firms. Not all industries gave us results which were consistent in all the four regressions; hence we report only those industries where we have got consistent results for all the four regressions.

Table 16: Regression Results of Mac Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | -0.015*** | -0.019*** | 0.000 | 0.000 |
| roy | -0.040 | -0.005 | 0.137 | 0.701* |
| rd | -0.260 | -0.157 | -0.021 | 0.010 |
| ex | 0.026 | 0.001 | -0.023 | -0.038** |
| imcap | -0.144** | -0.177** | -0.018 | -0.033 |
| hori | 2.184*** | 2.205*** | 0.8*** | 0.758*** |
| bac | -17.118* | -20.617* | -7.574** | -9.206** |
| for | -0.217 | 0.073 | -1.003 | -2.005* |
| dem | 0** | 0** | 0* | 0.000 |
| hhi | 0.000 | 0.000 | 0.000 | 0.000 |
| logL | 0.223*** | 0.215*** | 0.199*** | 0.179*** |
| logK | 0.024 | 0.043* | 0.055 | 0.030 |
| logRM | 0.792*** | 0.774*** | 0.827*** | 0.858*** |
| Constant | 0.521* | -0.852** | 0.578*** | 0.671*** |

**FPB Ind: Manufacture of food products and beverages**
Hausman test rejects the null of random effects model for AF, DF and DF LP regressions whereas for AF LP regression the null of random effects model is not rejected. We find that lagged forward is positive and significant in all the regressions implying that domestic firms in FPB Ind have benefited from foreign firms which supply to FPB Ind.

Table 17: Regression Results of Tel Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | 0.017** | 0.013* | 0.006 | 0.001 |
| roy | 3.493** | 0.943 | 4.191** | 1.874 |
| rd | -0.443 | -0.560 | -0.169 | -0.205 |
| ex | -0.049 | -0.054 | 0.020 | 0.020 |
| imcap | -0.007 | -0.008 | -0.014*** | -0.013*** |
| hori | 0.104 | 0.399 | 0.151 | 0.459 |
| bac | 39.856*** | 36.792** | 28.552* | 30.048** |
| for | -5.196** | -3.452 | -2.856 | -1.290 |
| dem | 0*** | 0*** | 0*** | 0*** |
| hhi | 0*** | 0*** | 0.000 | 0.000 |
| logL | 0.218*** | 0.205*** | 0.132*** | 0.133*** |
| logK | -0.044*** | -0.05*** | 0.011 | 0.012 |
| logRM | 0.905*** | 0.923*** | 0.832*** | 0.833*** |
| Constant | -1.083*** | -1.075*** | 0.397*** | 0.458* |

**WA Ind: Manufacture of wearing apparel; dressing and dyeing of fur**

For WA Ind Hausman test rejects random effect model for AF and DF regressions, for AF LP and DF LP regressions Hausman test does not reject the null of random effects model. Lagged forward is positive and significant in all the regressions implying that domestic firms in WA Ind have benefited from foreign firms which supply to WA Ind.

**NMMP Ind: Manufacture of other non-metallic mineral products**

Hausman test rejects random effect model for all the regressions. Lagged Horizontal is found to be negative and significant in all the regressions indicating that domestic firms have been negatively affected by foreign firms in the same industry. Foreign firms in other two digit industries supplying to domestic firms in NMMP Ind seem to have a beneficial effect on domestic firms as lagged Forward is found to be positive and significant in all the regressions.

Table 18: Regression Results of Opt Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | 0.017 | 0.014 | 0.013** | -0.001* |
| roy | 3.176** | 6.033** | 1.603 | 9.204*** |
| rd | 2.081 | 2.363 | 1.456 | 1.496 |
| ex | -0.117 | -0.090 | -0.051 | 0.086*** |
| imcap | -0.146 | -0.255** | -0.080 | -0.232** |
| hori | -1.108*** | -1.389*** | -0.799*** | -1.015*** |
| bac | -11.073 | -23.901 | -5.878 | 22.320 |
| for | -10.206** | -12.37** | -6.988* | -1.821 |
| dem | 0.000 | 0.000 | 0.000 | 0* |
| hhi | 0* | 0* | 0** | 0*** |
| logL | 0.121*** | 0.114*** | 0.122*** | 0.103*** |
| logK | -0.003 | 0.041 | 0.000 | 0.000 |
| logRM | 1.038*** | 1.058*** | 1*** | 1*** |
| Constant | 0.316 | 0.537 | 1.237*** | 0.801*** |

Table 19: Lagged Regression Results of FPB Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | -0.014** | -0.017*** | -0.001*** | -0.011 |
| roy | 1.293* | -2.625** | 1.028*** | -1.746* |
| rd | -11.171*** | -11.265*** | -3.389** | -7.14*** |
| ex | 0.111 | 0.099 | 0.152*** | 0.444*** |
| imcap | -0.093*** | -0.089*** | -0.137*** | -0.236*** |
| laghori | -0.659* | -0.767** | 0.031 | 0.059 |
| lagbac | 4.244 | 3.014 | -8.506 | 13.529 |
| lagfor | 37.847** | 42.893** | 32.766*** | 59.615*** |
| dem | 0 | 0 | 0*** | 0*** |
| hhi | 0 | 0.001 | 0.001 | 0.001 |
| logL | 0.178*** | 0.177*** | 0.238*** | 0.235*** |
| logK | 0.034* | 0.035* | 0 | 0 |
| logRM | 0.915*** | 0.921*** | 0.59*** | 0.542*** |
| Constant | -0.275 | -0.273 | 0.725*** | -0.615* |

**BM Ind: Manufacture of basic metals**

Hausman test rejects random effect model for all the regressions. Results show that domestic firms in BM Ind have been negatively affected by supplying to foreign firms in other industries and buying from foreign firms in other industries.

Table 20: Lagged Regression Results of WA Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | -0.016 | -0.012 | 0.003*** | 0.004*** |
| roy | 19.5 | 19.464 | 16.411*** | 16.688*** |
| rd | 3.362 | 3.619 | 4.699* | 4.66* |
| ex | -0.047 | -0.055 | 0.128*** | 0.129*** |
| imcap | -0.021 | -0.021 | -0.063*** | -0.065*** |
| laghori | -2.12 | -2.019 | -1.46 | -1.586 |
| lagbac | -248.627 | -249.794 | -497.39* | -544.778* |
| lagfor | 27.707** | 26.162** | 16.213*** | 16.295*** |
| dem | 0.01 | 0.006 | 0.003 | 0.002 |
| hhi | 0 | 0 | 0 | 0 |
| logL | 0.119*** | 0.119*** | 0.089*** | 0.087*** |
| logK | 0.032 | 0.035 | 0.017 | 0.016 |
| logRM | 1.063*** | 1.07*** | 1*** | 1*** |
| Constant | -0.854** | -0.824* | 0.548*** | 0.589*** |

**Mac Ind: Manufacture of machinery and equipment n.e.c.**

Hausman test rejects random effect model for AF, DF and DF LP regressions whereas for AF LP null of random effect model is not rejected. Lagged horizontal and lagged forward are found to be positive and significant in all the regressions implying that domestic firms in Mac Ind have benefited from foreign firms in the same two digit industry and by buying from foreign firms in other two digit industries. Lagged backward is found to be negative and significant in all the regressions indicating that domestic firms in Mac Ind have been affected negatively by supplying to foreign firms in other two digit industries.

Table 21: Lagged Regression Results of NMMP Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | -0.028*** | -0.028*** | -0.014*** | -0.013*** |
| roy | -1.172 | -1.107 | -0.087 | -0.021 |
| rd | -0.003 | -0.006 | 0.022 | 0.019 |
| ex | 0.017 | 0.051 | -0.026 | -0.011 |
| imcap | 0.004 | 0.004 | 0.001 | 0.001 |
| laghori | -3.096** | -3.344** | -1.569*** | -1.678*** |
| lagbac | 4.598 | 3.438 | -4.929 | -5.117 |
| lagfor | 15.7* | 14.957* | 6.619** | 6.489* |
| dem | 0.001*** | 0.001*** | 0*** | 0*** |
| hhi | 0 | 0 | 0 | 0 |
| logL | 0.259*** | 0.26*** | 0.245*** | 0.243*** |
| logK | 0.001 | 0.003 | 0.116* | 0.112* |
| logRM | 0.868*** | 0.866*** | 0.923*** | 0.927*** |
| Constant | -0.703** | -0.711** | 0.264** | 0.073 |

**Mot Ind: Manufacture of motor vehicles, trailers and semitrailers**

The Hausman test here rejects the null of random effect model for all the regressions. Lagged horizontal is found to be positive and significant in all the regressions implying that domestic firms in Mot Ind have benefited from foreign presence in the same industry.

Table 22: Lagged Regression Results of BM Ind

| **Variable** | **AF** | **DF** | **AF LP** | **DF LP** |
|---|---|---|---|---|
| age | 0.011* | 0.009 | 0.021*** | 0.019*** |
| roy | 5.44 | 5.457 | 11.647* | 11.831* |
| rd | 2.018 | 2.159 | 0.216 | 0.216 |
| ex | -0.132*** | -0.128*** | -0.071*** | -0.064*** |
| imcap | -0.001 | -0.002 | 0 | 0 |
| laghori | -0.159 | 0.142 | -1.748 | -1.326 |
| lagbac | -0.627*** | -0.642*** | -0.452** | -0.48** |
| lagfor | -10.217* | -10.427* | -16.065*** | -17.401*** |
| dem | 0 | 0 | 0 | 0 |
| hhi | 0 | 0 | 0 | 0 |
| logL | 0.16*** | 0.155*** | 0.19*** | 0.189*** |
| logK | -0.012 | -0.011 | 0.001 | 0 |
| logRM | 0.9*** | 0.907*** | 0.934*** | 0.937*** |
| Constant | -0.048 | -0.062 | -1.165* | -1.087* |

## 6.3 Summary of Results

We find that Tex Ind, PP Ind , EMac Ind and Trans Ind are the industries where there are no spillover effects due to various linkages with foreign firms. FPB Ind and Mot Ind are the industries where forward and horizontal spillovers respectively come into effect positively after a lag. In WA Ind we get evidence for positive forward spillovers both contemporaneous and with a lag. In Chem Ind, FM Ind and Opt Ind one finds negative horizontal spillovers whereas one finds positive backward spillover in RP Ind and Tel Ind. In BM Ind we find evidence for negative backward and forward

Table 23: Lagged Regression Results of Mac Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | -0.004 | -0.007 | 0 | -0.012 |
| roy | -0.057 | -0.323 | 0.129 | -0.108 |
| rd | -0.304* | -0.196 | -0.039 | -0.15 |
| ex | 0.013 | -0.005 | -0.012 | 0.009 |
| imcap | -0.146* | -0.176*** | -0.017 | -0.047 |
| laghori | 1.487*** | 1.233** | 0.671*** | 2.086* |
| lagbac | -56.44*** | -61.716*** | -32.185*** | -71.403*** |
| lagfor | 12.237*** | 13.655*** | 5.786*** | 13.291 |
| dem | 0 | 0 | 0 | 0 |
| hhi | 0*** | 0** | 0*** | 0 |
| logL | 0.217*** | 0.207*** | 0.199*** | 0.179*** |
| logK | 0.027 | 0.048* | 0.055 | 0.03 |
| logRM | 0.801*** | 0.783*** | 0.827*** | 0.858*** |
| Constant | 0.18 | 0.884** | 0.893*** | 1.924*** |

spillovers contemporaneously as well with lag. Results of NMMP Ind are very puzzling, it is found that it has positive contemporaneous horizontal spillovers and negative lagged horizontal spillovers, NMMP Ind is also found to be positively affected by lagged forward spillovers whereas contemporaneous forward spillover seems to have no effect. Mac Ind is found to be positively affected by both contemporaneous as well as lagged horizontal spillovers and negatively affected by both contemporaneous and lagged backward spillovers. Mac Ind again very interestingly seems to be positively affected by lagged forward spillover whereas it is not affected by contemporaneous spillover variable.

Table 24: Lagged Regression Results of Mot Ind

| Variable | AF | DF | AF LP | DF LP |
|---|---|---|---|---|
| age | -0.002 | -0.002 | -0.003** | 0.002 |
| roy | -1.513 | -2.309** | -0.634 | -1.737** |
| rd | 1.112*** | 0.633 | 0.543*** | 0.682** |
| ex | 0.048 | 0.039 | 0.002 | 0.054 |
| imcap | 0*** | -0.016*** | 0*** | -0.008*** |
| laghori | 0.548** | 0.702*** | 0.31** | 0.602*** |
| lagbac | 27.944 | 41.213* | 11.705 | 39.323** |
| lagfor | -0.288 | -1.102 | 0.086 | -1.722 |
| dem | 0 | 0 | 0 | 0* |
| hhi | 0 | 0 | 0 | 0 |
| logL | 0.191*** | 0.18*** | 0.215*** | 0.228*** |
| logK | -0.002 | 0.005 | 0.012 | 0.011 |
| logRM | 0.933*** | 0.937*** | 0.965*** | 0.784*** |
| Constant | -0.402*** | -0.121 | 0.573*** | 0.657 |

WA Ind, BM Ind and Mac Ind are the industries where we have obtained consistent results in the contemporaneous and the lagged analysis. Comparing these results we find that for WA Ind Lagged Forward spillover has more positive effect, for BM Ind we find that Lagged Backward spillover has more negative effect and Lagged Forward spillover has lesser negative effect. On similar comparison of Mac Ind results we find that Contemporaneous Horizontal spillover has more positive effect and Contemporaneous Backward spillover has lesser negative effect.

## 6.4 Discussion of Results

In the Wearing and Apparel Industry we find that domestic firms, which have had interactions with foreign firms in other industries as their buyers or prospective buyers, have benefited implying that the numerous informational asymmetries associated with the interaction between foreign seller and local buyer in relation to the capability of the technology being sold and its worth are absent (Nelson and Winter (1982) and Caves (1996)). Domestic firms in the Chemical Industry seem to have been affected by foreign firms and their investments in the same industry as well as lowering of tariff barriers which exposed them to competition from cheap imports (KPMG India(2003)). As cited in the literature review ( for e.g. Smarzynska (2004 a)) domestic firms in the Rubber and Plastic Industry and Manufacture of Radio, Television and Communication Equipment and Apparatus industry have benefited by supplying to foreign firms in other industries. Effect of foreign firms in the Non-Metallic Mineral Products Industry on domestic firms in the same industry seems to have time dimension to it. This might be because of the nature of the industry since this industry also includes glass, ceramic etc. manufactured for industrial as well non-industrial use, the product line for which might vary every year. Domestic firms in this industry are benefited from interactions with foreign suppliers, and the benefits, accrues to them after some lag. Our analysis shows that domestic firms in the Basic Metal Industry and the Machinery and Equipment Industry, supplying or trying to supply foreign firms in other industries are not benefited by the interactions they have with them. This could be the case when foreign firms source most of their needs (especially need for capital equipment) from their parent company as this allows them lower cost and achieve greater quality. This supports the conclusion of Ray and Venaik (2001) that presence of large

MNE affiliates leads to lower production of specialized inputs in the economy, in their study they also find that MNE affiliates in India have a higher propensity to import capital equipment (we find this to be true even for our sample) from their parent and from affiliated suppliers which could be one of the reasons for negative backward linkage. Negative forward spillover indicates that for domestic firms in the Basic Metal Industry there exists some kind of informational asymmetry associated with the interaction between foreign seller and local buyer. Domestic firms in the Fabricated Metal products Industry and the Medical, Precision and Optical Instruments, Watches and Clocks Industry seem to be crowded out by foreign firms in the same industry, however, domestic firms in Machinery and Equipment Industry seem to have been benefited by foreign presence in the same industry and these firms also are benefited by foreign seller from other industries though with some time lag.

# 7 Conclusion

We started with the aim of finding inter and intra industry spillovers on domestic firms due to the presence of foreign firms in the Indian Manufacturing Industry, we found evidence for the same in eleven out of the fifteen sectors on which analysis were conducted. It was found that there exist positive as well negative inter-industry spillovers and positive as well as negative intra industry spillovers in the Indian Manufacturing Industry. Though various reasons for this negative inter-industry spillover are theoretically available it is much difficult to determine the same empirically and hence more work is required to better understand this particular aspect. We also tested for lagged spillover effects and found evidence for them, however, on comparing lagged as well as contemporaneous spillovers we found that for two industries lagged spillover was more effective whereas for one industry contemporaneous spillover had more effect implying that over time spillovers affect industries varyingly according to the nature of the industry.

Table 25: Aggregated Sectors of Input Output tables 1993-1994 and 1998 1999

| Aggregated Sector | Original Sector |
|---|---|
| All Crops | Paddy,Wheat,Jowar,Bajra,Maize,Gram,Pulses,Sugarcane,Groundnut,Jute,Cotton,Rubber,Coconut,Tobacco,Other crops |
| NIC 15 | Tea,Cofiee,Milk and milk products,Other livestock products,Fishing,Sugar,Khandsari,boora,Hydrogenated oil, contd |
| NIC 15 | Edible oils other than vanaspati,Tea and cofiee processing,Miscellaneous food products,Beverages |
| NIC 17 | Khadi,cotton textiles(handlooms),Cotton textiles,Woolen textiles,Silk textiles,Art silk,syntheticfi ber textiles, contd |
| NIC 17 | Jute,hemp,mesta textiles,Carpet weaving,Miscellaneous textile products |
| NIC 18 | Readymade garments |
| NIC 21 | Paper,paper prods. and newsprint |
| NIC 24 | Inorganic heavy chemicals,Organic heavy chemicals,Fertilizers,Pesticides,Paints, varnishes and lacquers, contd |
| NIC 24 | Drugs and medicines, Soaps,cosmetics and glycerin,Syntheticfi bers, resin,Other chemicals |
| NIC 25 | Rubber products,Plastic products |
| NIC 26 | Structural clay products,Cement,Other non-metallic mineral prods. |
| NIC 27 | Iron,steel and ferro alloys,Iron and steel casting and forging,Iron and steel foundries,Non-ferrous basic metals |
| NIC 28 | Hand tools, hardware,Miscellaneous metal products |
| NIC 29 | Tractors and agri. implements,Industrial machinery(F and T),Industrial machinery(others),Machine tools, contd |
| NIC 29 | Other non-electrical machinery,Electrical appliances |
| NIC 31 | Electrical industrial Machinery,Electrical wires and cables,Batteries,Other electrical Machinery |
| NIC 32 | Communication equipments,Electronic equipments(incl.TV) |
| NIC 33 | Watches and clocks,Miscellaneous manufacturing |
| NIC 34 | Motor vehicles |
| NIC 35 | Ships and boats,Rail equipments,Motor cycles and scooters,Bicycles, cycle-rickshaw,Other transport equipments |
| All Others | Animal services(agricultural),Forestry and logging,Coal and lignite,Crude petroleum,natural gas,Iron ore,contd |
| All Others | Manganese ore,Bauxite, Copper ore,Other metallic minerals,Lime stone,Mica,Other non metallic minerals,contd |
| All Others | Tobacco products,Furniture andfi xtures-wooden,Wood and wood products,Printing and publishing,Leather footwear,contd |
| All Others | Leather and leather products, Petroleum products,Coal tar products,Ofice computing machines,Construction,contd |
| All Others | Electricity,Railway transport services,Other transport services,Storage and warehousing,Communication,Trade,contd |
| All Others | Hotels and restaurants,Banking,Insurance, Ownership of dwellings,Education and research, contd |
| All Others | Medical and health,Other services, and Public administration |

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