FDI Spillovers on Innovation and Productivity: Evidence from Foreign and Domestic Firms in the Indian Manufacturing Sector

Ph.D. Thesis

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CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled **FDI Spillovers on Innovation and Productivity: Evidence from Foreign and Domestic firms in the Indian Manufacturing Sector** in the partial fulfillment of the requirements for the award of the degree of **DOCTOR OF PHILOSOPHY** and submitted in the **DISCIPLINE OF Economics, Indian Institute of Technology Indore**, is an authentic record of my own work carried out during the time period from July 2012 to January 2018 of PhD Thesis submission under the supervision of Dr. Ruchi Sharma, Associate Professor, Indian Institute of Technology Indore.

The matter presented in this thesis has not been submitted by me for the award of any other degree of this or any other institute.

Signature of the student with date
(Ab Qayoom Khachoo)

This is to certify that the above statement made by the candidate is correct to the best of my/our knowledge.

Signature of Thesis Supervisor #1 with date **(Dr. Ruchi Sharma)**

Signature of Thesis Supervisor #2 with date **(NAME OF THESIS SUPERVISOR)**

Ab Qayoom Khachoo has successfully given his/her Ph.D. Oral Examination held on **2nd January, 2018.**

Signature of Chairperson (OEB)
Date:

Signature of External Examiner
Date:

Signature(s) of Thesis Supervisor(s)
Date:

Signature of PSPC Member #1
Date:

Signature of PSPC Member #2
Date:

Signature of Convener, DPGC
Date:

Signature of Head of Discipline
Date:

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Above all, I am grateful to the Almighty, for giving me strength and ability to understand and learn.

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DEDICATION

To mom Zainub and dad Khazir Mohd,
with unconditional love and gratitude

SYNOPSIS

Introduction

The global economy has experienced several waves of globalization in its' history. Each wave led to a growing interdependence among countries through increasing amounts of foreign trade, cross-border financial flows, and migration. One of the main features of the globalization at the end of the 20th century was the rapid increase in FDI. The upsurge in FDI has given rise to debates, both in academia and public space, regarding the impacts of FDI on developing countries. The proponents of globalization associate inflows of FDI with a series of benefits for host countries. However, others view FDI as a new form of colonialism or imperialism.

The debate on globalization, though previously centered on direct effects of FDI on macroeconomic variables such as GDP, employment, and balance of payments, has now shifted towards the indirect effects on microeconomic variables like productivity and innovation at the firm level. These indirect effects usually go under the heading of spillovers. Spillovers occur when FDI generates outcomes that become available to other firms at no cost. In other words, spillovers are externalities that arise from the activities of foreign companies in the host country, benefitting domestic companies, without receiving any compensation. It is imperative to mention that externalities resulting from multinational (MNC) entry by no means are automatic. In fact, in most of the cases, local incumbents have to bear additional costs so as to benefit from these externalities. However, this extra cost does not necessarily correspond to a direct payment to a MNC in return for the supply of some specific assets. In particular, to assimilate the FDI spillovers, domestic firms, apart from improving their absorptive capacity, need to invest in R&D, skilled workers, and organizational practices. The empirical research on the possible effects of FDI on host economies started with the seminal works of Caves (1974) and Globerman (1979). Since then, a sizeable amount of empirical studies focusing on FDI spillovers on productivity have surfaced. While the theoretical foundations for such spillovers are generally accepted, empirical work, however, does not present unanimous findings. Several studies report significant productivity gains induced by the presence of foreign-owned enterprises in the host country; others find adverse or non-significant effects on domestic productivity. This divergence between theory and empiricism as well as the lack of unanimity within the latter probably increases the relevance and need for furthering the research on spillover effects.

Besides productivity, FDI inflows could have a potential impact on the R&D activities and therefore, on innovation output of incumbents in many ways. Irrespective of whether MNCs spend on R&D or not in the host location, enhanced competition due to the entry of MNCs may have a direct effect on the R&D efforts of the incumbent firms (Caves 1974). Alternatively, to face the competition from MNCs, local companies may acquire technological imports; however, such import still necessitates R&D to adapt the to local conditions. FDI entry may also entrench R&D and innovation culture among local companies. For instance, MNCs R&D activities in many countries have spurred an R&D drive among the domestic firms, and some of these companies (e.g. software companies) directly compete with MNCs (UNCTAD 2006). Furthermore, MNCs through joint ventures and R&D collaborations with local firms provide ample opportunities for the latter to learn how to conduct R&D and make it commercially successful.

Against this backdrop, we attempt to analyze spillovers from FDI on the innovative activity of firms operating in Indian manufacturing sector. Instead of simply adding another single country study on productivity spillovers, we go a further step by empirically estimating the existence of spillovers on domestic innovation arising from components of FDI (horizontal and vertical FDI). While examining FDI spillovers, the thesis takes into account the location of incumbents vis-à-vis to the best practice frontier. Three questions the thesis addresses are:

(1) Like productivity spillovers, does FDI-related spillovers manifest on innovation?
(2) Does incumbent status as a supplier, client or competitor affect the absorption of spillovers arising from FDI?
(3) Does incumbents proximity to the best practice frontier or distance from it conditions spillovers arising from FDI?

Literature Review

Theoretical works suggest that MNCs produce both pecuniary and knowledge externalities, and such external effects arise through four main channels of competition, demonstration and imitation, worker mobility and spin-offs, and backward and forward linkages. From the theoretical point of view, one can identify the different types of externalities and the various roles played by these channels in mediating such external effects. The number of empirical studies investigating the existence of FDI spillovers and their impact on domestic firms is much higher than the theoretical studies. While empirical studies have been conducted on macro as well on the micro-level, the results obtained, however, are contradictory. The macroeconomic studies use aggregate data for a single country or a group of countries, and systematically obtain a positive impact of FDI on economic growth of hosts. These studies, although popular, provide a limited scope for interpretation of spillovers. Microeconomic studies, on the other hand, can reveal more in detail the complexity of spillover mechanism. The micro studies consider the effects on the productivity of local firms while taking into account their linkages with foreign companies. In contrast to macro studies, which often argue in favour of a positive effect, the findings of micro studies are mixed. For instance, Aitken and Harrison (1999) and Djankov and Hoekman (2000) find that FDI adversely affects local productivity while as Caves (1974), Globerman (1979), Blomstrom (1986) and Javorcik (2004) claim that FDI positively affects the productivity of local firms. The third category of empirical works, for instance, Girma et al. (2007), at loggerheads with the studies mentioned above, however, argue that impact of FDI on local productivity is insignificant. It is evident that the empirical literature hitherto has failed to establish an unambiguous link between FDI and local productivity. Most scholars often invoke this empirical inconclusiveness as the main motivation for furthering the research on spillover effects.

Spillover Channels

There are a number of conduits which mediate the impact of FDI on domestic firms and these conduits are largely classified into two broad channels: intra-industry and inter-industry. Intra-industry channel encompasses demonstration, competition and labour turnover effects, particularly affecting the local firm that work neck to neck with foreign firms in the same sector. In intra-industry case, FDI affects local firms through demonstration effect or through learning-by-doing. For instance, local firms analyse and observe the output of MNCs R&D projects or benefit from the exposure to superior technology of foreign firms. Besides, domestic firms may receive benefits via labour market turnover or human capital mobility. The managers and workers who once worked for MNCs may move to local firms' or set up their own start-ups. The expertise and knowledge embedded in these workers go a long way to help local firms to improve their performance (Cheung & Lin, 2004; Fosfuri et al., 2001). Moreover, FDI through competition effect compels local firms to enhance their performance (Markusen & Venables, 1999; Wang & Blomstrom, 1992). Foreign entry not only disturbs the existing equilibrium in the domestic market but also triggers a tougher competition pushing local firms to utilize the available resources more efficiently (Gorg & Strobl, 2005; Fosfuri et al., 2001; Driffield & Taylor, 2000). On the contrary, inter-industry effects are realized by the firms working in different vertically related sectors and mainly rely on the existence of forward and backward linkages (Blalock & Gertler, 2008; Crespo & Fontoura, 2007; Javorcik, 2004). Local sourcing by MNCs and providing technical assistance to local firms are viewed as important provisions for occurrence of inter-industry spillovers.

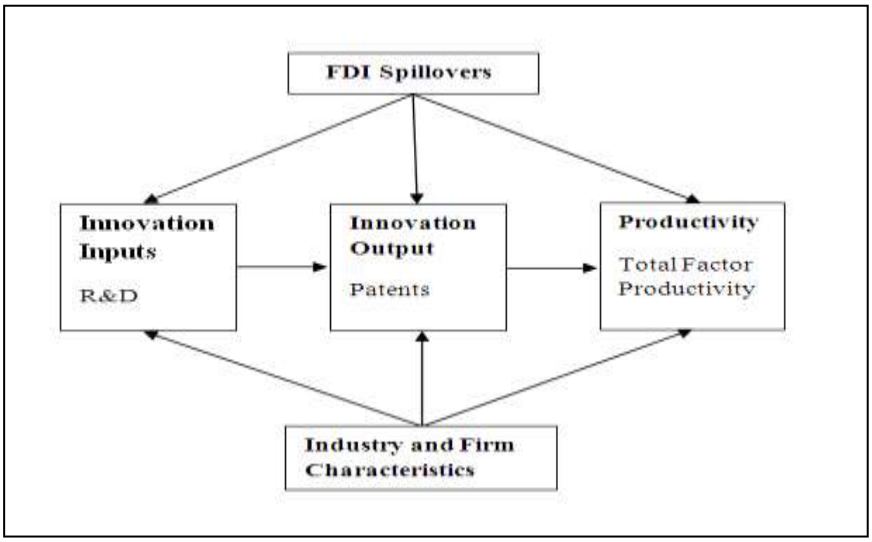
Research Objectives

The thesis is an endeavor to explore whether incumbent firms are able to translate the externalities received from MNCs into the productive use and if these spillovers manifest on their innovation and productivity. The thesis has three particular interests. Firstly, to examine the extent to which FDI spillovers impact the innovation activities (R&D and patenting) and productivity (*tfp*) of incumbent firms active in Indian manufacturing sector. Secondly, to analyze whether spillovers are relatively stronger for incumbents serving as suppliers and/or clients to MNCs than the incumbents acting as rivals to them. Lastly, to investigate whether the incumbent firms located near to the best practice frontier receive more spillovers than the firms located further away from it.

Third objective is particularly important as not all incumbents are uniformly affected by the FDI entry, and not all of them respond the entry homogenously. As follows from Schumpeterian multi-sector growth models that advanced entry may induce innovation in incumbents close to the frontier and trigger productivity growth in them, however, the entry may also reduce the expected rents from doing R&D for incumbents residing further away from the frontier, hence retarding their innovation and eventually impeding productivity growth. It suggests that spillovers arising from FDI entry may not equally benefit the incumbents; however, the benefits received will depend on the location of incumbent vis-à-vis to the technology frontier. Building on this theoretical construct, we attempt to provide an empirical analysis of how spillover effects across incumbents vary depending on their proximity to/distance from the frontier. In particular, based on the closeness or remoteness to their own industry frontiers, how incumbents' patenting and *tfp* growth reacts to the FDI.

Based on the interconnectedness of the thesis objectives, we employ an augmented version of Crepon et al's. (1998) model. The model as depicted in Figure 1.1 consists of few subsequently related equations- the R&D equation linking R&D expenditure to its determinants; the innovation equation linking R&D spending to innovation output; and the productivity equation relating innovation output to the productivity. The R&D equation models both the decision to invest in R&D and the actual level of R&D by a firm as a function of FDI spillovers. The second equation specifies the innovation output (patenting) of a firm as a function of its own R&D investment and FDI spillovers. In the productivity equation, innovation output (patenting) enters as an exogenous variable along with FDI spillover variables. In all the specification, along with the variables of interest, are incorporated firm and industry specific controls, which determine the changes in the dependent variables. The purpose of inclusion of innovation output as an exogenous variable in productivity equation is to explicitly account for the fact that innovation output influences the changes in productivity. Firms invest in R&D to develop process and product innovations, which in turn contribute to their productivity. The model, therefore, encompasses two subsequently linked relationships: the innovation relation linking FDI spillovers to innovation and the productivity relation linking innovation output and FDI spillovers to the changes in *tfp* occurring at firm-level.

Figure 1.1: Conceptual Model for Empirical Analysis



Source: Author's adaptation based on Crepon et al., (1998)

Data and Methodology

The data for the study comes from various sources. For innovation analysis, we use data on patent grants compiled from the various issues of the patent office journal, the official gazette of the Indian Patent Office (IPO) administered by the Office of the Controller General of Patents, Designs & Trade Marks. The information on patent applications, patent grants, designs, and trademarks is made public in the form of quarterly publications. Other firm level data is compiled from Prowess Center for Monitoring Indian Economy (CMIE) database. The Prowess contains financial information on over 8000 companies (including 4500 services and construction companies) listed on the Bombay Stock Exchange (BSE) as well as on the unlisted limited companies having sales more than US $0.25 million.

An added feature of the study is that it employs a series of national input-output tables to work out the intra- and inter-industry trade linkages. However, the previous empirical studies calculate such linkages using a fewer input-output tables and thus are unable to capture temporal variation in linkages. These national input-output tables are taken from World Input-Output Database (WIOD). The study covers a period of 14 years spanning from 2000 to 2013. Econometric analysis is based on a micro-level (firm level) dataset comprising 520 firms belonging to 17- three-digit manufacturing industries. The sample comprises firms from high-tech, medium-tech and low-tech sectors, thereby removing the bias of including firms from a specific sector only. We have 14 years of observations per firm; hence the maximum number of firm years is 7280. We employ DEA technique to construct best practice frontier for each industry included in the sample and Malmquist Productivity Index (MPI) to compute *tfp* changes occurring at firm-level.

The two major problems inherent in the model and the nature of the data are selectivity and endogeneity. The problems if untreated may render the empirical estimates highly biased. Most of the studies on R&D partially suffer from the selection problem. Of all the firms engaged in R&D activities, only a minority make their R&D expenses public. So the studies restricted to firms that report their R&D expenditure are prone to selectivity bias. Further, endogeneity has been a major issue with many of the past studies on FDI and R&D. The endogeneity is a major problem here as well. For example, R&D is endogenous in the innovation equation and FDI spillover variables are endogenous in both the innovation and the productivity equations. Further, disturbances in our model, reflecting in part the unobserved variables and firm effects, are also likely to be correlated.

We treat all these estimation issues by relying on econometric techniques that eliminate the problems of selectivity and endogeneity. The selection bias is addressed by relying on the Heckman's two-step model and employing a generalized probit specification for R&D investment. To tackle the problem of endogeneity, we adopt an instrumental variable technique with starting business ratings (SBR), hiring index (HI) and trading cost index (TCI) as instruments for horizontal, backward and forward FDI respectively.

Empirical Results

We begin our empirical analysis with investigating the existence of FDI spillovers on the R&D behaviour of incumbent firms (Table 1.1). In the selection equation, the coefficient estimates on horizontal spillover variable (l_1hfd) and backward spillover variable (l_1bfd) are positively significant indicating that FDI increases the probability of investing in R&D activities. The impact, however, is relatively strong for the firms residing in supplying sectors suggesting the flow of knowledge spillovers through backward linkages. The insignificant coefficient estimates on forward spillover variable (l_1ffd) reflect the absence of any such spillovers in the downstream sectors.

In the outcome equation, we observe similar results: l_1*hfd* and l_1*bfd* show a significant positive impact on the R&D intensity, which implies that both rivals, as well as suppliers of foreign affiliates, receive significant spillovers from the presence of MNCs in the host country. Like selection equation, the coefficients on l_1*ffd* in the outcome equation shows no signs of significance reflecting non-existence of spillovers on incumbents acting as clients to MNC affiliates.

Table 1.2 presents the results for the estimation of patent grants used as the innovation output variable. As the estimates show, the relationship between patent grants and l_1*hfd* is positively significant indicating that the presence of FDI in the industry is associated with an increase in innovativeness. It reflects that incumbent firms acting as rivals to foreign affiliates possibly benefit either from the strong competitive pressure or due to the knowledge flows from FDI companies that result from the mobility of people and related spin-offs, demonstration effect and imitation. The estimates concerning vertical spillovers (impact from the foreign presence in upstream or downstream industries) reveal the positively significant impact on firms operating upstream and acting as suppliers to MNCs. However, firms operating downstream as clients to MNCs appear not to receive any spillovers from FDI. Significant estimates for l_1*bfd* imply increased demand for intermediate inputs from MNCs enable local suppliers to operate at a more efficient scale. The positive coefficients on l_1*bfd* also signify that MNCs encourage production of higher quality inputs by providing local suppliers with technical assistance, worker training, managerial and organizational support. Although foreign companies through backward linkages can improve the quality of inputs produced upstream as well as reduce the prices of such inputs, these spillovers, however, do not seem to pass through forward linkages to the firms operating downstream.

Finally, we describe the effect of FDI entry on incumbent's *tfp* growth. The estimates obtained from standard FE, and IV-FE models (Table 1.3) reflect a positive and significant correlation of l_1hfd and l_1bfd with the subsequent *tfp* growth in incumbents, however, with the exception of l_1ffd. The estimated coefficients for both l_1hfd and l_1bfd are significant across all specifications suggesting that FDI not only spurs the productivity growth in the firms operating in upstream sectors but also improves it in the firms competing with foreign affiliates in the same sector. Contrary to l_1bfd and l_1hfd, coefficients on l_1ffd are insignificant in both FE and IV specifications, suggesting lack of benefits to client firms.

We check the prediction from Aghion et al. (2009) that spillover effects on productivity vary depending on incumbents' proximity to/distance from the technology frontier. To test this prediction, we interact FDI variants with the proximity to the frontier variable. The interaction variables appear positively correlated with all the dependent variables supporting the proposition that FDI effects on incumbents are heterogeneous, with firms located near to the best practice frontier benefiting more than ones located further away from it.

Table 1.1: Heckman's Two-Step Estimation Results

Independent Variables	Linearity in size and age				Non-linearity in size and age			
	Selection equation		Outcome equation		Selection equation		Outcome equation	
l_1hfd	0.138**	(0.065)	0.093**	(0.043)	0.141**	(0.063)	0.097**	(0.046)
l_1bfd	0.181***	(0.074)	0.125**	(0.059)	0.187***	(0.079)	0.129**	(0.063)
l_1bfd	0.061	(0.058)	0.093	(0.091)	0.063	(0.058)	0.099	(0.094)
l_1prxm	-0.122	(0.083)	-0.116*	(0.076)	-0.129	(0.089)	-0.137	(0.092)
l_1hfd*l_1prxm	0.166*	(0.071)	0.148**	(0.058)	0.174*	(0.089)	0.151**	(0.063)
l_1bfd*l_1prxm	0.091**	(0.039)	0.073**	(0.028)	0.094*	(0.047)	0.081**	(0.034)
l_1bfd*l_1prxm	0.114	(0.086)	0.103	(0.073)	0.124	(0.098)	0.109	(0.079)
ep	0.013*	(0.008)	0.812***	(0.019)	0.017*	(0.011)	0.893***	(0.027)
im	0.021	(0.019)	0.159*	(0.089)	0.028	(0.025)	0.161*	(0.093)
lns	-0.012	(0.019)	-0.091	(0.095)	-0.037*	(0.021)	-0.118*	(0.097)
lns^2					0.109**	(0.057)	1.056**	(0.482)
$lnag$	-0.053	(0.069)	-0.172	(0.128)	-0.068	(0.072)	-0.188	(0.139)
$lnag^2$					0.298***	(0.081)	0.562**	(0.277)
$lnprf$	0.081*	(0.053)	0.137***	(0.031)	0.093*	(0.058)	0.153***	(0.039)
lvg	0.011*	(0.006)	0.035	(0.029)	0.019*	(0.010)	0.047	(0.041)
lnk	0.063	(0.048)	0.169**	(0.072)	0.071	(0.053)	0.196**	(0.089)
hhi	-0.483*	(0.268)	-0.943**	(0.378)	-0.519*	(0.293)	-0.979**	(0.383)
rdl	0.261***	(0.092)	0.319***	(0.019)	0.278***	(0.099)	0.338***	(0.036)
dlc	0.019**	(0.009)			0.023**	(0.009)		
Mills lambda	-2.472***	(0.489)			-2.618***	(0.513)		
obs.	10542		7280		10,542		7280	

*Standard errors are in parentheses. *, **, *** denote significance at 10%, 5% and 1% respectively. Firm and time dummies included*

Table 1.2: Estimates of Patent Grants

Dep. Var. Patent grants	(1) ZIP		(2) ZIP		(3) ZIP		(4) ZINB		(5) ZINB		(6) ZINB	
l_1hfd	1.309**	(0.728)	1.417**	(0.704)	1.229**	(0.752)	1.198***	(0.350)	1.515***	(0.521)	1.388***	(0.451)
l_1bfd	0.099***	(0.019)	0.066***	(0.014)	0.054***	(0.012)	0.039**	(0.013)	0.044**	(0.017)	0.037**	(0.019)
l_1ffd	0.133*	(0.118)	0.139	(0.126)	0.157	(0.123)	0.154	(0.132)	0.172	(0.161)	0.168	(0.157)
l_1prxm	-0.098**	(0.055)	-0.107*	(0.078)	-0.109*	(0.086)	-0.044*	(0.027)	-0.059*	(0.035)	-0.051*	(0.043)
l_1hfd*l_1prxm			0.194***	(0.069)	0.142***	(0.074)			0.166***	(0.099)	0.172***	(0.092)
l_1bfd*l_1prxm			0.127**	(0.068)	0.133**	(0.079)			0.153**	(0.086)	0.139**	(0.073)
l_1ffd*l_1prxm			0.198	(0.191)	0.176	(0.163)			0.212	(0.209)	0.201	(0.198)
l_1nrd					0.459***	(0.166)					0.475***	(0.147)
lns					0.199*	(0.144)					0.174	(0.153)
ep					0.006*	(0.003)					0.009**	(0.003)
im					0.019	(0.016)					0.012	(0.013)
lnag					0.064**	(0.043)					0.086**	(0.049)
dpp					-0.086	(0.081)					-0.092	(0.087)
obs.	7280		7280		7280		7280		7280		7280	

*Standard errors are in parentheses. ***, **,*denote significance levels at 1, 5and 10 per cent levels respectively. Firm fixed effects and time effects included.*

Table 1.3: Change in *tfp*: FE and FE-IV Estimates

Dep. Var. ΔTFP_{it}	(1) FE	(2) FE	(3) FE	(4) FE-IV	(5) FE-IV	(6) FE-IV
l_1hfd	2.970*** (1.254)	3.015*** (1.581)	3.678*** (1.621)	2.325*** (0.433)	2.550*** (0.666)	2.488*** (0.700)
l_1bfd	1.373*** (0.542)	1.526*** (0.554)	1.602*** (0.713)	1.117*** (0.128)	1.173*** (0.173)	1.224*** (0.208)
l_1ffd	0.398 (0.434)	0.705 (0.746)	0.767 (0.783)	0.279 (0.520)	0.272 (0.527)	0.294 (0.554)
l_1prxm	-0.081** (0.044)	-0.125* (0.068)	-0.129* (0.070)	-0.064* (0.040)	-0.052 (0.046)	-0.094* (0.051)
$l_1hfd{*}l_1prxm$		0.771*** (0.275)	0.748*** (0.277)		0.264*** (0.104)	0.266*** (0.109)
$l_1bfd{*}l_1prxm$		0.334*** (0.116)	0.355*** (0.119)		0.592*** (0.252)	0.602*** (0.257)
$l_1ffd{*}l_1prxm$		0.045 (0.063)	0.053 (0.050)		0.068 (0.059)	0.071 (0.058)
l_1pg			0.114** (0.083)			0.121** (0.089)
lns			0.121 (0.129)			0.174 (0.153)
ep			0.007** (0.001)			0.009** (0.003)
im			0.021 (0.014)			0.025 (0.017)
lnag			0.091 (0.079)			0.086** (0.049)
dpp			-0.011 (0.013)			-0.012 (0.037)
obs.	7280	7280	7280	7280	7280	7280

*Standard errors are in parentheses. ***, **,*denote significance levels at 1, 5and 10 per cent levels respectively. Firm fixed effects and time effects included.*

Conclusion

The mounting prominence of FDI has led several researchers to study the question whether local firms derive any benefit from such inflows and whether spillovers are significant enough to justify the generous treatment given to foreign investors? However, empirical evidence on the effects of FDI on host country firms is not unanimous. It is argued that the dissimilar methodological approaches and different country contexts used in previous research could explain the difference in the findings. Nonetheless, even studies using firm-level panel datasets (seen as the most appropriate type of data to investigate the causal effect of inward FDI on local firms' productivity) diverge. This divergence in the existing empirical works justifies the need for this thesis. The thesis contributes to the literature on many fronts. One it provides a fresh empirical evidence not only on productivity spillovers but innovation spillovers as well. Two it investigates the existence of innovation spillovers in the context of India, which has never been the focus of any empirical work at the time of the present study.

The thesis employs a large firm-level dataset comprising 520 firms belonging to 17-three digit manufacturing industries for the period 2000-2013. By using DEA technique, we have been able to work out *tfp* changes occurring at firm-level and construct best practice frontier for each industry included in the sample. For the vertical spillovers, we have used time-varying input-output tables, which allowed us to consider a changing structure of the economy. We distinguish between various measures of spillovers, such as horizontal and vertical (backward and forward) measures. Examining the spillovers on incumbent firms while taking into account their proximity to the best practice frontier provides insights into the FDI effects on incumbent innovation and productivity.

The results of the thesis are in conformity with some of the previous studies, in the sense that horizontal and backward spillovers are strongly confirmed, while forward ones are found insignificant. Additionally, these spillovers are sensitive to the incumbents' proximity to the frontier. Horizontal spillovers seem to be much stronger for the firms competing with foreign affiliates while as backward spillovers are relatively robust for firms which are domestic. Therefore, being in the supplier position brings in considerable innovation and productivity gains, foreign companies being interested in the quality of supplied inputs, so they provide necessary assistance in the form of technology transfer, know-how and training to the workforce. As a result, firms operating in upstream sectors can improve the quality of intermediate inputs they produce and eventually increase the overall productivity. Moreover, the benefits associated with backward spillovers are more important for domestic suppliers than other foreign suppliers. For clients in downstream sectors instead, the situation appears less favourable.

The study confirms that the proximity to the best practice frontier plays a vital role in the assimilation of spillover. It suggests that companies with higher technical efficiency are better able to benefit from the spillovers than ones with lower technical efficiencies. Empirical estimates reflect that downstream firms cannot exploit the benefits associated with upstream technology transfer besides the FDI.

The existence of intra-industry and inter-industry spillovers (particularly backward spillovers) calls for the policy framework that, on the one hand, will encourage the entry of new firms into the sectors with foreign presence and on the other will strengthen the linkages between foreign affiliates and local suppliers. Moreover, there is a need to devise specific policies for laggard firms located at the lower end of the frontier so that they can enjoy the benefits of spillovers.

Promoting an internationally attractive business environment is vital to derive benefits from foreign investment. By improving the environment for doing business, economies can make it more attractive for companies to invest and manufacture within their borders. Specifically, economies can accomplish this by increasing the ease of doing business in their markets by making it easier to start a business, deal with permits, employ workers, register property, get credit, protect investors, pay taxes, trade across borders, enforce contracts, and close a business.

The efforts to strengthen manufacturing supply chains and improve logistics, investment in education and workforce training, and adoption of sound strategies to improve investment climate would probably help economies to host large foreign investments. High performing supply chains and efficient logistics systems attract investment and boost exports, particularly for small businesses. Economies should look at improving ports and intermodal connections to inland transport infrastructure, streamlining customs procedures, and addressing unwarranted and inconsistent regulation as a way to promote domestic manufacturing.

The results and conclusions in this study are statistically robust, but need to be qualified. In particular, the study only covers firms listed on the stock exchange. There is, thus scope to extend the analysis to take non-stock market firms into account. Further, the study does not take into account the country of origin of the investor, which can have a profound impact on the spillovers generated by foreign firms active in the host country.

LIST OF PUBLICATIONS

Publications:

1. Khachoo, Q. & Sharma, R. (2016). Multinational entry and innovation in host country: does proximity to the frontier matters? *Journal of Economics and Business* (under review)

2. Khachoo, Q. & Sharma, R. (2016). FDI entry and R&D behavior of incumbents: evidence from India. *Journal of Economic Studie*s, 46(3), Indexing: Scopus, Emerald Publication,

3. Khachoo, Q. & Sharma, R. (2016). FDI-induced spillovers on innovation: an investigation into intra and inter-industry effects. *Global Economic Review, 45(4):311-330*. Indexing: SSCI, Scopus, Taylor and Francis Publication,

Conferences Papers and Participation

1. Khachoo, Q. & Sharma, R. (2015) "FDI-induced R&D spillovers on innovation: evidence from Indian manufacturing sector" presented at 8th Conference on Micro Evidence on Innovation and Development (MEIDE), New Delhi, 10-12 February 2015.

2. Khachoo, Q. & Sharma, R. (2016)" FDI and incumbent innovation: an investigation into intra and inter-industry effects" presented at the 52nd Annual Conference of the Indian Econometric Society (TIES) at IIM Kozhikode, 4-6 January 2016.

3. Khachoo, Q. & Sharma, R. (2016) " Foreign entry and patenting by manufacturing incumbents" presented at 3rd Indialics International Conference on Innovation and Sustainable Development at CDS Kerala, 16-18 March 2016.

4. Khachoo Q. & Sharma, R. (2016) "FDI entry and incumbent R&D in Indian manufacturing sector" presented at 9th doctoral conference at IBS Hyderabad, 21-23 April 2016.

Table of Contents

List of Figures

List of Tables

ACRONYMS

CDM	Crepon, Duguet and Mairesse
CEE	Central and Eastern European
DBR	Doing Business Reports
DEA	Data Envelopment Analysis
DIPP	Department of Industrial Policy and Promotion
DST	Department of Science & Technology
EMR	Exclusive Marketing Rights
FEMA	Foreign Exchange Management Act
FERA	Foreign Exchange Regulation Act
FDI	Foreign direct investment
FPE	Factor-Price-Equalization
GDP	Gross Domestic Product
GE	General Electric
GERD	Gross Expenditure on R&D
HCE	Heteroscedasticity Consistent Estimator
HHI	Hirschman–Herfindhal Index
HI	Hiring Index
IMF	International Monetary Fund
IPR	Intellectual Property Rights
KPF	Knowledge Production Function
LHI	Labour Hiring Index
LRM	Linear Regression Models
LP	Labour Productivity
LPG	Liberalization, Privatization, Globalization

MNC	Multinational Corporation
MNE	Multinational Enterprise
MPI	Malmquist Productivity Index
OLI	Ownership-Specific Advantages (O), Location Advantages (L) And Internalization Advantages (I)
OLS	Ordinary Least Squares
PSDC	Penang Skills Development Centre
R&D	Research And Development
RBI	Reserve Bank of India
SBI	Small Business Index
SBR	Starting Business Ratings
TCI	Trade Cost Index
TCS	Tata Consultancy Services
TE	Technical Efficiency
TI	Texas Instruments
TRIPS	Trade-Related Intellectual Property Rights
tfp	Total Factor Productivity
UK	United Kingdom
UNCTAD	The United Nations Conference On Trade and Development
US	United States

Chapter 1

Introduction

1.1. The Context

The thesis is an endeavor to look into the impact of Foreign Direct Investment (FDI) by multinational corporations (MNCs) on the innovative and productivity performances of incumbents firms in the host country. The empirical studies on the impact of FDI on productivity are sizeable; however, the evidence emanating from them is rather mixed and devoid of clarity. Moreover, the empirical research is mostly concentrated on the productivity impact of FDI with a few studies analyzing export related spillovers and spin-offs. Like productivity, FDI can influence the R&D and innovative activities of the incumbents either acting as suppliers or clients to MNCs or competing head-to-head with the latter in the product market. Therefore, the thesis besides examining productivity effect, predominantly aims to explore the impact of FDI on the innovation activities of incumbent firms and provide empirical evidence on it in the context of Indian manufacturing sector. With empirical findings based on rich firm-level data, this research is expected to contribute by deepening understanding of the conditions under which the innovation and productivity of incumbent firms in a host country benefit from FDI spillovers.

In its history, the global economy has experienced many waves of globalization. Each wave of globalization through increasing volumes of international trade, mounting cross-border capital flows and rising migration of workforce has led to growing interdependence among the nation states of the world. One of the noticeable and yet important feature of the globalization at the end of the 20th century was the rapid increase in FDI. The rise in FDI is attributed to the emergence of MNCs which through FDI not only tap the overseas markets but exploit the differences in production costs existing over there. FDI not only allows holding production costs down but also help MNCs to remain competitive in the international market and satisfy their quest for profits.

The unprecedented growth in FDI has given rise to debates about the effects of globalization. These discussions, taking place both in academia and public space; highlight apprehensions of the people regarding the impacts of globalization on developing and less developing countries. The proponents of globalization associate FDI with a series of benefits for the host countries. FDI is seen as an essential ingredient of economic growth, an addition to domestic investment, and a resilient source of financing current account deficit. The supporters of FDI go as far as claiming that FDI, in fact, is a panacea for all economic problems persisting in developing and less developing countries (Ogueze & Odim, 2015). Developing countries usually lack the necessary capital (financial as well as physical) to boost their economic growth. FDI through the transfer of financial capital, technology, and managerial know-how, is capable of improving the growth prospects of these countries as well help them to catch up with developed countries. Those holding anti- globalization and anti-market views, on the other hand, argue that FDI is a new form of colonialism or imperialism (Moosa, 2002; Smith, 2015). It leads to an ever increasing dependence of developing countries on advanced nations for technology and finance, exposes the former to higher geopolitical risks as well as worsens the already existing income inequality in these countries. A substantial foreign ownership often gives rise to concerns about the loss of national sovereignty and compromise over national security. The opponents blame that inward FDI adversely affects employment; retards indigenous technological progress, and worsens the trade balance of the host countries.

Apart from the direct effects positive or negative, FDI is also believed to have indirect consequences for the performance of incumbent firms operating in the host country. These indirect effects usually go under the heading of spillovers, at times also referred as externalities.[1] The constructs of spillovers and externalities although perceived as similar, however, do not exactly overlap. There is a subtle difference between the two. Externalities occur when FDI generates outcomes that become available to other firms at no cost. In other words, these are the benefits that accrue to other actors/companies and for which no compensation is paid out to the FDI firms. Spillovers, on the other hand, are externalities that arise between specific foreign and local agents/firms as a result of some formal or informal relationships between them (Morrissey, 2012). FDI related externalities may be pecuniary or non-pecuniary. As Dunning & Lundan (2008, p. 361) put it, "the former derive from buyer-supplier linkages between MNC affiliates and domestic incumbents wherein the MNC participation influence the supply and demand conditions for local firms." Non-pecuniary externalities also known as technology or knowledge spillovers may be either intentional or unintentional. These occur when the activities of MNC subsidiaries in the host location influence the technological endowment of local firms' as well as foster process of adaptive learning in them. Externalities generated by FDI have long attracted the attention of not only scholars but also of governments and policy makers, interested in the potential developmental impact of FDI on host economies. The topic of this thesis also falls under the realm of FDI-related externalities. In particular, the thesis is an endeavour to look into the spillover effects of FDI on the innovative activities of the incumbent firms operating in Indian manufacturing sector. Spillovers are analysed in the light of the best practice frontier so as to understand whether the location of incumbents in a productivity distribution matters in the assimilation of FDI-related spillovers. In other words, we investigate whether incumbents' proximity to the best practice frontier or distance from it matters in promoting such spillovers. Analysing spillovers

[1] The constructs of spillovers and externalities are used interchangeably in this thesis.

in light of best practice frontier is important since FDI through escape-competition effect and discouragement effect may affect the incumbents' differently. The escape-competition effect emphasize that presence of much advanced foreign firms in host country induce innovation in sectors that are close to the technology frontier while as discouragement effect states that foreign presence impedes innovation in sectors that are further behind the frontier. Incumbent firms close to the frontier have relatively high technical efficiency than firms residing away from the frontier. The former can escape and survive competition threat by innovating successfully or doing more R&D and coming up with new intensive innovations. This Schumpeterian escape-entry effect is similar to escape-competition effect developed by Aghion et al. (2001). In the case of incumbents located further behind the frontier, FDI may discourage their innovation incentives by reducing the expected rents or payoffs from doing R&D. These laggard incumbents with a lower technical efficiency have no hope of winning against the advanced entrants and hence cannot survive entry threat. There is ambiguity in the existing literature regarding characteristics of incumbents in determining spillovers. While some studies (Glass & Saggi, 1998; Pearce, 1999) stress that lower productivity gap between foreign and domestic firms imply substantial spillovers to the later and others argue that significant productivity differential between foreign and domestic firms is a prerequisite for spillovers to occur (Findlay, 1978). Thus, it becomes an important exercise to verify empirically which of the two aforementioned arguments hold while we analyse productivity spillovers in context of Indian manufacturing.[2]

The three principal questions addressed in this thesis are:

[2] Technological externalities lead to productivity spillovers from MNCs to domestic firms in the host country. Technology spillovers and productivity spillovers are distinct, albeit related, concepts, which should be treated as such in empirical analysis Smeets' (2008). The distinction may seem irrelevant from the host country's perspective, however, the policy implications of each are very different. We will use the terms "productivity spillovers" and "technology spillovers" interchangeably throughout the study to refer to the same concept.

(1) Like productivity spillovers, do FDI-related spillovers also manifest on the innovative activities of incumbent firms? Alternatively, apart from productivity, are there innovation spillovers on incumbent firms arising from FDI entry into the host country?
(2) Does incumbent status (as a supplier, client or competitor to the MNCs), affect the degree of spillovers received by it?
(3) Does incumbents proximity to the best practice frontier or distance from it conditions spillovers arising from FDI?

In particular, the study concentrates on the spillovers generated by horizontal and vertical FDI on innovation (R&D and patenting) and total factor productivity *(tfp)* of the incumbent firms, whose main activity falls in the domain of manufacturing. The analysis is carried out for the firms residing in the same industry as MNC as well as for the firms' active in upstream and downstream industries. In other words, while analysing the spillovers arising from FDI, we take the status of firms into account to see whether acting as rivals (intra-industry spillovers) or acting as suppliers/clients to the MNCs (inter-industry spillovers) is more advantageous. Since an incumbent may not have a choice in being the competitor or supplier to MNC, understanding the differential impact (if any) may be relevant for policy recommendation. Further, the location of an incumbent with respect to the best practice frontier is taken into account to verify whether spillovers encourage innovation and enhance productivity in firms staying close to or away from the best practice frontier.

Before we start analysing FDI-related spillovers on innovation and productivity in the context of Indian manufacturing sector, it becomes imperative to define FDI, discuss the status of FDI in India and highlight the policies related to FDI adopted by India and the changes therein over the years. Section 1.2 gives a brief definition of FDI and talks about the different types of FDI and the motives behind them. Sections 1.3 and 1.4 respectively discuss the FDI-related policies adopted by India and highlight recent trends of FDI inflows to India. The nature of R&D and trends in patenting in India is presented in section 1.5. Section 1.6 outlines objectives of the thesis. Section 1.7 gives a brief description of the methodology used in the study. Section 1.8 highlights contribution of the thesis and section 1.9 delineates the organization of the thesis.

1.2. Definitions and Structure of FDI

FDI, besides portfolio investment and bank loans, is one of the main components of international capital flows. FDI represents an investment made to attain a lasting interest or obtaining a long-term stake in an enterprise operative outside the investor's economy. The investment is direct as the investor who may be an individual, a company or a group of entities is seeking a direct control or having a significant degree of influence over the management of the foreign enterprise. The consensus on what constitutes a controlling interest is not undisputed, but shareholding of a minimum of 10% is generally regarded as allowing the direct investor to exert a significant degree of control over the key policies of the enterprise. The International Monetary Fund's (IMF) Balance of Payments (BOP) Manual (1993) defines FDI as, "an investment that is made to acquire a lasting interest in an enterprise operating in an economy other than that of the investor, the investor's purpose being to have an effective voice in the management of the enterprise." FDI involves a long-term relationship, reflects an investor's (parent company's) lasting interest and control over the management of an enterprise residing outside the economy of the investor (UNCTAD, 1999). To comply with the international standard, RBI follows FDI definition provided by the IMFs in BOP Manual 6. According to BOP Manual 6, "direct investment is a category of cross-border investment associated with a resident in one economy having control or a significant degree of influence on the management of an enterprise that is resident in another economy". Apart from the equity that gives rise to control or influence, direct investment also includes investment in indirectly influenced or controlled enterprises, investment in fellow enterprises, debt, and reverse investment. Direct control or influence may be achieved by owning equity, which provides voting power in the enterprise, or could be achieved indirectly through acquiring voting power in another enterprise that has voting power in the enterprise in question. Immediate direct investment relationships entail direct ownership of equities by the direct investor to the extent of 10 per cent or more of the voting power in the direct investment enterprise. If a direct investor owns more than 50 per cent of the voting power in the direct investment enterprise, he is treated as controlling that enterprise. The existence of a significant degree of influence entails that the direct investor owns between 10 to 50 per cent of the voting power in the direct investment enterprise. Indirect direct investment relationships arise when the investor owns voting power in one direct investment enterprise that owns voting power in another enterprise or enterprises, *i.e.*, through a chain of direct investment relationships, an entity is able to exercise indirect control or influence. The key terms "significant degree of control" and "long-lasting affiliation" distinguish FDI from portfolio investments and other forms of international capital flows such as bank loans. Portfolio investment is short term investment undertaken by institutional investors through the equity market. In comparison to FDI, portfolio investment is relatively volatile and therefore keeps on fluctuating even for small changes in the rate of interest and minor disruptions in the political atmosphere of the host country. The term "lasting interest" in foreign entity distinguishes FDI from other forms of capital flows such as international bank loans and financial aid from advanced countries. The long-term interest involves the transfer technical 'know-how' and management skills to the affiliates (Lipsey, 2003). Since firms turn into MNCs by conducting FDI or setting up affiliates abroad and relocating 'a part or all’ of their production activities to these affiliates, therefore, FDI can be used a substitute for the terms like MNEs, transnational company or MNCs.

There are several reasons for firms to internationalize. However, the two primary motives to go multinational are: to tap and cater the demand directly by shifting the production facilities to overseas markets instead of serving them through exports, and to lower production costs by employing economical resource inputs available overseas. These motives are often used as a basis to differentiate between two main types of FDI: horizontal FDI and vertical FDI. While as former can be thought of an investment activity involving foreign manufacturing of products and services that are roughly similar to those produced in the home country, and the latter is associated with the geographical division of the production chain vertically. Horizontal FDI derives its name from the fact that MNC duplicates the same activity across different locations. The motive behind this type of FDI is to save on shipping and trading costs since it is too costly to serve the foreign market by exports due to high transportation costs or trade barriers. Vertical FDI is referred as vertical because while conducting this kind of FDI, MNCs split their production process vertically. The idea is that manufacturing process comprises many stages with different input requirements and that input prices vary across locations. MNCs, therefore, split the production chain vertically by relocating part of their production abroad and via by capitalize on lower production costs existing overseas. For instance, by outsourcing labour intensive production stages to countries where labour is cheap and abundant, MNCs to a great extent can hold their production costs down.

Vertical FDI can be backward oriented or forward oriented and accordingly can be categorized as backward FDI and forward FDI. The former involves establishing a supplier of inputs or buying upstream industries that produce intermediate inputs for the downstream operations of the MNC. This type of FDI mostly occurs in extractive and mining industries such as oil extraction, bauxite mining, tin mining and copper mining. The purpose is to supply inputs to downstream operations like oil refining, aluminium smelting and fabrication, tin smelting and fabrication. In the case of forward FDI, MNCs establish affiliates overseas. These affiliates, as a rule, draw their inputs from the parent companies and hence stay after them in the production chain. Forward FDI also involves purchase or control of distribution outlets and retailers where the foreign investor can sell its products. For example, when Volkswagen entered the US market, rather than distributing cars through independent US dealers, it acquired a large number of dealers to dispose of its vehicles (MacCleary, 2006).

In reality, it is not possible to have a clear division between horizontal and vertical FDI because former also involves affiliates drawing some headquarter services from the parent company, even when the firm duplicates the same production activity in several countries. Thus, each horizontal MNC has some vertical traits. Further, sometimes foreign subsidiaries satisfy the criteria of both horizontal and vertical FDI, so it becomes difficult to separate the two types of FDI. It is called complex FDI- a mix of “vertical” and “horizontal” motivations (Alfaro & Charlton, 2007). The empirical literature has either shown little evidence of purely vertical FDI, or that it is difficult to identify vertical FDI, while there is considerable support for the horizontal FDI hypothesis. Some studies have been concentrating on finding better measures of relative endowments to solve the ‘vertical’ FDI puzzle: interestingly, some of them recognize that even vertical FDI could be partly motivated by market-seeking reasons (Braconier et al. 2002, 2005).

1.3. India’s FDI Policy Framework

Like other developing countries particularly those of East Asian countries, India, with the introduction of the massive programme of liberalization, privatization, and globalization (LPG) also opened up its economy to foreign investment, however, no sooner than last decade of 20th century. Opening up of the economy gave MNCs access to the huge Indian market as well as to the new and cheap production opportunities. Consequently, FDI inflows since then are continually growing; specifically, post year of 2000 further streamlining of the policies related to foreign investment resulted into massive FDI inflows into the economy. Indian economy has now cemented its place in the list of top FDI destination countries of the world. Based on the various policy regime changes related to FDI in India, we analyse the events through three time periods−India's cautious welcome policy towards FDI prior to 1970 (Bhati, 2006); India shutting down to FDI in 1970s and reopening to FDI post-1990s (Choudhury & Khanna, 2014).

1.3.1. Cautious Welcome Policy (1947-1970)

The dawn of independence brought into the spotlight various issues related to the import of overseas capital and the need for defining a policy on foreign investment. The newly independent government recognized that foreign capital participation is essential for the rapid growth of the industry. However, it is equally important to regulate the foreign capital participation for national interest. Indian Prime Minister Jawaharlal Nehru on April 6, 1948, released a declaration stating that government will not object to foreign capital provided that major interest in ownership and effective control of an undertaking rests in Indian hands (Statement on Industrial Policy, 1948). The early years of the 1950s did not see any foreign enterprise gaining a majority ownership in an Industry. However, the notable exception was the licensing of three oil refineries to Stanvac, Caltex, and Burmah-Shellwere 100% foreign ownership was allowed (Kust, 1965). In the 1960s obtaining a majority share in an Indian enterprise, was still a distant dream for foreign investors with only twenty-six of more than four hundred collaboration agreements concluded in 1961 giving the foreign enterprise majority ownership (Choudhury & Khanna, 2014).

The government of India (GOI) realizing the gaps in the production capacity of the domestic firms, started to encourage FDI in new production facilities as well in the areas where domestic production was insufficient to meet the local demand. The government also announced the list of the industries where FDI was welcome. These industries among others included fertilizers, pharmaceuticals, and aluminum. This policy regime attracted several MNCs, particularly in the pharmaceutical sector the number of foreign enterprises increased to forty-six. The rise in FDI inflows was substantial during the period 1957-1963 (Kudaisya, 2011). However, foreign firms in India did face some constraints on account of high import tariffs, import licensing requirements and non-convertibility of the Indian rupee. Before, establishing a plant or starting a business, foreign companies were required to obtain permissions from several government departments. Even after getting a permit, the state interfered in matters like the nature of the item produced and the quantity and pricing of the finished product (in certain industries). These regulations, with extreme controls on FDI, along with a high tariff wall, sheltered domestic companies from overseas competition (Choudhury & Khanna, 2014).

1.3.2. Restrictive FDI Policy (1970-1980)

In the early 1970s, GOI introduced the Foreign Exchange Regulation Act (FERA) which strictly restricted the transactions involving foreign exchange and controlled the import and export of currency. Strict regulation of foreign transactions gave birth to a black market for buying and selling of foreign currency in India. Eventually, the government realized that FERA rules were perhaps a hindrance to economic liberalization. The law was repealed in 1999 and replaced by Foreign Exchange Management Act (FEMA) which to some extent liberalized foreign exchange controls and removed many restrictions on foreign investment. Under the FERA, foreign companies were not allowed to have an equity holding of more than 40%. However, exemptions were at the discretion of the government. FERA not only disallowed setting up of branch plants but prohibited the use of foreign brands as well; however, it promoted hybrid domestic brands in India such as Hero-Honda and Maruti-Suzuki. Apart from creating a black market, critics also blame FERA for slowing down technical capability, loss of export opportunity and encourage rent-seeking on imports of technology by domestic partners, with little efforts to undertake R&D, develop new or improve the quality of existing products and look out for export markets (Ahluwalia, 1985). A small number of out-dated and fuel inefficient car models of the 1950s produced at very high costs by the passenger automotive industry, for instance, probably validates the criticism levelled against FERA. The 1980s witnessed a gradual relaxation of the foreign investment rules-perhaps best symbolized by the setting up of joint venture project of small car manufacturing of Maruti with Japan's Suzuki Motors in 1982. It was followed by Pepsi's entry in the second half of the decade, to primarily export processed food products from Punjab, and also to bottle its popular beverages for the domestic market.

1.3.3. Reopening to FDI post-1990s

Indian economy experienced a significant policy shift in 1991when the GOI, on the advice of IMF, introduced a chain of massive economic reforms (known as LPG) to boost global business, manufacturing, and financial services in India. It was made clear in the Industrial policy resolution of 1991 that foreign investment is indispensable for economic growth as it brings advantages of technology transfer, marketing know-how, managerial techniques and new possibilities for export promotion. To attract foreign capital necessary measures were undertaken which among others include: removal of ceilings on foreign equity, allowing entry and expansion of FDI into consumer goods, lifting of restrictions on the use of foreign brand names in the domestic market, abandoning the local content and foreign exchange balancing clauses that were existing earlier. In order to boost FDI participation in the local economy, a few parallel measures such as abolishing industrial licensing system and withdrawing from the primacy given to public sector were initiated. To provide a further boost to inflows, foreign investors were allowed to take automatic approval route which allows them to undertake investment projects without taking a prior approval from the Central Government. Besides, from time to time, additional steps have been taken by the Government of India to remove the hurdles in the path of foreign investors both at the stage of entry and later in the process of establishing the venture.

Along with relaxing the FDI regime, parallel steps were taken to allow foreign portfolio investments into the Indian stock market through the mechanism of foreign institutional investors. India, thus, adopted a two-pronged strategy to encourage foreign investment: one to attract FDI and two to stimulate the inflows of portfolio capital with an aim to ease out the financing constraints faced by Indian enterprises. This was achieved by streamlining the procedures and removing investment caps that exist earlier in certain sectors. As a result of these policy changes, both FDI and portfolio investment has shown tremendous growth over the years. It may not be out of place to mention here that like some of the other countries particularly East Asian countries, India now follows an FDI regime which is considered as investor friendly.

1.4. Trends in FDI inflows to India

Private foreign capital has a substantial presence in Indian industry prior to independence in 1947. Foreign firms mostly British in origin dominated India’s mining, plantation, trade and much of the fledgling manufacturing base. At the time of independence the total stock of private foreign capital in India was valued at $1.2 billion at 1948 exchange rates (Athreye &

Kapur, 2001). After independence with the departure of foreign companies from India foreign capital started dwindling. In the 1960 the private foreign capital amounting $0.39 billion was recorded in India. In the 1970s there was hardly any new foreign investment in India: indeed some of the foreign firms left the country. Inflows of FDI remained meagre in the 1980: they averaged less than $0.2 billion per year from 1985 to 1989. In the 1990s, as part of wide-ranging liberalization of the economy, fresh foreign investment was invited in a range of industries. Table 1.1 highlights the year wise level of FDI inflows and their annual growth rate from 1970-2015.

New policy regime changed the perception of foreign investors towards India. FDI inflows started picking up from a mere $0.73 billion in 1990, reached more than $2 billion in 1995 reflecting a more than two-fold increase over a five-year period. As evident from Table 1.1, early years of the 2000s also witnessed a rise in foreign capital inflows. Compared to $4.02 billion inflows received in fiscal 2000-01, the inflows for the 2001-02 fiscal stood at $6.13 billion, representing a growth of 52% over the previous year. This surge in inflows can be seen as a corollary of FEMA (1999) which alongside liberalizing foreign exchange controls, took away many restrictions on foreign investment. The upward trend, however, could not sustain for 2002-03 and 2003-04. In these years, FDI inflows dropped down by 18% and 14% respectively. FDI inflows underwent an upsurge after 2004-05; more specifically the surge was phenomenal post 2005-06 fiscal. From $4.32 billion in 2003-04, FDI inflows increased to $6.05 billion in 2004-05 and to $8.97 billion in 2005-06, registering a growth rate of 40% and 48% respectively over the previous years. India received FDI inflows amounting $22.82 billion in 2006-07, 154% higher than 2005-06 figures. The rising trend in inflows sustained throughout 2007-08 and 2008-09. FDI inflows rose by 53% to $34.84 billion in fiscal 2007-08 and further to $41.87 billion in 2008-09 exhibiting 20% growth in inflows over the previous fiscal. This substantial rise in FDI inflows can partly be attributed to the opening up of the capital account. As part of the capital account liberalization, FDI was gradually allowed in almost all sectors, except a few on the grounds of strategic importance, subject to compliance with sector-specific rules and regulations.

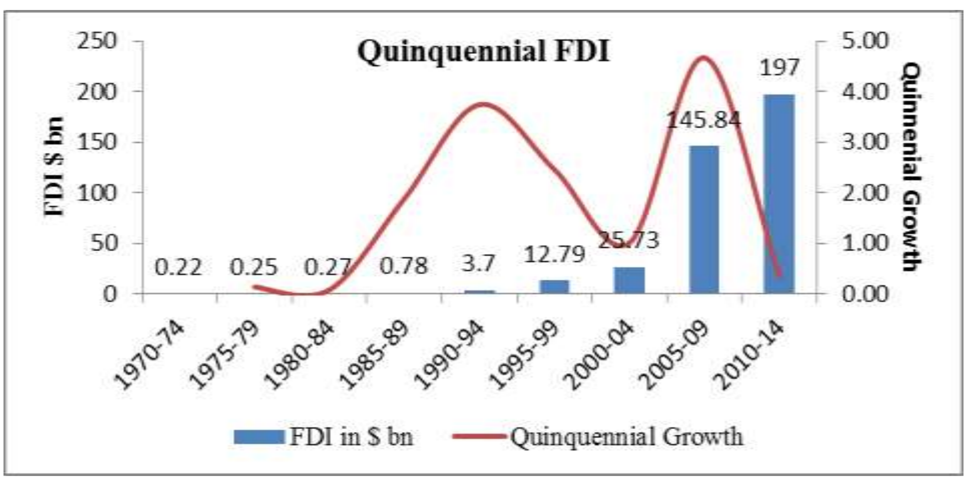
During 2009-10, a year of financial crisis, FDI suffered a setback with inflows declining by 10 % to $37.74 billion. FDI in 2010-11 further fell by 8% to $34.84 billion. During 2011-12, FDI inflows to the country rose by 34 % to reach $46.55 billion before plummeting down by significant 26% to $34.29 billion in 2012-13. The drop in inflows could be attributed to sluggish growth coupled with high inflation that economy experienced in 2012. The slow pace of policy reforms related to land acquisition and environment, as well as a delay in opening up of sectors like retail; insurance and real estate for 100% FDI are believed to have deterred FDI flows into India. Towards the year end of 2012, the government took many initiatives to prevent the further fall in inflows. For instance, it allowed FDI into multi- brand retailing as well as streamlined procedures for FDI in single-brand retail and petroleum refining. GOI further relaxed its rules for FDI in aviation and television broadcasting and also gave approval to 100% foreign ownership in telecommunication. As a result of these policy initiatives and some other parallel measures, inflows into India bounced back to $36.86 billion in 2013-14, showing an increase of over 5% than the preceding year. India received foreign investment amounting $45.14 billion in 2014-15 up by significant 25% compared to previous fiscal, while FDI figures for the year 2015-16 stood at $55.48 billion, registering a rise of 23% over the previous fiscal. This upsurge in FDI inflows is probably the outcome of “Make in India” programme, an initiative by the GOI designed to accelerate inflows and foster innovation through building best-in-class manufacturing infrastructure and protecting intellectual property rights. According to the latest data release by the Department of Industrial Policy & Promotion (DIPP) India, the cumulative FDI inflows from April 2000 to March 2016 stood at $424.167 billion.

Table 1.1: Trends in FDI inflows (1990-2015) and its % Growth

Year	FDI Inflows ($ bn)	% Growth	Year	FDI Inflows ($ bn)	% Growth
1970-71	0.05		1993-94	0.58	-0.11
1971-72	0.05	0.05	1994-95	0.97	0.67
1972-73	0.02	-0.63	1995-96	2.01	1.07
1973-74	0.04	1.13	1996-97	2.42	0.20
1974-75	0.06	0.50	1997-98	3.57	0.48
1975-76	0.09	0.49	1998-99	2.63	-0.26
1976-77	0.05	-0.40	1999-00	2.16	-0.18
1977-78	0.04	-0.29	2000-01	4.02	0.86
1978-79	0.02	-0.50	2001-02	6.13	0.52
1979-80	0.05	1.68	2002-03	5.21	-0.15
1980-81	0.08	0.63	2003-04	4.32	-0.17
1981-83	0.09	0.16	2004-05	6.05	0.40
1982-83	0.07	-0.22	2005-06	8.97	0.48
1983-84	0.01	-0.92	2006-07	22.82	1.54
1984-85	0.02	2.41	2007-08	34.84	0.53
1985-86	0.11	4.51	2008-09	41.47	0.20
1986-87	0.12	0.11	2009-10	37.74	-0.10
1987-88	0.21	0.80	2010-11	34.84	-0.08
1988-89	0.09	-0.57	2011-12	46.55	0.34
1989-90	0.25	1.76	2012-13	34.29	-0.26
1990-91	0.73	1.90	2013-14	36.86	0.07
1991-92	0.77	0.05	2014-15	45.14	0.22
1992-93	0.65	-0.16	2015-16	55.48	0.23

Source: UNTAD and World Development Indicators (WDI), World Bank.

Table 1.2: Quinquennial FDI inflows



Source: UNCTAD &WDI, World Bank.

1.5. Nature and Status of R&D and Patenting in India

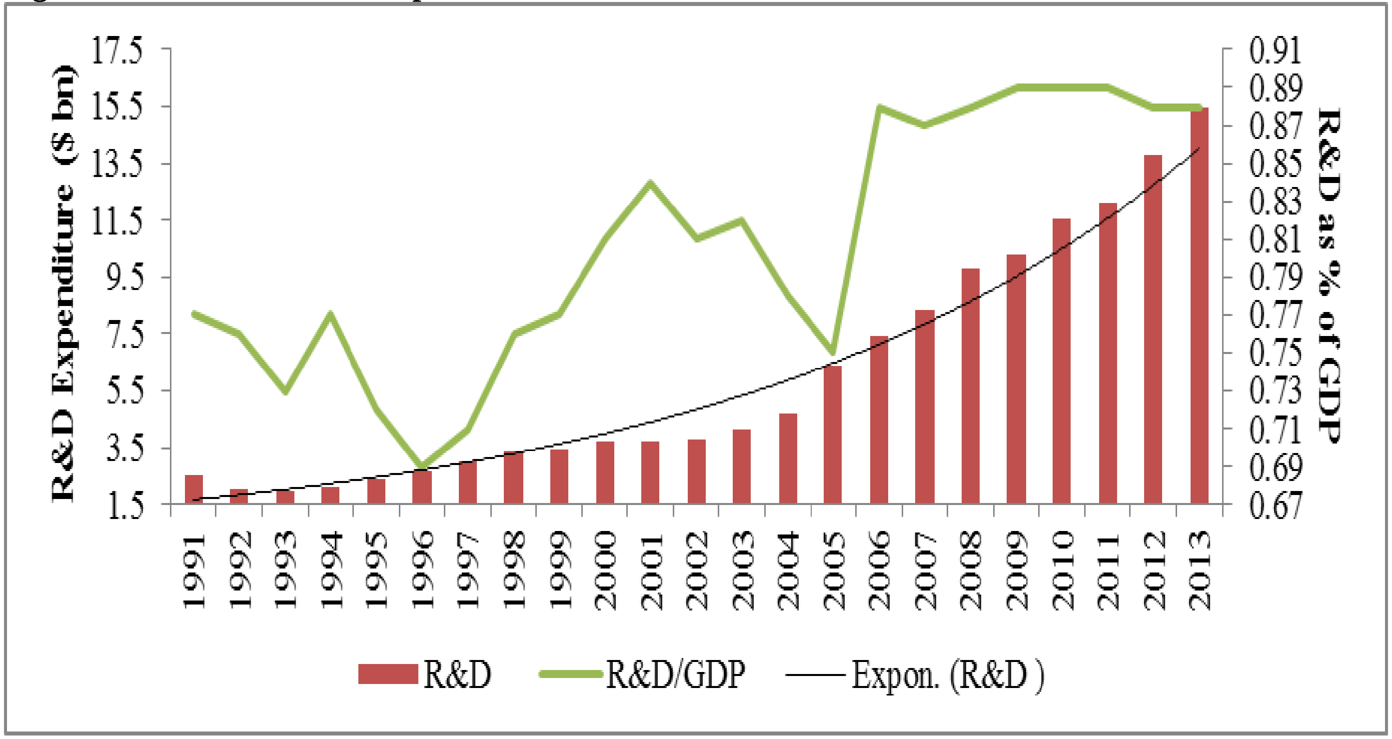
1.5.1. R&D in India

The Indian Research and Development (R&D) System can be grouped by way of a variety of performers and funding sources. The performers include the national laboratories, universities, in-house R&D laboratories and non-profit organizations. The funding sources include the Central Government, State Governments and the industry. In the Central Government, scientific research is carried out under both these groups. R&D performing bodies inter alia included Department of Atomic Energy (DAE), Department of Space (DOS), Defense Research & Development Organization (DRDO), Council of Scientific and Industrial Research (CSIR), Indian Council of Agricultural Research (ICAR). In the R&D funding group fall the Department of Science & Technology (DST), Department of Biotechnology (DBT), Ministry of Earth Sciences (MES) etc. among others.

Although the primary role of R&D performing group is to undertake R&D, they also sponsor some amount of extramural research in the areas of their interest. On the other hand, the R&D funding group is primarily engaged in its major role of promoting scientific research in extramural mode. Research carried out by the Public Sector, Private Sector and Non-Governmental Organization is supported mainly with their own sources. Whereas, Academic Sector performs R&D through both intramural as well as extramural sources. It may not be out of place to mention that scope and coverage of the R&D activities has been revised and substantially enlarged by including R&D expenditure incurred by multinational companies, small scale industries and companies not covered by the Department of Scientific and Industrial Research (DSIR) under its recognition Scheme.

Gross expenditure on R&D (GERD) in India has shown a consistent rise over the years (figure 1.2). It increased from $2.51 billion in 1990-91 to over $15 billion in 2012-13 showing a more than sevenfold increase. After recording a slight decrease in the early years of liberalisation, GERD started picking up post 1994-95. From $2.38 in 1995-96, it increased to $3.73 billion in 2000-01 registering an increase of more than $1 billion. GERD amounting $4.71 billion in 2004-05 increased more than three times and stood at $13.81 billion in 2011-12. Although, there has been a substantial rise in absolute amount of R&D, the relative share of R&D to GDP, however, improved marginally. India's R&D/GDP ratio currently hovering at 0.88% gradually mounted from 0.77% in 1990-91 to 0.89% in 2010-11. The relative share of R&D in India's GDP plummeted to 0.69% in 1995-96 afterwards it increased consistently and reached 0.84% in 2000-01. R&D to GDP ratio recorded a fall for over a stretch of four years post 2000-01. The ratio plunged to a low of 0.75% in 2004-05; however, it started improving afterwards and reached around 0.87% by 2009-10. During the same period per capita R&D expenditure in India more than doubled from $4.8 in 2004-05 to $10.29 in 2009-10. In terms of PPP$, the GERD in India was $16.6 billion in 2004-05. However, the same increased to $40 billion in the year 2011-12. As a percentage to world GERD, India's share increased from a mere 1.9% in 2004-05 to 2.1% in 2011-12. While over the years, R&D figures have shown a healthy increasing trend, but with a mere 2.1% share in the global R&D expenditure compared to USA (33.6%), Japan (12.6%) and China (12.6%), India is still lagging behind in the field of technology and innovation. To improve the R&D status and enhance its position (regarding technology and scientific knowledge) at the global level, India not only requires an increase in overall R&D spending but also virtually needs research and innovation in all the key areas.

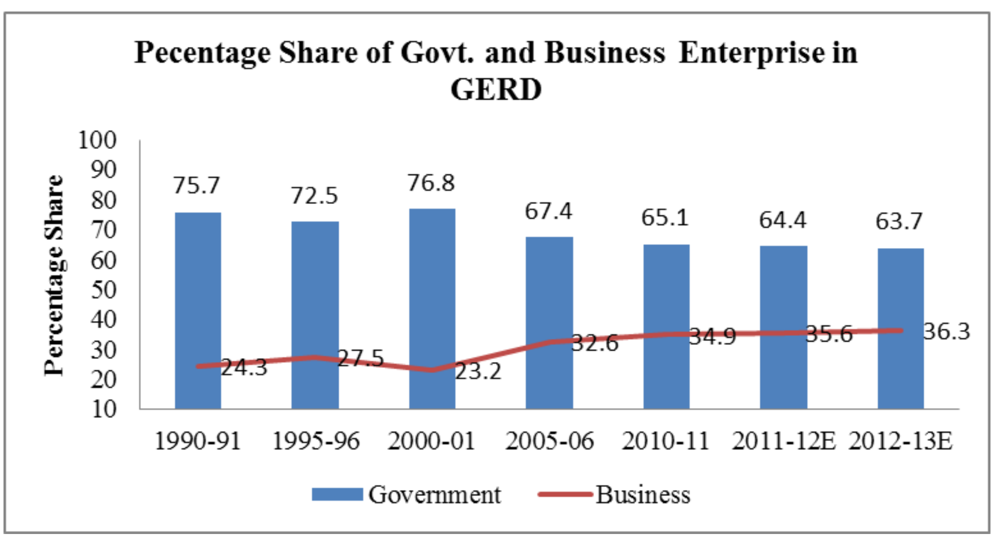
Figure 1.3: Trends in R&D expenditure since 1991



Source: Department of Science and Technology (DST), various reports.

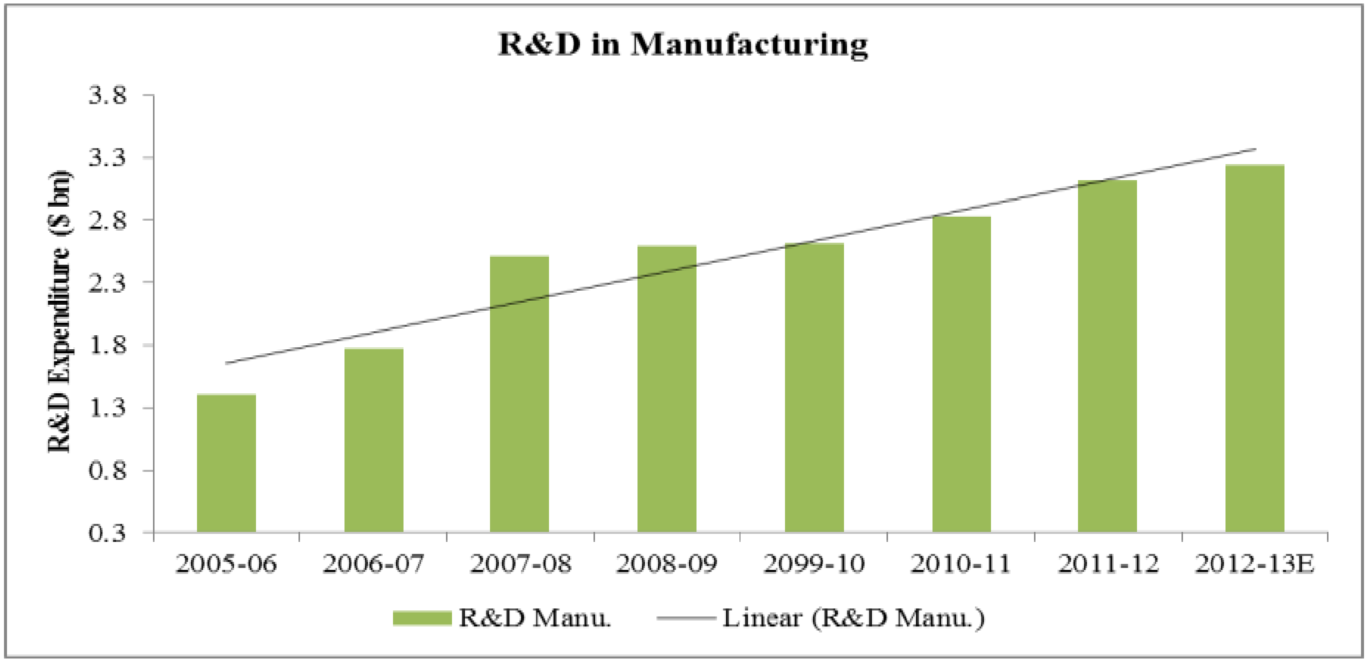
R&D expenditure in India is mainly driven by the government sector comprising of central government and state governments. Even now the government accounts for over 63.7% of the total R&D performed within the country although the share of government has tended to come down over time (Figure 1.3). This has been accompanied by an increase in R&D investments by business enterprises, which now account for about 37% of the total – a significant increase from just 24% in 1991 (for China the similar percentage is about 71% by business enterprises and research institutes (read government) account for only 19%). The increase in the share of R&D performed by business enterprises is generally considered to be a desirable trend as business enterprises tends to implement or commercialise the results of their research rather more quickly than the government sector where much of the research does not fructify into products and process for the country as a whole. R&D spending in industries such as drugs and pharmaceuticals, transportation, information technology, chemicals, bio-technology, electrical and electronics is predominately private while as in defence, fuels, and metallurgy most of the R&D is Public R&D.

Figure 1.4: Share of Government and Business Enterprise Sector in GERD



Source: Source: DST, various reports.

Figure 1.5: R&D trends in Manufacturing Sector



Source: Author's calculation form Research and Development Statistics 2011-2012
Note: excludes agriculture, forestry & fishing, mining & quarrying, defense & telecommunications

It may not be out of place to highlight the nature and extent of R&D activities undertaken in India. The R&D activities in India are largely adaptive in nature because domestic firms pursue R&D either to adapt the imported technology to local needs or to reverse engineer the R&D products of MNCs. Similarly, foreign affiliates undertake R&D to adapt the technologies brought from the parent organizations The adaptive nature of R&D also manifests in the increase in the frugal innovations like Tata Nano, GE's portable electrocardiography (ECG), Pureit water filters and Micromax phones (Battelle & FICCI, 2013). The demand for such innovations arises from local needs, user preferences and paying capacity of customers. However, there is an upsurge in patenting which suggests that innovative R&D in India is rising. Some of the high-tech hubs like Bengaluru, Chennai, Delhi, Hyderabad, Mumbai and Pune have seen the maximum patenting activity (FICCI, 2013). The surge in Indian patenting is to be ascribed to foreign R&D centres. As Mani (2009) asserts that rise in patenting does lead one to infer that India has become innovative rather it has become an important location for innovative activity to occur.

1.5.2. Patenting in India

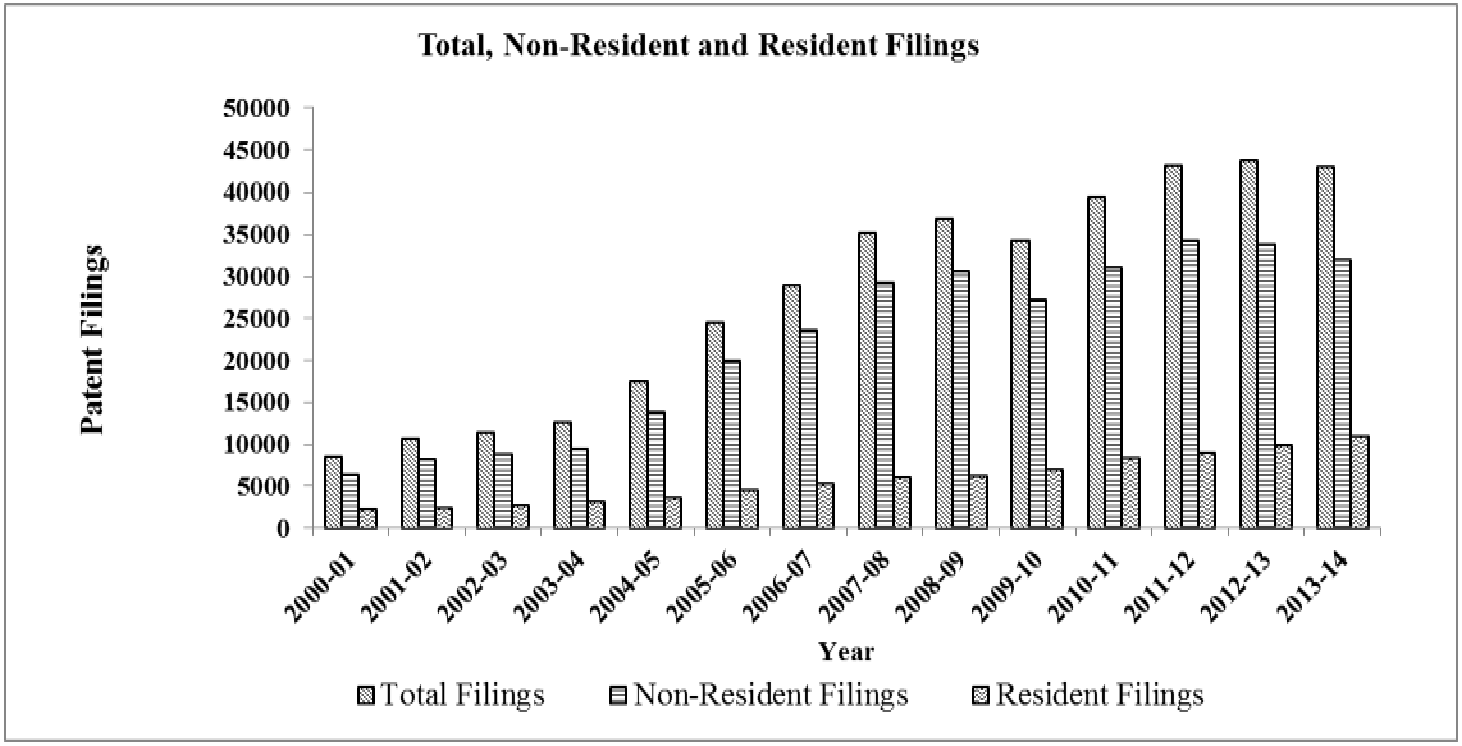
India introduced a full product patent regime a decade later in 2005 after signing the agreement on Trade-Related Intellectual Property Rights (TRIPS) in 1995. However, before 2005, Indian patent law has been amended twice in 1999 and 2002. Each amendment increased the compliance of Indian patent laws with TRIPS. In 2005, India allowed product patents in pharmaceuticals, chemicals, drugs, food, and agrochemicals as well as extended the patent expiry period to twenty years, similar to that in the US. The patent regime also granted exclusive marketing rights (EMRs) based on patents granted, thus enabling foreign firms with patents to derive competitive advantage in selling their patented products. These reforms in patent system succeeded in allaying the fear of intellectual property theft in MNCs and eventually gave rise to the increase in the patent filings with Indian Patent Office (IPO).

Despite some issues being raised about the compliance of Indian patent regime with international benchmarks, the patenting activity in India has grown rapidly. The filing statistics as shown in Figure 1.3 clearly indicate the expansion of the patent sector. In absolute terms the number of patent filings in 2003-04 stood at 12,613 compared to 11,466 filings in 2002-03 representing a 10% growth in the flow of applications. As opposed to 9,395 non-resident filings, the number of resident filings were 3,218 contributing approximately 25% of the total number of filings during the year. This figure has risen nearly 39% to 17,466 filings in the corresponding period between 2004 and 2005 with local filings up by 21% to 3,630. Out of a total of 24,505 applications filed in 2005-06, only 4,521 (18.44%) were submitted by Indians, with remaining 19,984 filed by non-Indians. Indian patent office received 28,940 and 35,218 applications in 2006-07 and 2007-08, reflecting a growth of 18% and 22% in total filings. During the same period the number domestic filings went up by 18% and 14% to 5,314 and 6,040 respectively. The number of patent applications filed in 2009-10 was 34,287 compared to 36,812 in 2008-09 representing a decrease of about 7% in the filings. The number of applications for patents which originated in India were 7044 contributing nearly 21% of the total number of filed applications during the year. This figure has risen nearly 25% to 42,951 in the corresponding period between 2013 and 2014. The number of Indian filings also picked up approximately by 56% during the same period. With the digitization of patent office records, new search interface, and e-filing options being available, coupled with the setting-up of the Indian Patent Office (IPO) as a search and examining authority, patent filings and grants are likely to register healthy growth in near future.

The statistics on patent applications reveal that there has been a rise in the patent filings in India over the years. The resident as well as non-resident filings have grown tremendously, with filings by later showing a higher rise than the filings by the former. The number of patent filings portray a more general picture of the innovation scenario in the country; however, the true state of innovation is better reflected when we look into the figures on patent grants and analyze their growth over the years.

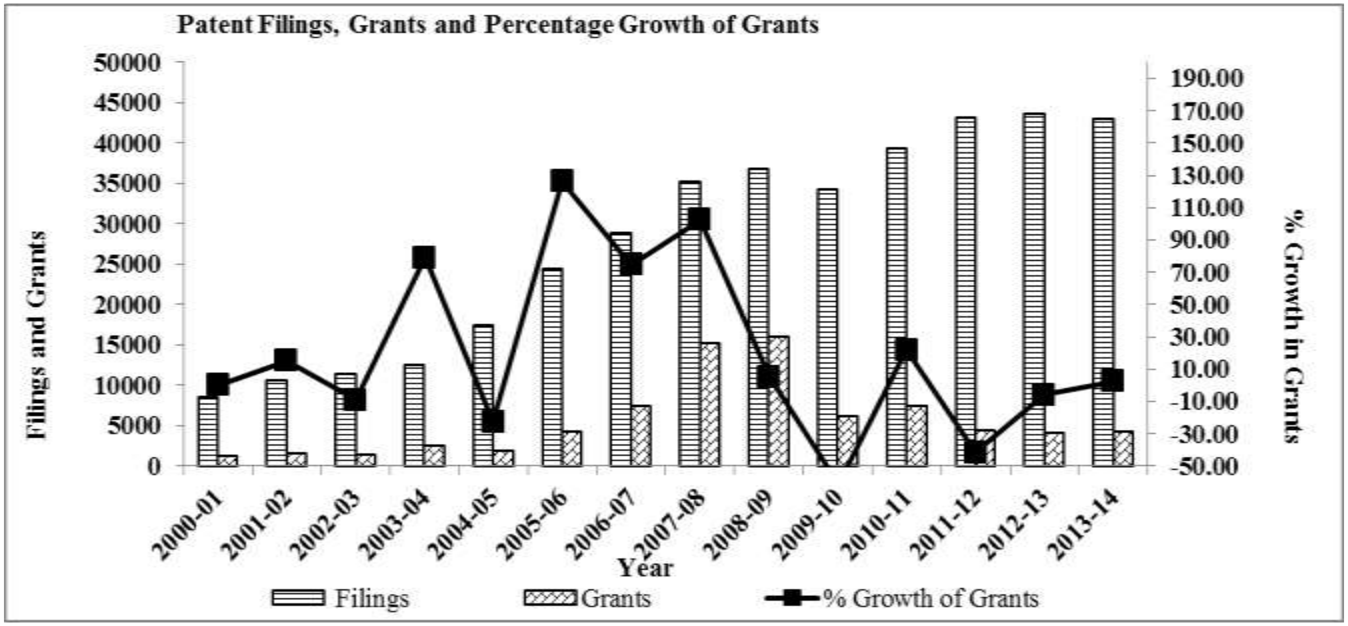
During the financial years of 2001-02 and 2002-03, patent grants registered an annual growth of 15% and -9% during the same period. The growth rate in grants picked up by 79% to 2,469 grants in 2003-04 fiscal before dropping by nearly 23% to 1,911 grants in 2004-05. From 2004-05 onwards both the patent filings and patent grants witnessed an upsurge which continued till 2009-10. This rise is the outcome of a digitization drive carried out from 2006-09 resulting in publication of about 1, 20,000 applications during the period. As a result, the applications which got examined during previous years were mature for grant during 2007-08 and 2008-09 and consequently 15,316 and 16,061 patents were granted during these years respectively. India has seen a sharp drop in patent grants from 2008-09 onwards. The figures significantly plummeted to 4,126 in 2012-13 showing a drop of 74.31% as compared to 2008-09 figures (16,061 grants). This sharp drop in patent grants can be explained in terms of: one shortage of skilled man power with patent office for examining the patent applications, two the introduction of quality system in the patent office from 2009 onwards by adopting patent manual, patent office procedures and various guidelines regarding quality examination.

Figure 1.6: Patent filings in India from 2000-01 to 2013-14



Source: Annual Reports from the Office of the Controller General of Patents, Designs, Trademarks and Geographical Indications

Figure 1.7: Patent filings and grants in India from 2000-01 to 2013-14

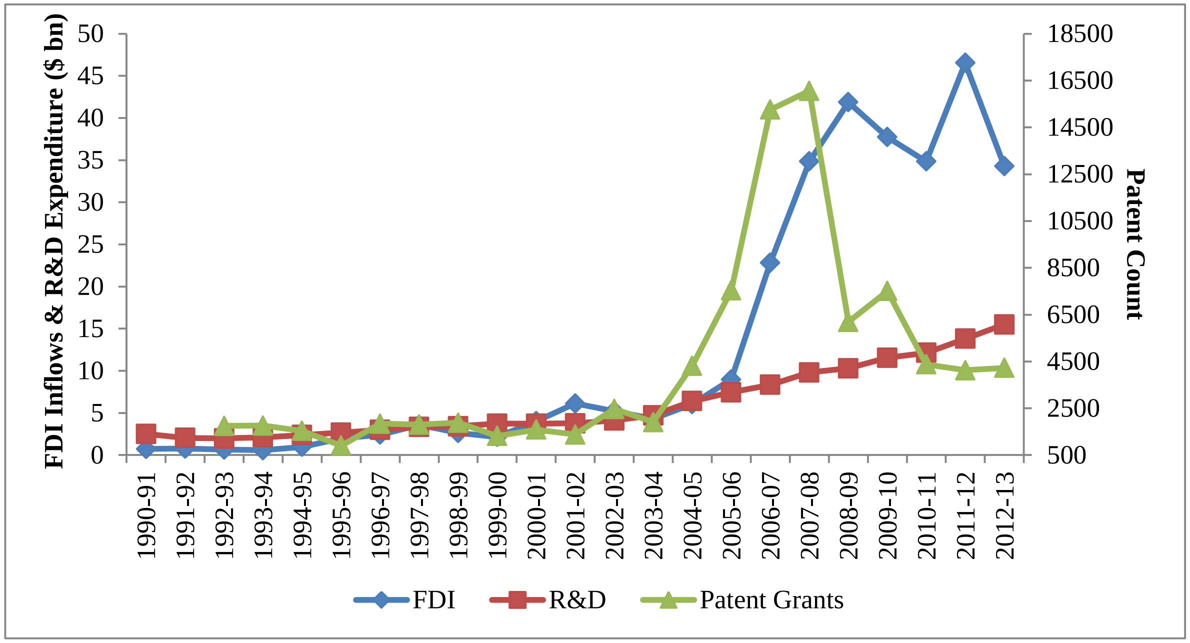


Source: Annual Reports from the Office of the Controller General of Patents, Designs, Trademarks and Geographical Indications

To get a rough idea about whether R&D expenditure, patent grants and FDI inflows move in cohesion, we have plotted them together in Figure 1.8. As evident from the figure all the three variables behave more or less same till 2003-04. FDI and patent grants have recorded drastic change while as R&D has risen smoothly post 2004-05. The drastic increase in FDI inflows was largely due to the expanded list of industries or sectors which were opened up for foreign equity participation. This was followed by relaxation of various rules, regulations and introduction of various policies by the government to promote the FDI inflows. The rise in patent grants can be partly attributed to the growing presence of Western multinationals in India's industrial landscape. Thanks to a surge in FDI in both manufacturing and R&D over the past five years, foreign MNCs have been playing a growing role in innovation and patenting in India. In 2013, foreign companies represented 81.7% of domestic patents obtained from the USPTO; in 1995, they had accounted for just 22.7% of the total (Mani, 2014). In part the upsurge in patent grants may be ascribed to the decision by GOI to grant product patents for pharmaceuticals, drugs and agrochemicals. Due to the mailbox provision patents filed specifically in the areas of pharmaceuticals, drugs and agrochemicals were kept on hold for a period of ten years from 1995-2005. Although, inventors were allowed to file patent applications during this period but the decision to grant a patent on such applications was delayed up until Jan 1, 2005. This could be a potential reason for the spurt of patent grants post 2005.

The steady growth in R&D expenditure is largely the result of tax incentives extended by the GOI to encourage domestic enterprises to commit more resources to R&D. This policy has evolved over time and is now one of the most generous incentive regimes for R&D in the world: in 2012, one-quarter of industrial R&D performed in India was subsidized (Mani, 2014). Also foreign investment in India has grown significantly over the years. India is home to about 870 MNC centers utilizing the workforce here. In absolute sense, R&D expenditure by FDI companies has shown a robust increase from $0.06 billion (INR 2.86 billion) in 2002-03 to $0.62 billion (INR 28.83 billion) in 2009-10 (FICCI, 2013). The share of foreign companies in overall R&D has risen to around 20 percent according to the most recently available estimates. The 'knowledge augmenting' or 'knowledge exploiting' strategies of MNCs have led to setting up of increased number of R&D centers in physical proximity to the manufacturing units in India. These strategies seem to be driven by the 'pull' factors of MNCs as they seek substantial market share here. This strategy has been on the rise with the development of global innovation networks (Basant, 2012).

Figure 1.8: Trends in FDI Inflows, R&D Expenditure and Patent Grants



Source: WDI, DST and Various Annual Reports from the Office of the Controller General of Patents, Designs, Trademarks and Geographical Indications

1.6. Objectives of the study

Many developing countries attract foreign investment in an attempt to improve the productivity of domestic firms. However, it is ambiguous whether local firms learn from the inflows of foreign investment, and if they do, which firms derive more benefits. It is also equally unclear which forms of FDI whether horizontal or vertical are most beneficial to host country firms. Moreover, there seems to be no consensus on where does the FDI-related spillovers manifest predominantly, i.e. which measure of firm performance (innovation or productivity) is mostly affected by FDI. So, keeping in view the ambiguities lingering the spillover mechanism, the thesis is an endeavour to explore whether incumbent firms are able to translate the externalities received from MNCs into the productive use and if these spillovers manifest on their innovation like they do on productivity. The thesis has three particular objectives.

1. To examine and differentiate between spillovers from different types of FDI and empirically measure the magnitude of their impact on incumbent innovation and productivity.

2. To analyse whether spillovers are relatively stronger for incumbents serving as suppliers and/or clients to MNCs than the incumbents acting as rivals to them.

3. To examine if the proximity to best practice frontier help incumbents to assimilate FDI-related spillovers more easily than incumbent firms located further behind the best practice frontier.

1.7. Methodology

Based on the interconnectedness of the thesis objectives, we employ an augmented version of Crepon et al.'s (1998) model. The model consists of few subsequently related equations- the innovation expenditure equation linking R&D expenditure to its determinants; the innovation equation linking R&D spending to innovation output; and the productivity equation relating innovation output to the productivity. The innovation expenditure equation models both the decision to invest in R&D and the actual level of R&D by a firm as a function of FDI spillovers. The second equation specifies the innovation output (patenting) of a firm as a function of its own R&D investment and FDI spillovers. In the productivity equation, innovation output (patenting) enters as an exogenous variable along with FDI spillover variables. In all the specification, along with the variables of interest, are incorporated firm and industry specific controls, which determine the changes in the dependent variables. The purpose for inclusion of innovation output as an exogenous variable in productivity equation is to explicitly account for the fact that innovation output influences the changes in productivity. Firms invest in R&D to develop process and product innovations, which in turn contribute to their productivity. The model, therefore, encompasses two subsequently linked relationships: the innovation relation linking FDI spillovers to innovation and the productivity relation linking innovation output and FDI spillovers to the changes in *tfp* occurring at firm-level.

The two major problems inherent in the model and the nature of the data are selectivity and endogeneity. The problems if untreated may render the empirical estimates highly biased. Most of the studies on R&D partially suffer from the selection problem. Of all the firms engaged in R&D activities, only a minority make their R&D expenses public. So the studies restricted to firms that report their R&D expenditure are prone to selectivity bias. Further, endogeneity has been a major issue with many of the past studies on FDI and R&D. The endogeneity is a major problem here as well. For example, R&D is endogenous in the innovation equation and FDI spillover variables are endogenous in both the innovation and the productivity equations. Further, disturbances in our model, reflecting in part the unobserved variables and firm effects, are also likely to be correlated.

We deal with all these estimation issues by relying on econometric techniques that eliminate the problems of selectivity and endogeneity. The selection bias is addressed by relying on the Heckman's two-step model and employing a generalized Probit specification for R&D investment. To tackle the problem of endogeneity, we adopt an instrumental variable technique with starting business ratings (SBR), hiring index (HI) and trading cost index (TCI) as instruments for horizontal, backward and forward FDI respectively.

Econometric analysis is based on a micro-level (firm level) dataset comprising 520 firms belonging to 17- three-digit manufacturing industries. The study covers a period of 14 years spanning from 2000 to 2013. The sample comprises firms from high-tech, medium-tech and low-tech sectors, thereby removing the bias of including firms from a specific sector only[3]. However, the sample is not evenly distributed across industries. The majority of the firms in the sample are either from high-tech or from medium- tech industries, with a relatively less number of firms coming from low-tech industries. The selection of the sample is guided by the availability of the data. From the database, we select the firms whose main activity is in manufacturing and are listed on the National Stock Exchange over the period 2000-2013. We have 14 years of observation per firm; hence the maximum number of observations is 7280.

1.8. Contribution of the study

The thesis as an addition to the existing literature examines the existence of FDI-related innovation and productivity spillovers arising to incumbent firms operating in Indian manufacturing sector. It differentiates between spillovers generated from horizontal and vertical FDI and again in case of vertical spillovers distinguishes between spillovers generated by backward FDI (through the linkages between domestic suppliers and foreign clients)

[3]We have followed OECD (2003) classification to define different technology sectors and drawn concordance with NIC 2008. Further details are given in Chapter 4.

and those arising from forward FDI through the linkages between MNCs and local clients. This is done by means of a dataset on FDI by industry supplemented with information on buyer-supplier linkages obtained from a series of national input-outputs tables. The study develops intra-and inter-industry measures to capture the effects of FDI on innovative and productivity activities of the incumbent firms' active in the same industry as the MNCs and in upstream and downstream industries. The study as a departure from traditional productivity approach directly examines spillovers on innovation. Examining the spillovers on innovation is relatively more desirable because theories usually make predictions about the effects of foreign entry on innovation rather than about the (derived) productivity effect. As Stiebale & Reize (2011) argue that a better way to assess the spillovers on domestic firms is to examine not only their productivity but also their innovation activities such as spending on R&D or introduction of product and process innovations. Likewise, Salomon & Shaver (2005) advocate that learning from FDI can be more thoroughly captured by observing the innovative output of incumbent firms rather than their productivity, for productivity necessarily generate innovation output.

While analysing the impact of FDI entry on incumbent innovation and *tfp*, the study pays particular attention to the heterogeneity in the FDI spillover effects, i.e., whether these effects are conditioned by the incumbents' proximity to or distance from the best practice frontier. Since in the existent spillover literature, empirical evidence regarding dependency of FDI spillovers on incumbent characteristics is conflicting. While some of the empirical studies maintain that firm characteristics such as higher technical efficiency and absorptive capacity are essential for spillovers to materialize. Others argue that for the spillovers to occur there must be a technological gap between foreign entrants and existing incumbents. Therefore, to clear the air about this ambiguity, there is a need for further empirical analysis of the spillover effects.

1.9. Outline of the Thesis

This thesis is divided into five further chapters. The next chapter reviews the literature followed by chapter 3 which describes the research frame work and hypothesis development. Chapter 4 presents the baseline econometric model and discusses the various econometric issues inherent in the data. Chapter 5 covers the empirical analysis and Chapter 6 provides conclusion and discusses policy implications.

Chapter 2 conducts a broad survey of the theoretical and empirical literature on the innovation and productivity spillovers generated by foreign affiliates' activities in host countries. It further defines the basic concept of spillovers and distinguishes between spillovers and externalities and again between pecuniary and non-pecuniary externalities while focusing on the existing empirical analysis of their geographical and social dimensions. Apart from documenting the main theoretical and empirical contributions on FDI spillovers, chapter 2 also elaborates on various channels through which spillovers occur as well as presents the taxonomy of these channels. The chapter goes on to review theoretical and empirical studies, both at the micro and macro level, on inward-FDI related spillovers. This survey aims to identify the main factors determining the occurrence of these spillovers, namely the host country's absorptive capacity, the technological gap between foreign and domestic firms, foreign subsidiaries' technological behaviour, and their degree of host-country embeddedness. The chapter concludes by presenting the main arguments and empirical evidence reported by the FDI literature supporting the existence of the positive effect that foreign investment has on the host country firms.

Chapter 3 begins with the discussion on the research gaps found while reviewing the literature on FDI spillovers. The chapter brings in the construct of proximity to the best practice frontier to observe if the innovation activities of firms staying near to the frontier are differently impacted upon by the FDI-related spillovers than ones located far behind the frontier. Based on the research gaps and backed by theoretical and empirical literature, chapter 3 develops the hypotheses to be tested in this thesis. The chapter concludes by presenting a research framework on FDI, innovation and productivity.

Chapter 4 lays out the methodological framework of the thesis. Based on the research objectives, it sets out a common conceptual framework to analyse spillovers and adopts a specific econometric strategy for empirically examining each of the research objectives. Besides addressing various econometric issues related to the model and the data, it provides the description of the sample and its distribution across industries. The chapter 4 further elaborates on the various data sources employed, as well as highlights the data cleaning process to arrive at the final sample. Moreover, it presents the description of the variables and the methods used in their construction.

Chapter 5 sets the stage for the empirical analysis. It evaluates the nature of R&D carried out by incumbent firms operating in Indian manufacturing sector. By employing a probit model, the chapter identifies the factors that influence a firm’s decision to undertake R&D and explores if these factors are different from ones affecting the actual level of R&D investment undertaken by a firm. Specifically, it investigates the extent to which spillovers generated by horizontal and vertical FDI affect not only the probability of engaging in R&D but R&D intensity at firm-level as well.

Chapter 5 goes on to empirically examine the spillovers from horizontal and vertical FDI by adopting a grant patent approach. In particular, it relates the patent grants received by firms with the R&D investment carried out by them. In addition, it evaluates the impact of foreign presence on the patenting activities of firms that produce ‘at or near’ to the best practice frontier as opposed to firms producing at the lower end of the frontier. In addition, chapter 5 provides the empirical evidence on productivity spillovers generated by horizontal, backward and forward FDI. It evaluates the changes happening in *tfp* at firm-level, and decomposes and links these changes into those taking place due to increase in innovation activities and those occurring due the increased foreign activity in a sector and from the linkages generated thereby with related sectors.

The final chapter begins with a summary of the preceding chapters and underlines their findings. It then suggests further directions for research in these areas and tackles some policy implications arising from the empirical results of the thesis.

Chapter 2

Review of Theory and Literature

2.1. Introduction

There is a significant body of theoretical literature on MNCs. Most of these theoretical models on MNCs and their effects on the host countries only started to emerge from early 1950s. In this chapter, a review of these theories is taken up. These theories answer some of the important questions often raised about MNCs and their operations such as what makes MNCs to conduct FDI, why they prefer FDI over exporting and arms-length transactions, what makes them to choose a particular mode of entry while venturing into foreign markets and how they sustain in markets where conditions are pretty different from those in the home country market. Apart from reviewing the theoretical literature on the existence of MNCs, the chapter also provides an overview of the various strands of empirical research on the spillovers generated by the MNCs while operating in the host countries. Theories on MNCs along with explaining why firms go multinational offer the theoretical basis for the spillovers generated by the activities of MNCs in the host country. MNCs are not only more productive than local firms (Griffith, 1999), but in major economies also account for a significant proportion of business-led R&D activities. It is reasonable, therefore, to assume that MNEs can be a better source of pecuniary and technological externalities than equivalent local firms. The aim of this chapter, therefore, is to provide a theoretical background to explain both the existence and growth of MNCs and the main motives of the international activities as they appear to be important factors in determining the spillover benefits. The main objective is to provide a comprehensive analysis of FDI from different theoretical perspectives and to pinpoint to di(similarities) of each conceptual and theoretical approaches.

The structure of the chapter is arranged in the following manner. Next section is devoted to explain various theories on MNCs and presents a critique of them. In Section 2.3 the concept of spillovers is introduced along with the various definitions and transmission mechanism involving spillovers. Section 2.4 provides a review of the different strands of the existing empirical literature on spillovers. The emphasis here is on the sources of ownership advantages, its preservation and exploitation in different economic and institutional environment and the role played by the host location. Section 2.4 concludes the chapter by developing the hypotheses to be empirically tested in the thesis.

2.2. Theories on FDI

The importance of, and growing interest in, the causes and consequences of FDI has led to the development of a number of theories that try to explain why MNCs conduct FDI, where they choose to locate their production and how they choose a particular entry mode. Theories explaining FDI have emerged from different fields such as economics, international business, organization and management, all trying to explain the same phenomena from different points of view. The aim of this section is to provide an overview of some of the important theories emanating from the various fields mentioned above. In general FDI theories can be divided into many stands:

2.2.1. The Neoclassical Theory

The neoclassical theory of portfolio flows, views MNCs as an arbitrageur of capital in response to changes in interest rate differentials (Nurkse, 1933; Ohlin, 1933; Iversen, 1935). The underlying principle of the neoclassical theory is that firms invest overseas in an attempt to equate the marginal return on capital with its marginal cost. The theory rests on the basic presumption of risk neutrality, which implies that FDI is a perfect substitute to domestic investment. Relaxing the assumption of risk neutrality Tobin (1958) & Markowitz (1959) in their portfolio diversification theory, assert that FDI occurs as a mean of reducing the average risk of international transactions. Similar view is shared by Heckscher-Ohlin model (1919; 1933), which postulates that foreign investments are determined by difference in factor endowments existing across locations and that capital moves out from the areas where its marginal productivity is low (capital abundant areas) towards the areas where marginal productivity of capital is high (capital scarce areas). MacDougall (1960) & Kemp (1964) again assumed that capital moves to the capital scarce countries with expected higher returns. However, it lies in the hands of countries to manipulate the returns on capital by imposing taxes on capital mobility and thereby enhance their welfare. MacDougall's (1960) model predicts that foreign capital penetration, whether in the form of FDI or portfolio capital, has had many benefits for the host countries. These benefits would include more jobs for the local workforce, higher tax revenues from corporate, improvements in domestic productivity levels, local firms acquiring technical know-how from much advanced foreign firms and adopting more efficient methods of production.

In summary, all the above approaches are based on the strong assumptions of perfect capital mobility and technology across nations, absence of any transaction costs, and homogeneity of inputs. These assumptions are unlikely to hold in the real world context. The neoclassical theories although explain the reasons of capital mobility but have completely ignored the role of firms in facilitating the flow of capital across regions. Moreover, empirical studies estimating the relationship between relative rates of return in a number of countries and the allocation of FDI among them found no support for this hypothesis (Aggarwal, 1980).

2.2.2. Industrial Organization Theory

In order to explain the emergence of MNCs and their role in the economic growth and international trade, several important theoretical frame works surfaced. The framework of international production emerged in the 2nd half of the 20th century. The focus of these theories moved from the country to firm level. The market imperfection theory developed by Hymer (1976) emphasized the role of MNCs as global industrial organizations. Criticizing the underlying assumptions such as perfect mobility of factors of production, free entry and homogenous products of neoclassical theory, Hymer (1976) opines that FDI exist because of the imperfect product markets caused by monopolistic advantages and entry barriers. In order to sustain their business and overcome the locational disadvantages arising from the differences in work culture, language and legal system in the host country, foreign entrants must possess some firm specific tangible and intangible advantages such as superior marketing and distribution skills, access to raw materials and finance, economies of scale, management skills and ability for horizontal and vertical integration (Rugman et al., 2011). In the Hymer's (1976) theory FDI is seen as a means of transferring knowledge and other firm assets, both tangible and tacit, in order to organize production abroad for the purpose of making a profit and maintaining market power in oligopolistic industries.

Drawing upon the industrial organization theory and monopolistic competition, Kindelberger (1969) recognized that the existence of FDI can be explained by various factors such as market imperfections in the goods markets resulting from product differentiation, market imperfections in factor markets arising from access to proprietary knowledge and capital, internal or/and external economies of scale (e.g., vertical integration), and government interference with international production. According to Kindelberger (1969), the firm has to possess comparative advantages which are large enough to overcome locational disadvantages and must be transferable to foreign subsidiaries. Lall & Streeten (1977) argue that some of the firm specific advantages cannot be sold to other firms as these are inherent in organization or difficult to define, value and transfer. Intangible assets such as organizational and managerial capabilities explain why firms compete on international markets. Caves (1971) emphasized that FDI is more likely to occur in oligopolistic industries. He put emphasis on product differentiation as a necessary condition for direct investment as it stimulates rivalry through advertising.

The above authors recognize FDI as a separate form of capital flows beyond mere financial capital, put firms in the center of analysis and recognize market imperfections. However, Hymer's (1976) theory was criticized for focusing on structural market imperfections as a reason for FDI and for neglecting the strategic objectives of MNCs (Dunning & Rugman, 1985). Robock & Simmonds (1983) argued that possessing firm-specific advantages does not necessarily imply that firms will engage in FDI as they may exploit their specific advantages through trade or licensing. Finally, Hymer's (1976) theory does not explain where and when FDI takes place.

2.2.3. Macroeconomic Approach

The macroeconomic development approach draws extensively on neoclassical theory of geographical distribution of factor endowments. This approach encompasses the work of Vernon (1966) & Kojima (1978, 1982). Vernon's (1966) theory rests on the product life cycle hypothesis, according to which internalization strategy of MNCs depends on the four stages of product cycle which include innovation, growth, maturity and decline. The proclivity of MNCs to engage in international production changes as the product moves from its innovatory to its mature phase. The greatest part of new products is firstly manufactured in the home country to satisfy the local demand and to facilitate the efficient coordination between R&D and production units. In a later phase of the cycle as demand increases firms start to export to countries with similar level of income. Later on, as the product becomes more and more standardized the role of R&D becomes less important while a decisive role is assumed by wage costs, transportation costs and higher entry barriers into marketing and distribution channels. The importance of location characteristics in the stage when a product becomes standardized and reaches maturity is critical as the firm decides to invest abroad to maintain its competitive position against its domestic and foreign rivals.

Vernon's (1966) theory provides useful insights into the importance of the absorptive capacity of domestic firms to imitate foreign products leading to the setting up of production facilities by the MNC on the local markets, thus further enhancing the potential for indirect effects of FDI.

Kojima (1978, 1982) views the MNC as an instrument by which the comparative trading advantage of nations may be better advanced (Ben Hamida, 2007). He states that MNCs invest abroad in sectors requiring intermediate and internationally mobile products that fit the production process comparatively well, but that need to be combined with inputs in which the host country is relatively well endowed. Hence, FDI is seen as a complement to trade. Kojima (1978, 1982) suggested that FDI would be undertaken from a comparatively disadvantaged industry in the home country to a comparatively advantaged industry in the host country. Thus FDI would promote an upgrading of industrial structure in both countries and accelerate trade between them. Kojima (1978, 1982) concluded that the lower the technological gap between the investing and host countries, the easier it is to transfer and upgrade the technology in the latter.

2.2.4. OLI Paradigm

Although, there have been a number of theories in the economic history embedding internationalization process of companies. Of all the theories, the Dunning's eclectic theory (1977), thus far, is the most relevant and well-recognised model for explaining why firms internationalize. The model integrates the previous theories of internalization and attempts to provide a general analytical framework to explain the motives behind internationalization process. One of the main conduits through which internationalize, as the theory maintains, is the FDI. The decision to invest overseas is largely associated with ownership-specific advantages (O), location advantages (L) and internalization advantages (I). Of these, the locational advantage is what determines the hosts for the international activities of MNC firms. In other words, locational advantage serves as a key in determining which countries are most suitable to host the MNCs. In order to attract global investments, host country can to some extent engineer its competitive advantage by changing the relative attractiveness of various locational factors over time.

The three main locational factors that MNCS look into before investing overseas are-(i) economic advantages comprising quantity and quality of factor endowments, scope and size of the market, and transport and telecommunication costs; (ii) political advantages which include public policies specific to MNCs, trade and international production; and (iii) social and cultural advantages which encompass factors like geographical distance between home and host countries, language and cultural diversity, general attitude towards foreigners and free enterprise.

In the OLI paradigm, possession of firm-specific assets constitutes the basis for firms becoming MNCs. In fact, the process of internationalization gives rise to many difficulties for the firms engaging in international production. These difficulties mainly arise from the lack of knowledge about the foreign markets. MNCs may be oblivious of the consumer choices in the host country, ignorant of business practices prevalent over there, and unaware of labour market conditions and regulations existing in the host country. These obstacles often entail extra costs to be borne by the foreign firms willing to invest in host locations. To overcome these disadvantages, such firms need to possess some kind of comparative advantage so as to overweigh the extra costs associated with relocating the production facilities overseas. Such advantages are often referred to as firm-specific assets and include things like patents, trademarks, brand names, superior knowledge and technology, distribution networks and managerial practices. Intangible assets are believed to be of great importance in the decision to invest abroad as these are easier to transfer to the foreign affiliates than tangible assets.

The third important element in the decision to internalize is the international advantage. Indeed, firms possessing ownership-specific advantages have many ways to tap foreign markets and minimize the costs associated with serving the foreign markets. For instance, MNCs can serve foreign markets through spot transactions (exports), arm's-length transactions (licensing, franchising, or subcontracting) or through internalizing the transactions. However, there are certain disadvantages associated with the first two modes of serving overseas markets. For example, firstly MNCs sometimes cannot adequately serve the foreign markets through exports because either of high trading costs or huge demand for products existing in the host country. Secondly, in arm's length market transactions, there are market failures mainly due to opportunism by agents, and firms may fear unwanted loss of knowledge assets. Thirdly, as the capability perspective focuses on that the difficulties inherent in international technology transfer (Kogut & Zander, 1993). Varying levels of codifiability, teachability and complexity of knowledge assets may impede inter-firm technology transfer through arm's-length contracts. Therefore, to avoid any issues related to market transactions, MNCs instead by pass them with internalizing transactions between headquarters (HQs) and overseas subsidiaries (Buckley, Clegg, & Wang, 2002).

In sum, Dunning's OLI model define MNCs ownership-specific advantages and address how MNCs' superior technological assets are transferred to subsidiaries and sometimes become available across borders for countries other than the home country.

2.2.5. Resource Based View and Capability Perspective

The resource-based view and capability perspective illustrates how FDI spillovers help local firms replenish their internal resources. These approaches emphasize that learning from external knowledge is not automatic but requires costly investments and conscious effort on the part of firms to absorb it. The larger the technology gap, the more costly the investment for learning (Wang & Blomstrom, 1992), although technological backwardness in a host-country firm may facilitate technology diffusion in the first place (Findlay, 1978). Therefore, FDI spillovers will sustain only if local firms keep up with innovative activities and replenish locational advantages (Cantwell, 1989).

The resource-based view provides further fine-grained conceptualization of resources such as knowledge management and capabilities (Amit & Schoemaker, 1993; Grant, 1996). If those are in the form of knowledge, a firm's internal resources are, however, subject to depreciation, prone to getting stuck in the competence trap, and trigger organizational rigidities (Argote et al., 2003; Ernst et al., 2011; Kaplan & Henderson, 2005; Katila, 2002; Leonard-Barton, 1992). Therefore, the firm has to access external knowledge.

Nevertheless, performance change based on external knowledge does not occur automatically, because it is difficult to acquire tacit elements of knowledge, and different organizational routines can impair inter-organizational learning (Grant, 1996; Spencer, 2008; Szulanski, 1996). In this regard, the dynamic capability perspective (Easterby-Smith & Prieto, 2008; Spencer, 2008) elaborates the requirements for successful learning and dynamic capability-building in a firm. For instance, performance change due to external knowledge is conditional on the absorptive capacity of recipient local firms. Absorptive capacity is an umbrella terminology that refers to the ability to identify and acquire valuable external knowledge, assimilate it through the process of interpreting the acquired knowledge and finally exploit it by combining it with existing internal knowledge (Brettel et al., 2011; Cohen & Levinthal, 1989); or it can include the ability to learn from inter-firm networking by bridging the gap between different organizational routines (Dyer & Singh, 1998; Lane & Lubatkin, 1998; Lewin et al., 2011). Both formal and informal mechanisms for inter-firm interactions may be used to overcome barriers to inter-organizational knowledge transfer (Mowery et al., 1996).

In sum, the resource-based view, particularly the capability perspective, postulates that external knowledge complements internal knowledge. For successful utilization of external knowledge, the recipient firm needs strong absorptive capacity and inter-organizational skills. This perspective justifies why FDI spillovers, as a type of external knowledge, are deemed to influence the performance of host-country firms and establishes discussion of the necessary conditions with respect to the capabilities required in host-country firms for successful manifestation of performance change.

2.2.6. New Trade Theory

New trade theory provides an alternative framework for analyzing FDI based on general equilibrium models. It is mainly based on industrial organization approach, internalization theory and OLI framework combined with features of imperfect competition such as product differentiation and economies of scale. Ownership advantages arise from knowledge capital, location advantages from country size, trade costs and differences in factor endowments and internalization advantages from joint input property of knowledge capital (Faeth, 2009). Within the new trade theory three models have been developed based on proximity and concentration advantages, differences in factor endowments and their integration in knowledge capital models.

Horizontal model**:** The first set of models is related to horizontal type of FDI as an alternative to exports and it is based on only one factor of production and similar factor endowments across countries (Markusen, 1995, 2002). Markusen (1984) incorporated knowledge based ownership advantages such as R&D, marketing, scientific workers and product complexity which enable firms to engage in FDI. This enables easy transfer of knowledge based assets between production plants as latter has a joint input nature which can be used in multiple locations without diminishing in value. This in turn gives rise to firm economies of scale due to public good nature of knowledge which can be supplied to other plants at very low costs. Under these circumstances increase in cost efficiency gives rise to MNC.

Vertical model: Vertical FDI takes place by geographical fragmentation of production in order to exploit difference in factor costs between countries. This type of FDI is modeled under assumption that different parts of production process require different inputs. Therefore, it becomes profitable to split production chain across several locations to benefit, for example, from lower labour costs. Models of vertical FDI have been developed by Helpman (1984) and Helpman & Krugman (1985) by incorporating extended Heckscher-Ohlin trade theory with two factors of production and two sectors. The latter assumption is based on one perfectly competitive industry with constant returns to scale and the other producing differentiated products under increasing returns to scale. Similar to horizontal models, firms are assumed to possess knowledge capital which is internalized by the firms. Products in differentiated industry are produced using labour and knowledge capital with the latter being located in the headquarters. The driving force of the model is absence of factor-price-equalization (FPE) which enables firms to geographically fragment their production. In addition, the model assumes no trade and transportation costs thus firms have no motivation to have plants in multiple countries. Hence, the focus of Helpman's (1984) model was to show that MNC have an incentive to reallocate their production across geographical space if the countries differ in their relative factor endowments. However, vertical model has been criticized by Zhang & Markusen (1999) as labour abundant countries do not receive much FDI. They posit that notwithstanding that some of the labour intensive activities are undertaken abroad, MNCs still needs skilled workforce supported by good institutions and infrastructure in the host country.

Knowledge capital model*:* A more sophisticated model of MNC behaviour was developed by Markusen et al. (1996) & Markusen (1997) that combined horizontal and vertical motivations of MNCs. According to Markusen (1995) knowledge capital consisting of intangible capital, trademarks, brand names and human capital is the primary source of firms' specific advantages and provides opportunity for MNCs to go abroad. He argues that knowledge being partially non-excludable, non-rival, and non-codifiable (Arrow, 1962; Romer, 1990) generates a risk of expropriation and thus provides MNCs incentive to internalize and thus limit technology spillovers.

Carr et al. (2001) construct a model which allows empirical investigation of knowledge capital model and motives for horizontal and vertical FDI. Studies such as Markusen & Maskus (2002) showed that horizontal FDI is the most prevalent type of FDI. However, firm level data studies showed more complex forms of FDI and only a fraction of MNCs can be purely classified as horizontal and vertical FDI (Hanson et al., 2001; Feinberg & Keane, 2006). This led to new theoretical model developed by Yeaple (2003) which shows how complex internalization strategies lead to complicated FDI structures which are determined by complementariness between host countries.

Table 2.1: Summary of FDI Theories

FDI Theory	Explanation of FDI
Neoclassical Theory	FDI is an equilibrating force among segmented markets which eventually comes to an end when equilibrium is reestablished; that is, when rates of return are equalized among countries (Nurkse, 1933; Ohlin, 1933; Iversen, 1935; Tobin, 1958; MacDougall, 1960).
Industrial Organization Theory	FDI exists because of imperfect product markets caused by monopolistic advantages and entry barriers. To internationalize, firms must possess tangible and intangible advantages such as superior marketing techniques and distribution skills, access to new raw materials and finance, and management skills (Hymer, 1976; Rugman et al., 2011; Kindelberger, 1969).
Product Cycle Theory	The propensity of a MNC to engage in international production changes as the product moves from its innovatory to its mature phase and its production techniques are finally standardized (Vernon, 1966).
OLI Paradigm	FDI arises because of: **Ownership advantage (O)** which include firm specific assets such as patents, trademarks, brand names, superior knowledge and technology; **Locational advantage (L)** which include quantity and quality of factor endowments, scope and size of market, and transport and telecommunication costs and; **Internalization advantage (I)** involves ability to bypass market transactions and internalize them between HQs and overseas subsidiaries so as to avoid disadvantages or capitalize on the advantages, of imperfections on external (markets and public) mechanisms of resource allocation (Dunning, 1977)
Resource based view	MNCs sustain competitive edge over rivals by exploiting internal factors such as their productive assets and intra-firm coordination of activities rather than rather than external factors as compared to industrial organization view. MNCs are viewed as a repository of knowledge and emphasis is on the role of competition and firms' strategies when trying to maintain and continuously upgrade their technological know-how (Cantwell, 1989; Amit & Schoemaker, 1993; Grant, 1996).
Knowledge capital Model	A more sophisticated model of MNC behaviour besides explaining horizontal and vertical motivations of MNCs emphasizes the role of intangible capital in providing opportunities for MNCs to set their production facilities abroad (Szulanski, 1996; Easterby-Smith & Prieto, 2008; Spencer, 2008).

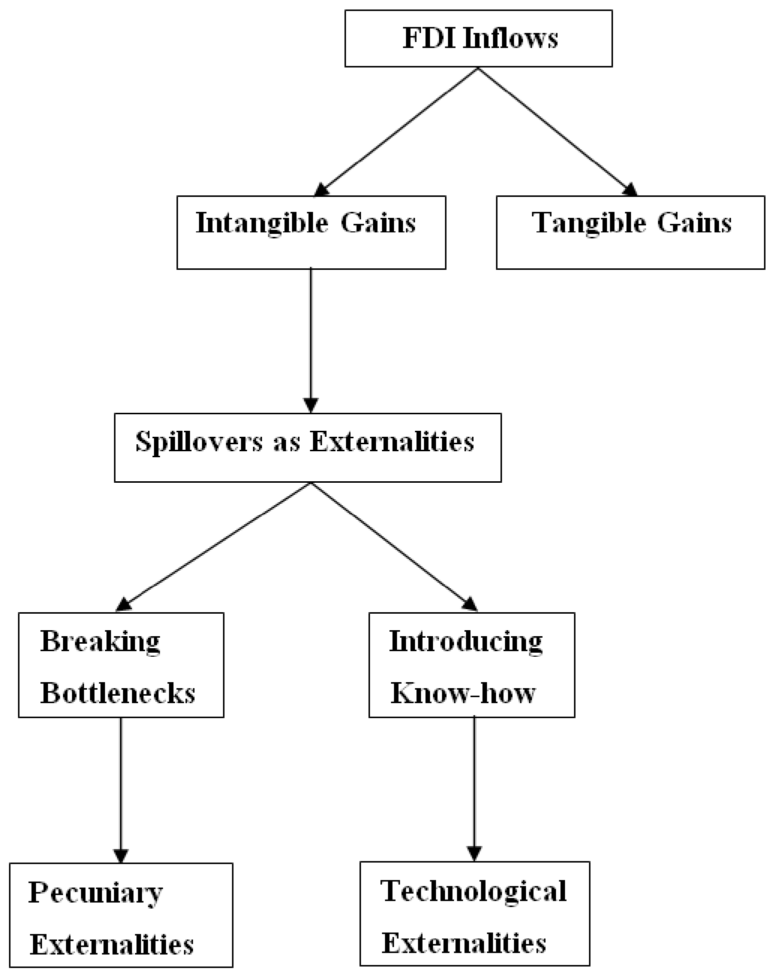
2.3. FDI Spillovers

The earliest studies on the impact of MNEs on host countries started from an assessment of the general welfare effect of FDI. The focus was largely on tangible, as opposed to intangible, gains. MacDougall (1960), for instance, analyzed tangible gains from FDI in terms of the respective impact on three notional agents in an economy, namely capital owner, labour provider, and host-country government. On the first two agents, FDI gives rise to a redistributive effect. FDI inflows reduce the marginal product of capital, resulting in shifting gains from capital owners to the labour force of the host country (MacDougall, 1960). On the government, FDI brings increased tax revenues. Additionally, MNE entry in the form of FDI influences economies of scale and balance of payments as well as the terms of trade in the host country. As opposed to tangible gains, there are intangible gains from FDI, which refer to the generation of external economies arising from MNE entry. External economies would be related to 1) 'the breaking of the bottle-neck', through removal of distortions in the market and 2) 'the introduction of know-how by foreign firms', through the mobility of MNE-trained workers as well as the increased awareness of local firms about new technologies (MacDougall, 1960).

The analysis of tangible gains has not taken center stage in the FDI impact literature (Meyer, 2004), because tangible gains can be caused by other forms of capital inflows to host countries. On the other hand, however, intangible gains are a unique impact of FDI. This distinctive aspect of FDI from other forms of capital movement leads to discussion of unique characteristics of FDI, as proposed by Hymer (1976). He separated FDI from other forms of cross-border capital movements, stating that 1) FDI is concerned with the extent to which a firm can exploit ownership-specific advantages and 2) FDI occurs in response to the need to address market imperfections due to oligopolistic competition by exerting control over firms in other countries (Yamin, 2000). As a result, later studies explore

FDI spillovers in conjunction with international operation of MNEs rather than auxiliary capital movements. Therefore, the impact on host-country firms arising from the bundle of both tangible and intangible resources by MNEs takes the form of pecuniary and technological externalities. Figure 2.1 summarizes definitions of FDI spillovers, as opposed to intangible gains.

Figure 2.1: Spillovers from FDI



Source: McDougall (1960).

In the view of Narula & Driffield (2012), FDI spillovers are externalities which become available as a result of MNE inward investment for host-country actors. Castellani (2012) views FDI spillovers as the synthesis of pecuniary externalities and technological externalities. The former are associated with the removal of distortion in host-country markets, and the latter with the emission of quasi-rents from MNEs' subsidiaries to local firms (Caves, 1974). The seminal work of Griliches (1979) identifies two types of potential positive spillovers from R&D activities: rent and knowledge spillovers. The former occur when the price of an input does not reflect the quality improvements derived from innovative activities. More broadly, pecuniary spillovers encompass shifts both in price and market structure, the benefits (rents or profits) of which cannot be extracted by the initiating party. This form of pecuniary externality arises for example from trade in intermediate goods and from the entry of MNCs into host country market. Knowledge spillovers are unintended transfers of knowledge, where the owner of such knowledge cannot prevent others from making use of it. The channels for such spillovers include: departure of key scientists or engineers; informal know-how sharing, unintended leakage of information at conferences or trade fairs, imitation of products or technological secrets through reverse engineering or product inspection, patent information; industrial espionage; scientific literature. Therefore, while rent spillovers arise from the transaction of goods, knowledge spillovers arise from the imperfect appropriability of knowledge, i.e. from its public- good nature. Although, in theory the distinction between two types of externalities is clear, in practice these may occur simultaneously and thus empirically it is difficult to disentangle these two dimensions.

2.3.1. Spillovers Transmission Mechanism

As evident from the above-mentioned literature, MNC entry can have several effects, both positive and negative, on host economies firms. The expected benefits often motivate the governments to strive for liberalizing policies to attract foreign investors. Examples of such benefits could be knowledge and productivity spillovers, technical progress, and/or increasing market access for local firms. However, there could also be adverse effects following the entry of foreign-owned firms, for instance via increased competition. In the following paragraphs, we discuss different channels through which local firms could potentially benefit from, or be hurt by, inward FDI.

As presented above, international trade theories and evidence indicate that it is rational to expect that MNCs are more productive than local firms. Indeed, MNCs have to possess a comparative advantage in the foreign market to circumvent the extra costs associated with FDI. The higher productivity of MNCs creates hopes for technology or knowledge transfer from foreign-owned firms to local firms. In that respect, technological progress is often used as an argument to justify the actions taken to attract FDI, especially in developing economies where catch-up regarding technology and know-how could mean a lot for the macroeconomic development (Javorcik, 2004; Aitken & Harrison, 1999). The rest of this sub-section is dedicated to elaborate upon the main channels through which knowledge and technology can be transferred to incumbents resulting in productivity growth.

The spillover effects from FDI to domestic firms are transmitted through a wide range of channels. These channels, as recognized by the literature on FDI externalities, include competition, demonstration and imitation, worker mobility and spin-offs, and backward and forward linkages. It is customary to explain how the aforementioned spillover channels work. Competition as a channel for the creation of externalities is widely recognized in the spillover literature. The entry of foreign firms into the host country escalates the level of competition in the domestic market, compelling local firms to utilize their resources as efficiently as possible. In order to react to the competition threat and uphold the market shares, local firms invest in improving their product quality and diversifying their product portfolio. For instance, Aghion et al., (2005) argue that increasing competition in the domestic market place is likely to stimulate innovative activities of the incumbent firms. Intense competition resulting from entry of MNCs into the host country market forces domestic firms to upgrade the production techniques and hence improve their productivity (Blalock & Gertler, 2003). In UK it has been found that in 1980s most of the indigenous firms responded to the Japanese MNCs' entry by improving their product quality as well diversifying the range of their products (Dunning, 1988). The improvement in efficiency or product quality of the local firms cannot be, strictly speaking, characterized as spillover effects from foreign entry since these may purely result from firms' own strategy and investment and not by the behavior of foreign firms. Nonetheless, it highlights an important aspect of the effects of MNCs on domestic firms. In fact, in most cases, such effects require a substantial effort on the part of domestic firms. To assimilate the benefits accruing from the presence of MNCs, the local firms need to undertake increasing investments in R&D, accumulate absorptive capacity, introduce organizational and managerial innovations and upgrade the skill profile of their workforce.

The second important channel for the transmission of FDI spillovers to domestic firms is the imitation. MNCs bring in the products, technologies; organizational and managerial practices that otherwise do not exist in the host country and demonstrate that a particular production technique is feasible in a given socio-economic context (Jenkins, 2005). Local firms through reverse engineering, industrial espionage, and informal contacts emulate the product and process technologies of the MNCs (Mansfield & Romeo, 1980). Alfaro & Rodriguez-Clare (2004) report that a MNC in Honduras introduced a little innovation in the form of providing free breakfast to the workers half an hour before the start of the morning shift. It not only incentivized the workers to report on time but also helped them to improve their productivity. Local firms quickly imitated this small organizational or management innovation which helped them to improve their overall productivity. Different examples came from the practices of information exchange and open labour markets in the Silicon Valley. As Saxenian (1994) describes:

"Every year there was some place, the Wagon Wheel, Chez Yvonne, Rickeys's, the Roundhouse, where members of this esoteric fraternity, the young men and women of the semiconductor industry, would head after work to have a drink and gossip and brag and trade war stories about contacts, burst modes, bubble memories, pulse trains, bounceless modes, slow-death episodes, RAMs, NAKs, MOSes, PCMs, PROMs, PROM blowers, PROM blasters, and teramagnitudes, meaning multiples of a million millions."

Both MNCs and domestic firms could benefit from the informal conversations of the workers since these serve as an important source of up-to-date information about competitors, customers, markets and technologies. The entry of Texas Instruments (TI) into India is a further illustration on how demonstration effects benefit domestic firms. The software professionals of TCS, Infosys and Wipro temporarily worked for TI on client's premises. These firms then imitated the TI's business model, centered on the use of powerful communication technology and high-end offshore R&D activities. These firms are now hugely involved in the offshore services business. TI also helped Indian firms to build their capabilities by sharing with them the organizational knowledge on process control, reporting and review which is critical in the offshore model (Giarratana et al., 2004).

The externalities transmitted through imitation and demonstration channels are mostly knowledge externalities. It needs a mention here that not every local firm is equally placed to benefit from such spillovers. The ones investing in absorptive capacity are better able to evaluate and utilize them (Cohen & Levinthal, 1989; Rosenberg, 1990). Moreover, firms require significant engineering efforts as well as substantial investments in R&D to imitate and decode the production technologies brought in by

MNCs. It has been documented that cost of imitating new products has an important effect on the incentives for innovation in a market economy (Mansfield et al., 1981). In addition to the requirement of absorptive capacity and engineering efforts, this type of spillover requires that the goods produced by local and foreign firms are to some extent similar. Indeed, the larger the difference between the goods, the less relevant is the foreign technology for the domestic firms, reducing the incentives to adopt it. This, in turn, reduces the magnitude of technical spillovers to be expected (Crespo & Fontoura, 2007).

Overall, for FDI spillovers to occur via a demonstration effect, a minimum level of knowledge from the local firms is required. Moreover, it requires some similarities between the goods produced. If these conditions are not met, local firms will most likely fail to adopt the new knowledge brought up by foreign affiliates, consequently reducing the amount of positive spillovers induced by their entry.

The mobility of workers and the related creation of spin-offs is the third important spillover channel. It is widely believed that MNCs tend to employ a higher share of skilled labour (Lipsey & Sjoholm, 2004). However, developing host countries, although abundant in the unskilled workforce, usually, lack the adequate supply of skilled workers required in making up the MNCs demand for quality workers. To avoid any further shortages, MNC provides necessary training and assistance to the local labour and thereby render them suitable to work for MNCs. In this way, their advent increases the supply of quality labour in the host country. Whenever those trained workers leave MNCs and decide to open their own start-ups or work with the local firms, they bring along what they have learned while working with foreign firms. The knowledge embedded in those workers creates a positive externality for the receiving firm (Fosfuri et al., 2001). As documented by Görg & Strobl (2005) that in Taiwan the firms which are run by owners that worked for MNCs in the same industry immediately prior to opening up their own firm have higher productivity growth than other domestic firms. This suggests that these entrepreneurs bring with them some of the knowledge accumulated in the MNC which can be usefully employed in the domestic firm. The labour mobility within and across the industries, to some extent, can be categorized as a pecuniary externality, since MNCs lower the prices of this particular input (skilled labour) through an increase in the supply of trained workers in the local economy. In the absence of this exogenous shock to labour supply, we may think of possibilities where domestic firms could hire skilled labour from a different labour market (perhaps from overseas) or could decide to train their own workforce, but in all these cases the quality-adjusted price for such labour would probably be very high. However, as long as the wages received by the moving workers does not incorporate all their embedded knowledge, the hiring firms receive an additional positive knowledge externality. Some of the case studies and qualitative works have widely documented this process. Spin-offs in the software industry could be cited as one such example.

Sands (2004) shows that more than 30 per cent of the founders of a sample of 52 Irish software firms started in the period 1981-2002, were previously employed by MNCs. Interviews carried out by Giarratana et al. (2004) to some of those firms also reveal that technical expertise is less relevant for spin-off firms than management skills and "business sense". For instance, DLG services (now Transware), a firm specialized in developing and testing localization software, was set up in 1996 by a Lotus' former employee. The founder and managing director of DLG reported that his experience had helped his staff in DLG to learn optimal organizational and management practices from Lotus, such as project management and relational marketing capabilities. Another case is Anam, a start-up established in 1999 by three former employees of Siemens Ireland and Logica which supplies wireless internet platforms for electronic commerce. The founders brought in both technical expertise in wireless products accumulated at the Irish Siemens Internet Security subsidiary, but also expertise in the area of general and international business management (Giarratana et al., 2004).

There is some evidence showing that to protect their firm-specific assets and to prevent high labour turnover, MNEs on an average pay higher wages to the workers than their domestic counterparts (Fosfuri et al., 2001; Lipsey & Sjoholm, 2004). This foreign-wage premium is called pecuniary spillovers from FDI (Fosfuri et al., 2001). Considering that MNEs pay higher wages in order to prevent or diminish labour turnover, one could expect to see less technological spillovers arising from labour turnover in countries where the wage differential between local and foreign-owned firms is high, i.e. where the pecuniary spillovers from FDI are high (Fosfuri et al., 2001; Crespo & Fontoura, 2007). This situation is more likely to be visualized in less developed countries in which the wage differential, due to lower local wage, is higher than in the advanced economies where this differential does not exist, or even if it is existent the disparity is not much noticeable. This somewhat jeopardizes the validity of knowledge transfer as an argument to justify the adoption of more liberal policies regarding foreign investors. Another labour-market-related factor suspected to influence the amount of labour turnover and eventually the magnitude of knowledge spillovers via labour mobility channel is the labour market legislation in the host country. More stringent labour laws would restrict the worker mobility which in turn reduces the extent to which knowledge would be spread by previous employees of foreign affiliates (Crespo & Fontoura, 2007). Moreover, laws regarding property rights could also impact the extent of such spillovers, as more restrictive policies (e.g., stringent property rights protection) would prevent the workers to use their knowledge acquired via foreign training in domestic firms, especially if they are employed by direct competitors (Fosfuri et al. 2001). Finally, the type of training provided by the MNEs influences the extent of spillovers, as the acquisition of more firm-specific knowledge results in less mobile workers due to a lower outside-value caused by its lower transferability. In the light of this evidence, it seems that technological spillovers via labour turnover are more likely to occur in the cases where the MNC and the local firms are not directly competing, where the knowledge acquired is more general, and where the foreign wage premium is lower.

The creation of backward and forward linkages with domestic firms is yet another channel which mediates pecuniary and technological externalities arising from the entry of MNCs into the host country. The other name that literature attaches to such linkages is the intra-industry and inter-industry effects. The former affect the firm activities within the same sector while the latter concern the firms operating in related sectors. The studies on intra-industry and inter-industry effects date back to Hirschman (1958) & Lall (1980) and more recently revived by Rodriguez-Clare (1996) & Markusen & Venables (1999). On entering into foreign market, the MNCs may set up plants in downstream sectors, to mainly produce final goods, or in upstream sectors producing primarily intermediate inputs. In both the cases such firms tend to crowd out domestic rivals, but at the same time are likely to induce backward (in the first instance) and forward (in the latter case) linkages with the local firms, which can, in turn, determine second order positive effects on the domestic competitors. MNCs setting up the plants in downstream industries need raw materials and component parts for the production of finished goods. These firms have the option to produce such inputs internally, to import them from overseas, or to source locally. Buying these intermediate inputs from local suppliers would mean more backward linkages than if MNCs source them from other countries. In fact, local sourcing will raise the demand for inputs in upstream sectors, thus incentivizing local firms to enter the upstream industries. Entry will result in an increase in the production and variety of such inputs as well as a fall in their prices. The whole process will create an externality for the firms (both foreign and local) operating in downstream sectors. On the one hand, due to product market competition, MNC entry into the downstream industries tend to crowd out domestic firms, but on the other hand, the backward linkage effect gives rise to pecuniary externality (in the form of higher profits due to lower input prices) for local producers.

Along with pecuniary externality, linkages effect gives rise to significant knowledge flows from MNCs to their local counterparts. For instance, although MNCs has access to cheap labour and raw materials in developing countries but local suppliers seldom meet the required quality standards. To meet the necessary quality requirements, MNCs assist their local suppliers through various ways. Local producers are provided with technical assistance on product design, quality control, factory outlet, labour and inventory management. MNCs also assist them in financial management and procurement. One finds a number of examples which illustrate that MNCs assist their local counterparts in all the aforementioned areas. For instance, when French company Saint-Gobain decided to set up a floating glass plant in Chennai (India), indigenous suppliers were disorganized and lacked the ability to reach minimum standards. Three years prior production operations, Saint Gobain set up a specialized team that worked with native suppliers: to develop cost and business models, to train a largely illiterate labour force, to educate firms in management concepts and to help them to obtain loans. In a span of less than four years, 80 per cent of raw material requirements were supplied by local firms, and local producers also began to supply intermediate inputs to other firms in India (UNCTAD, 2001). Likewise, when IBM could not find any supplier for packaging materials, the company, therefore abetted the local firm Ureblock to start producing such inputs. Ureblock now has a 200 m^2 building in the IBM plant and its responsibilities in the production process range from cleaning the final product to labeling, packaging materials and final delivery to IBM distribution department (UNCTAD, 2001). There are more examples of MNCs assisting indigenous firms in Vietnam, China, Thailand, Malaysia, UK, France, Brazil, Chile, and

Venezuela. In Malaysia Intel in association with Penang Skills Development Centre (PSDC) trains and coaches local suppliers. The venture has helped in creating a market for trained workers which can be hired both by MNCs and their rivals (UNCTAD, 2001). During the economic downturn caused by the East Asian financial crisis, Toyota Motor Thailand, in order to prevent the bankruptcy of its first-tier suppliers, provided them with a financial assistance amounting 1.6 billion baht through advance payment revolving funds, dead stock purchase schemes at cost, and advance payments for tooling expenses (UNCTAD, 2001).

While an improvement of supplier performances has been observed when MNCs source inputs from host countries. One may think of what happens to supplier performances when MNCS source their intermediate inputs from advanced countries. Recent studies report some evidence that MNCs' import of inputs from abroad also induce an improvement in quality and efficiency of the local counterparts. For instance, Potter, Moore, & Spires (2003) report some evidence of the flow relevant knowledge from MNCs to UK firms, and this transfer substantially improved productivity and product quality of upstream producers. Similarly, a survey on foreign affiliates in Northern Ireland reflects that knowledge transfer between MNCs and the local counterparts is a frequent occurrence. The survey reports that at least 50 per cent of the managers' surveyed stated that such transfer had a positive impact on the suppliers' competitiveness regarding price, quality or delivery conditions (Crone & Roper, 2001). Veugelers & Cassiman (2004) using the Community Innovation Survey data from Belgium also find some evidence of technology transfer occurring from foreign subsidiaries to local firms.

The recent literature rather than vouching a unidirectional flow of knowledge from MNCs to local firms comes up with a different view, which is MNCs actually exploit their international networks to tap into different scientific and technological domains, as well as extract and lever knowledge from the various host countries. From this perspective, there exists a two-way flow of knowledge between the foreign affiliates, their suppliers and other counterparts in host countries. Apart from establishing links to transfer technical expertise, skills, and managerial practices, MNCs also set up cooperative ventures with local firms wherein each party has something to learn. Joint ventures have substantial implications for spillovers. In fact, one envisages a great deal of horizontal cooperation among rivals resulting from setting up of such ventures. A case in point is the electronics firms in Silicon Valley cooperating on the common technological development projects but competing fiercely in the product market. A further example is the case of car producers sharing R&D as well as other types of investments, then competing with differentiated products incorporating the same components.

As we have learned from the literature above, backward and forward linkages arise when MNCs decide to produce locally. The MNC production in host country gives rise to new business opportunities for local producers in both upstream and downstream sectors, and therefore creates a larger market for their products. This larger market allows local producers to reap the economies of scale as well as benefit from the specialization and division of labour in the supplier activities. Furthermore, MNCs intentionally or unintentionally, transfer knowledge to local suppliers and other counterparts thus improving the quality and range of intermediate inputs of upstream suppliers, and efficiency of the firms active in downstream industries. One may expect a positive effect on the firms active in downstream industries or competing downstream with MNCs (horizontal spillovers). Such firms mainly benefit from the higher variety of input suppliers as well as from their increased efficiency. One may also envisage a positive effect along the supply chain (vertical spillovers) resulting mostly from knowledge externalities and scale effects. Nonetheless, the size of the vertical spillover effect is largely conditional on the extent of local sourcing by MNCs (Rodriguez-Clare 1996; Hirschman, 1958). On the contrary, if MNCs source/ import inputs from other countries, it will displace domestic suppliers and may eventually harm upstream local firms as well the ones operating downstream. This is a cause of concern for domestic producers and as well for the policy makers of the host countries. It, in fact, has created pessimistic views on the existence of spillover effects from FDI through backward linkages (McAlesee & McDonald, 1978; Potter et al., 2003; UNCTAD, 2001).

2.3.2. Taxonomy of Spillover Channels

In the above section, we emphasized on the role of FDI in generating spillovers/externalities for the host country firms. We have also sketched the types of spillovers and the main channels through which these occur. As we noted, both pecuniary and knowledge externalities can arise, and in many cases, the former effects can be more substantial than latter. In fact, the existence of externalities has important implications for public policy and empirical work. Pecuniary externalities mainly affect the profit function of incumbents whereas non-pecuniary/knowledge externalities help domestic firms to catch up with the frontier. We have also pointed out that such externalities occur through a wide range of channels like competition, imitation and demonstration, labour mobility and spin-offs, and forward and backward linkages.

Pecuniary and knowledge externalities arising from MNC presence affect domestic firms differently, and that degree of effort that domestic firms put in so as to assimilate them also vary across the firms. Based on the fact that spillovers neither materialize automatically, nor do these accrue to all local firms homogenously, Castellani & Zanfei (2006) have come up with a taxonomy that ranks spillover channels according to the importance of pecuniary versus knowledge externalities. We reproduce the visual presentation of their taxonomy in Table 2.2 What follows from this taxonomy as well as from the examples cited in the aforementioned subsection on spillover channels, is that pecuniary externalities appear to affect indigenous producers mainly through competition channel whereas knowledge externalities seem to be more relevant when local firms imitate the technologies, products and management practices of MNCs. Through labour mobility and related spin-offs, local firms along with some knowledge flows, seem to receive substantial pecuniary externalities. Finally, linkages seem to entail both pecuniary and knowledge externalities.

It is imperative to mention that externalities arising from MNC entry by no means are automatic. In fact, in most of the cases, local incumbents have to bear additional costs so as to benefit from spillovers. However, this extra cost borne by local firms does not necessarily correspond to a direct payment to the MNCs in return for the supply of some specific assets. In particular, apart from improving the absorptive capacity, domestic firms need to invest in R&D, skilled workers, and organizational practices. These efforts are likely to vary across the different channels. Demonstration effects and labour mobility probably require lowest effort, while domestic firms may need significant investments to benefit from imitation, competition, and linkages. In particular, when we look at knowledge externalities, domestic firms need to devote substantial resources to their relations with foreign affiliates. From this perspective, one can think of MNCs as a potential source of externalities with entry costs and, that spillover opportunities can be appropriated by those firms which are ready to bear these costs.

Table 2.2: Taxonomy of spillover channels

Channels	Pecuniary Externality	Knowledge Externality	Local Firm Effort
Competition	***	*	**
Imitation and Demonstration	*	***	*
Worker Mobility and Spin-offs	***	**	*
Forward and backward linkages	***	***	***

Source: Adapted from Castellani & Zanfei (2006).
Stars indicate magnitude of various spillovers transmitting through different channels. More stars denote greater magnitude than fewer stars.

2.4. Empirical Evidence on FDI Spillovers

While recognizing that externalities generated by FDI/MNCs through competition, imitation, labour turnover, and intra-and-inter industry linkages affect the activities of firms operating in the host country, empirical work, so far, has hardly been able to unravel the relative importance of these externalities as well as of the channels through which these occur. The main approach used in the extensive empirical literature has been to search for an aggregate (or net) effect of the presence of MNCs on the productivity of domestic firms in the same industry. Some efforts have also been devoted to investigating the conditions favoring positive effects which to some extent can be correlated with the different channels illustrated above. Most studies in this literature refer to such effects as technological spillovers from FDI (or MNCs), but it is well understood that these effects can only partially be attributed to the pure technological externalities (Breschi et al., 2005).

Early empirical works on spillovers from FDI mostly relied on cross-sector data and usually specified an equation for the value added per worker due to domestic firms in a sector as a function of the share of activities accounted for by foreign firms in the same sector. Controlling for other sectoral characteristics, the empirical estimates from these studies mostly reflect a positive association between the foreign presence and domestic productivity (see for example Caves, 1974; Blomstrom, 1986). This evidence was interpreted as consistent with productivity spillovers from MNCs. However, these empirical works were criticized by Aitken & Harrison (1999) on the ground that they suffer from severe specification errors. The authors argue that MNCs usually emerge in the knowledge intensive sectors, therefore, a positive association between the foreign presence and domestic productivity might simply reflect the fact that foreign firms are attracted towards the high productivity sectors in the host country. This endogeneity problem is likely to yield upward bias in empirical estimates on the spillover effects of MNCs. In order to address the question whether MNCs determine productivity spillovers on host country firms, this specification issue needs to be addressed. Scholars could partially solve the endogeneity problem by controlling for industry effects in cross-sectional regressions; and more effectively by exploiting the longitudinal dimension of the firm-level data which became increasing available in the recent years, as to account for the sector or firm-level fixed effects. Furthermore, the availability of more detailed data allowed for the estimation of a production function, leaving the researcher the choice of analyzing the effect of foreign presence on labour productivity or *tfp*. Most recent empirical studies choose the second route and modeled the effect of foreign presence in an augmented production function framework.

Most of the empirical works that employed an augmented production function approach to analyze the impact of FDI on domestic productivity tend to find no evidence of productivity spillovers from MNCs. For instance, in a review paper (build on previous work by Gorg & Strobl (2001)), Gorg & Greenway (2004), highlighted some 33 recent panel data empirical works most of them purged of endogeneity problems. These studies reveal either insignificant or negative productivity spillovers on domestic firms. The negative productivity spillovers have been attributed to undesirable competition effect which arises when MNCs restrict or minimize technology leakages to their local rivals. These negative competition effects offset any positive pecuniary and knowledge externalities induced by the MNCs.

The current empirical research on FDI externalities has two main strands which converge in a better understanding of the effects of the MNCs on domestic firm productivity. One strand is addressing specification and measurement issues while the other addresses the conditions which eventually favour positive spillovers. Within this line of research, the literature has placed considerable emphasis on vertical versus horizontal spillovers and on the role of technology gaps versus absorptive capacity in favouring spillovers. Several contributions have emphasized that whether FDI spillovers can be observed or not depends on where we search for them. These are more likely to occur across vertically related industries (vertical or inter-industry spillovers) than within the same industry (horizontal or intra-industry spillovers). The literature focusing on intra-industry spillovers has investigated some conditions which determine a higher potential for knowledge transfer. Within the intra-industry context, considerable attention has been placed on the role played by technology gap between foreign and domestic firms, and by the absorptive capacity of the latter.

The basic idea for empirical works searching spillovers across industries is that we should observe the lower intensity of negative competition effects and higher positive externalities along the supply chain than within the same sector. In fact, while MNCs may have a strong incentive to minimize information leakages to competitors, they may have an incentive to transfer some knowledge to the local suppliers. Furthermore, while within competition may take the form of market stealing effect, along the supply chain it mainly takes the form of an incentive to increase competitiveness, expand market shares of upstream and downstream firms. Many recent works have addressed this type of spillover by introducing two measures of foreign presence: the standard intra-industry measure of foreign activity, which captures horizontal externalities, and a sum of foreign presence in all other sectors weighted by the shares of purchase from each sector (drawn from technical coefficients in the input-output tables), which captures inter-sectoral externalities. Some studies distinguish between a measure of foreign presence in the industries that are supplied by sector *j* (downstream industries), which should capture the impact of MNCs through backward linkages on the productivity of their suppliers, and as a measure capturing the impact of forward linkages. Results unambiguously support positive inter-sector spillovers in the case of UK (Driffield et al., 2002), Latvia (Javorcik, 2004), Indonesia (Blalock & Gertler, 2005), Hungry (Schoors & Tol, 2002), Czech Republic, Poland and Slovenia (Damjian et al., 2003). They have supported the idea that the lack of any evidence of spillovers had to do with the fact that we were looking for them in the wrong place, i.e. within same industry where MNCs are active, and not in upstream and downstream sectors (Javorcik, 2004).

A rather extensive literature has examined spillovers by focusing on the role of technology gaps and absorptive capacity, but different views have emerged in this respect. On the one hand, scholars have argued that the lower technological gap between domestic and foreign firms would mean higher absorptive capacity of the former and thus the higher expected benefits regarding technology transfer to domestic firms. Cantwell (1989) labels this as the technological accumulation hypothesis. The hypothesis places importance on the ability to absorb and utilize foreign technology as a necessary condition for spillovers to take place. The analysis of the response of local firms to the entry and presence of US MNCs in the European markets over the period 1955-75 suggests that the most positive impact occurred in the industries where the technological gap was small (Cantwell, 1989). This is consistent with the view that relatively low technological differentials between domestic and foreign firms would grant higher ability of local economies to capture technological opportunities and respond to the stimuli created by MNEs. Kokko (1994) focuses on 156 industries that hosted MNEs in Mexico in 1970. His evidence suggests that in industries characterized by both large technological gaps and large foreign market shares; local productivity growth is significantly inhibited. In a similar work based on Uruguayan plants, Kokko et al. (1996) find positive and statistically significant spillover effect only in a sub-sample of locally-owned plants with moderate technology gaps vis-à-vis foreign firms. Empirical works by Cohen & Levinthal (1990); Girma (2005); Girma et al. (2007), and Blalock & Simon (2009) also accord with the view that to benefit from FDI spillovers, local firms must possess a sufficient level of technological capability to detect valuable external knowledge, internalize it and employ for commercial objectives. Alternatively, these studies suggest that to benefit from FDI spillovers, local firms need to have attained a threshold level of absorptive capacity enabling them to realize and assimilate the potential spillovers arising from MNC presence in the host country. In the presence of excessively low or high levels of absorptive capacity, local firms will hardly benefit from spillovers, either because they are unable to internalize foreign knowledge or because they already possess the state-of-the-art technologies (Girma, 2005). What can be inferred from these studies is that moderate levels of absorptive capacity is more conducive for the greatest local learning potential as these ensure that the knowledge sources and recipients are technologically proximate enough to fulfill effective knowledge exchange.

On the contrary, it is suggested that larger the technology gap between host country firms and foreign-owned firms, the larger the potential for technology transfer and productivity spillovers to the former. The argument that larger technology gap is conducive for spillovers to materialize can be explained in light of “catching up hypothesis” derived from the original idea put forward by Findlay (1978). In his seminal contribution, technological progress in relatively backward regions was formalized as a function of: the distance between their own level of technology and that of the advanced regions, and of the degree to which they are open to FDI. While this view is often thought of as an alternative to the technological accumulation hypothesis, it is worth noting that the role of absorptive capacity has not been neglected in the catching up tradition. In particular, it is acknowledged that a sort of lower bound of local technological capabilities exists, below which foreign investment cannot be expected to have any positive effect on host economies. Consistently with the catching up hypothesis, Blomstrom & Wolff (1994) find evidence that the growth of gross output per employee of locally owned firms in Mexico in 1970-75, is positively related to a measure of FDIs and of initial labour productivity gap between local firms and MNCs. In a sample of UK establishments, Griffith et al. (2002) find that a higher foreign presence increases productivity growth of firms which are lagging behind the productivity frontier in their industry. Consistently, Haskel et al. (2002) find that UK firms in the lower end of the *tfp* and skill intensity distribution are able to appropriate more productivity spillovers from foreign firms than the firms which are closer to the frontier. Driffield & Love (2003) also obtained results which are largely consistent with the catching up hypothesis. A different viewpoint on the role of technological gap proposes that it influences the type of knowledge MNCs will choose to transfer to the host countries (Glass & Saggi, 1998). In the presence of significant technology gaps, headquarters is likely to convey the less advanced technology to their affiliates, thereby limiting the potential for spillovers.

Another important related aspect in determining the occurrence of FDI-related spillovers is the type of activities that foreign subsidiaries decide to undertake in host countries, which in turn is a function of the level of the host country development. While it is normally assumed that foreign subsidiaries share the same technological capabilities as the parent company, in reality subsidiaries can evolve independently from the headquarters according to their choices and to the domestic environment (Birkinshaw & Hood, 1998). Subsidiaries can develop their technological capabilities by building on the host country technological advantage and can become as important as the headquarters as a source of new technological assets. But at the same time and to the same extent, subsidiaries' technological upgrading can be limited by the host country's degree of technological development. When local firms are technologically backward, MNEs will tend to engage themselves in low-value added activities and, as postulated by Wang & Blomstrom (1992), will not transfer advanced technologies to these foreign subsidiaries, thus reducing the scope for spillovers. The type of activities that foreign firms undertake in a host economy is strictly connected with the motives that in the first place prompted MNCs to invest abroad. Firms may undertake direct investment abroad to avail themselves of natural resources (resource-based FDI), to exploit the host country market (market-seeking investment), to restructure existing foreign production through rationalization (efficiency-seeking investment), or to acquire and create new assets. The first three motives can be classified as being asset-exploiting in nature while the last is asset-augmenting. As argued by Narula & Dunning (2000), different levels of host country development will attract different amounts of FDI and different types of MNC activity depending on the host economy's comparative advantage. Less developed countries due to the low level of productivity and underdeveloped infrastructure will attract very limited FDI and this will mainly be of the resource-seeking type. In contrast asset-augmenting FDI mainly takes place among industrialized countries. This implies that the occurrence of technological spillovers is contingent upon the host country's characteristics, in terms of the location advantages that it is able to offer to MNCs, which in turn determines the FDI motives and therefore the activities that foreign subsidiaries undertake.

An additional factor determining the incidence of FDI-related spillovers is the degree of embeddedness of foreign subsidiaries in the host economy (UNCTAD, 2001). If foreign subsidiaries operate in isolation and import most of their inputs, there is little scope for technological spillovers. As mentioned above, it is through the creation of backward and forward linkages that tangible and intangible assets can be transferred from foreign subsidiaries to domestic suppliers and customers. As shown by both a number of case studies reviewed by Belderbos et al. (2001), and the empirical evidence found in his study, it is not only host country characteristics such as market size, technological development, infrastructure, availability of proximate domestic suppliers, and local content regulations that are important determinants of backward linkages, but also certain foreign affiliates' characteristics such as their market orientation (domestic vs. export), their age, and their mode of establishment (greenfield vs. acquisition). In particular, domestic market-oriented foreign affiliates tend to use local inputs because the quality and technical requirements may be lower and they can be met by local suppliers. Export-oriented affiliates may instead be more inclined to source the intermediate products from abroad often from other units of the MNC. Acquired subsidiaries or subsidiaries established through joint ventures are more likely to source locally than greenfield subsidiaries, and in particular newly established greenfield subsidiaries. As observed by Belderbos et al. (2001), acquired subsidiaries are already embedded in the host economy and may have developed stable relationships with local suppliers which may continue to be exploited under the new ownership.

Another factor affecting the scope for technological spillovers from FDI is the host country's intellectual property right (IPR) regime. Although other host country regulatory regimes (such as tax and investment regulations), trade policies, and competition rules also affect FDI decisions, the host country IPR regime is the most important policy variable in determining not only the amount of FDI, but also the technology content of the activities that foreign firms undertake. This issue has recently become prominent on the international political agenda with the implementation of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs) which entails a minimum level of protection for all categories of property rights and requires the development of effective enforcement measures. The relationship between FDI and IPR is ambiguous. On the one hand, a weak IPR protection system can increase the probability of imitation thus reducing the amount of FDI a country receives. On the other hand strong, IPR protection may indeed encourage FDI but at the same time may make licensing more attractive and therefore have a negative effect on FDI. However, survey studies by Mansfield (1994) have shown that the effect of IPR regime varies across industries and is a function of the type of investment project. In particular, the role of IPRs was considered important by 100 major US firms with international operations in 1991 in the pharmaceutical and chemicals industries and it was less relevant for investment in distribution and sales.[4] In a more recent study Smith (2001) analyses the relationship between the IPR regime and US exports, sales of foreign affiliates, and licensing fees in 50 developed and developing countries in 1989. She finds significant evidence that a better-enforced IPR system has on average a positive effect on affiliate sales and license payments in countries with strong imitative capabilities. But at the same time a stronger IPR regime shifts activity away from exports and FDI and towards licensing. In addition, she finds that patent rights strongly and positively affect the inflows of knowledge, measured as R&D expenditures undertaken by affiliates. This evidence is stronger for countries with greater absorptive capacity. These results seem to suggest that the enforcement of property rights may favour international technology transfer through inward FDI-related spillovers and licensing in

[4]Smarzynska (2003a) based on data from questionnaires sent to foreign investors in Eastern Europe and former Soviet Union find that weak IPR protection deters FDI in drugs, cosmetics & health care products; chemicals; machinery & equipment; and electrical equipment and encourages MNEs to establish distribution facilities rather than to engage in local production.

those developing countries that have achieved a certain level of absorptive capacity. However, as tougher IPR protection makes technology licensing more attractive, domestic firms may get access to older technologies. A study by Mansfield et al. (1979) shows in fact that firms tend to transfer newer technologies abroad through their subsidiaries rather than licensing agreements. Therefore, overall the net impact of stronger IPR protection on technology transfer via FDI is ambiguous and it only affects the spillover potential not the actual realization of these spillovers.

Macro-level cultural and institutional factors are also expected to influence the relevance of FDI knowledge spillovers. For instance, cultural, social and legal differences between the home- and host economy modifies foreign firms' incentives to develop linkages with local partners (Rodriguez-Clare, 1996). Culture also influences the individual knowledge sharing approaches (Michailova & Hutchings, 2006). The knowledge that is not coherent with the recipient economy's culture will encounter societal, institutional and legal barriers to the transfer from headquarters to subsidiaries (Hennart & Larimo, 1998), thus reducing spillover potential. The influence of the host country markets and commercial regulations has also been investigated. Well-developed financial systems help host countries to take advantage from FDI (Alfaro et al., 2004, Choong, 2012). Further, while investing in host countries characterized by restrictive trade regimes, MNCs limit their local operations to low value-added activities, thus generating lower levels of local linkages (Belderbos et al., 2001; Kohpaiboon, 2006).

In summary, FDI-related R&D spillovers are determined by the degree of foreign subsidiaries' embeddedness in the host economy, by the technology gap between the foreign subsidiaries and the host country firms, by the level of domestic firms' absorptive capacity, by the type of technological activity that these firms are undertaking and by the enforcement of IPR protection. All these factors are mutually reinforcing and interrelated and all contribute to the realization of spillover potential.

2.4.1. Indian studies on FDI spillovers

With the opening of Indian economy in 1991, spillover effects have grabbed the attention of Indian scholars resulting into appearance of a number of empirical studies examining FDI spawned spillovers on domestic firms. Although there were a few pre-1991 empirical works investigating effects of FDI on domestic firms but large part of empirical literature on spillover effects in India specifically surfaced post 1991. Therefore, using liberalization year (1991) as reference, we divide these studies into pre-liberalization spillover studies and post liberalization spillover studies. The former set of studies show more or less unanimity on positive spillover effects from FDI on R&D and productivity of domestic firms. For instance, Desai (1980) reports that MNCs had a positive spillover impact on R&D in the host country. The study took Indian R&D as evidence to prove that imported technology encouraged in-house R&D. These findings were also supported by Kartak (1985, 1989) and Siddharthan (1988, 1992). Similarly, Lall and Mohammad (1983) and Nayyar (1983) found that manufacturing industries in developing countries with high foreign shares tend to be export oriented.

Using techniques from a stochastic production frontier and panel data for 368 medium and large sized Indian manufacturing firms for the period 1975-1976 to 1988-1989, Kathuria (2001) finds domestic firms belonging to scientific sectors like drug and pharmaceuticals, chemicals, electronics, etc. significantly gain from the foreign firms. In addition, the gain was extra where foreign and domestic firms were closer to the efficiency frontier. However, non-scientific domestic firms did not benefit from foreign presence. In a similar study conducted for pre-liberalization and post liberalization period, Kathuria (2002) shows that the extent of spillovers varied in two periods--pre-1991 and post-1991. The domestic firms gained from foreign firms irrespective of the sectors in which they reside; provided they had enough technological capabilities to decode spilled knowledge unlike pre-1991periods where the results differ for the two groups (scientific and non-scientific). A further study by Kathuria (2010) finds no evidence of spillovers. While taking into account the technology gap between foreign and domestic firms, the author shows that in majority of industries productivity of domestic firms is higher than foreign firms thus precluding the possibility of spillovers to all the sectors. Even in the sectors where foreign firms are more productive and the technology gap is accounted for, there is no evidence of spillovers resulting from the presence of foreign firms. Similarly, FDI inflow seems to have no impact on productivity once industries are divided according to size of the technology gap. Kathuria (2008) study the impact of FDI on the R&D investment of medium-and high tech manufacturing firms in India and shows that FDI had a negative impact on R&D investment by Indian firms in initial years of liberalization (1994-96) but no significant effect in 1999-2001. A latter study by Sasidharan and Kathuria (2011), however, suggests that FDI inflows and R&D decision of domestic firms are complementary but former does not have any impact on the extent of R&D spending by domestic firms.

Sasidharan and Ramanathan (2007) find no evidence of significant horizontal spillover effects and insignificant negative vertical spillovers effects on domestic manufacturing firms. The result was later contradicted by Behera (2015) who suggests that local firms benefit from vertical foreign presence, whereas the horizontal foreign presence at the industry level could not substantially increase the value addition of labour across Indian industries. Behera (2015) asserts that absorptive capacity of domestic firms is highly relevant to reap the benefit from foreign presence, and acts as a precondition for incorporating the benefit of FDI externalities. Furthermore, the FDI-technology spillovers seem to be higher for R&D-and technology-intensive firms. Marin and Sasidharan

(2010) look at MNC subsidiaries as ‘competence-creating’ and ‘competence-exploiting’. While competence creating subsidiaries had a positive impact on the host economy irrespective of the level of absorptive capacity of domestic firms, and competence exploiting subsidiaries have a negative effect, a result that holds again independently of the absorptive capacity of domestic firms. Disentangling spillover channels into demonstration effects and imitation effects, Franco and Sasidharan (2010) show that export spillover effects are mainly mediated by an imitation effect, contrary to the case of other emerging market economies like China, where a demonstration effect is evident. They also recognize that both the decision to export and export intensity are influenced most of all by the technological activities of local firms. Moreover, the findings of the analysis suggest that in-house R&D is more relevant than other external sources of technological knowledge such as disembodied technology imports to internalize the positive spillover effect emanating from MNEs.

It is evident from the above literature survey that the findings on spillover effects on domestic firms are mixed ranging from no spillovers to positive and negative spillovers. The inconclusive findings increase the relevance to further the research on spillover effects. Further, none of the above mentioned studies have attempted to look into the innovation impact of FDI. We, besides analyzing productivity spillovers, undertake the research on FDI spawned innovation spillovers by analyzing the patent grants of incumbent firms operating in Indian manufacturing sector. To estimate the spillover effects, we employ a series of input-output tables which has not been done by the Indian studies earlier. We will discuss more on the gaps of existing spillover literature in chapter 3.

Chapter 3

Conceptual Framework and Hypothesis Development

Using the detailed review of existing empirical findings, this chapter provides a critical assessment of the literature and develops propositions with respect to gaps and limitations identified. We begin with addressing the gaps in the literature, especially relating to spillovers on productivity. This review is followed by a discussion of recent theoretical developments to fill gaps. Based on the identified research gaps and recent developments in theoretical and empirical literature, we build the hypotheses that are tested in the chapter on empirical analysis. At the end of the chapter 3, we present the basic research framework adopted to explore the link between innovation and productivity and extend that framework to incorporate the spillover effects on innovation and productivity arising from FDI.

3.1. Gaps in Literature

FDI has both direct and indirect effects on the host economies. On the one hand, on average MNCs have higher productivity and a higher propensity to innovate and carry out R&D than national firms. Therefore, whenever foreign or domestic MNCs enter or expand activities into a given country, they contribute directly to the overall performance of the economy. On the other hand, they have external effects on entry, survival, and performance of other firms in the same country. We have reviewed the literature on this second aspect, and we have limited our discussion to spillovers arising from foreign affiliates to domestic firms in the host country. Theoretical works suggest that MNCs produce both pecuniary and knowledge externalities, and such external effects arise through four main channels: competition, imitation and demonstration, labour mobility and spin-offs, and backward and forward linkages. From the theoretical point of view, one can identify the different types of externalities and the different roles played by these various channels in mediating such external effects.

The volume of empirical studies addressing the issue of FDI spillovers and their impact on domestic firms is much higher than the theoretical studies. Although empirical studies have been conducted on macro as well on the micro-level, the results obtained, however, are contradictory. The first category of empirical works use aggregate data for a single country or a group of countries, and systematically obtains a positive impact of FDI on economic development in host countries (Bloningen & Wang, 2005, and Azman-Saini et al., 2010). Cross country studies, although popular, provide a limited scope for interpretation. Since the coefficient for FDI is the result of possible opposing effects, we do not know the relative importance of each one. Micro-level studies (for example, Aitken & Harrison 1991; Blomstrom 1986; Haddad & Harrison 1993; Hill 1982; Kathuria 2001, 2002, 2008; Sasidharan & Ramanathan 2007; Sasidharan & Kathuria 2011; Behera 2015) on the other hand, are able to reveal more details about the complexity of the technology transfer mechanism. The idea is to consider the effects on the productivity of local firms while taking into account linkages with FDI. In contrast to macro studies, which often argue in favour of a positive effect, the findings of micro studies are very diverse ranging from positive effect to insignificant effects and even negative effects.

The empirical works so far have mainly examined the impact of FDI on the productivity of domestic firms. Using different measures of productivity, such as *tfp* and LP and trying to associate improvement/ drop in any of these measures resulting from positive/negative spillover, the existing empirical works hitherto have failed to establish a unanimous relationship between FDI and local productivity. The findings are rather mixed and diverse. While some studies report that FDI adversely affects domestic productivity (Aitken & Harrison, 1999; Konings, 2001; Djankov

& Hoekman, 2000; Liu, 2008); others, at loggerheads with the empirical works claiming negative spillovers, find that FDI positively affects domestic productivity (Caves 1979; Globerman, 1979; Blomstrom 1986; Damijan et al., 2003; Javorcik, 2004), and yet a third category of empirical studies, for instance, Girma et al. (2007), Barrios & Strobl (2002) and Kinoshita (2001) reveal that the impact of FDI on local productivity, if not negative, is insignificant. The ambiguity as well as the lack of unanimity in the empirical findings on spillovers probably calls for furthering the research on spillover effects.

The motivation for the study comes from the fact that typically spillovers studies employ a productivity approach and infer technology transfer from MNCs to domestic firms from productivity performance. However, productivity growth could be the result of non-technological factors such as having access to better quality inputs which improves the overall efficiency of production rather than technological improvement (Driffield & Jindra, 2012). In addition, the situation is more complex given the variety of influencing factors of productivity and the way productivity is estimated, which could lead to contradictory findings (MacGarvie, 2006). The mixed findings reported in meta-analysis such as Havranek & Irsova (2011), and Irsova & Havranek (2013) could be the result of the indirect methodologies adopted by the literature linking economic performance with FDI. There is a possibility that there exist a direct link between FDI spillovers and domestic innovation. Innovation facilitated by international knowledge spillovers can be more directly assessed in firm's efforts to launch new products or patents (Salomon & Shaver, 2005).

Inward FDI is an important external knowledge source, especially for emerging host countries; it is perhaps surprising to observe that the empirical studies linking FDI with host country innovation are scarce. Moreover, innovation is crucial for sustainable economic development (Grossman & Helpman, 1994). For an emerging economy, it is particularly important for policymakers' to evaluate the cost and benefit of attracting inward FDI and to understand the role of FDI in influencing innovation.

Keeping in view the dearth of literature on innovation spillovers, the study, therefore, seeks to further the understanding of technology spillovers from inward FDI on incumbent firms (both domestic and foreign) operating in host countries through the direct lens of innovation measured by R&D spending and patent grants. Analysing R&D behaviour of foreign firms is important for two reasons. One, foreign affiliates have captive access to the R&D labs of their parent firms, therefore, their propensity to undertake R&D could be lower than local counterparts. Two, access of foreign affiliates to their parent firm's resources can ease off their financial constraints; hence they may invest more in R&D. The study has three particular interests. First, to examine the extent to which FDI spillovers impact the innovation inputs (specifically R&D spending) of incumbents active in the host country. Second, to test if the spillovers from horizontal and vertical (backward and forward) FDI benefit the incumbents' innovation output particularly the patent grants. Alternatively, the attempt is to empirically examine if the incumbent firms are able to translate the knowledge externalities received through intra- and inter-industry linkages (developed with MNCs when the latter ventures into the host market) into the productive use and whether these spillovers manifest in the patenting activity and productivity gains. Third, to explore whether or not, spillovers from FDI are conditional on the incumbents' proximity to/distance from the technology frontier.

The investigation into the above two objectives will probably lead us to answer the pertinent question that whether the foreign firms enhances or diminishes the innovativeness of the incumbent firms. FDI inflows could have a potential impact on the R&D spending and therefore, on innovation output of incumbents in many ways. Irrespective of whether MNCs spend on R&D or not in the host location, the enhanced competition due to MNCs may have a direct bearing on the R&D efforts of the incumbent firms (Caves, 1979). Alternatively, in order to face the competition from MNCs, domestic firms acquire technological imports; however, such imports may still necessitate R&D to adapt the imported technology to local conditions. Similarly, absorption of spillovers from FDI may also necessitate domestic firms to indulge in R&D spending (Feinberg & Majumdar, 2001; Kathuria, 2002). FDI entry may also entrench R&D and innovation culture among local companies (evident from the co-movements of FDI and R&D post-1991, Figure 1.8, Chapter 1). For instance, MNCs R&D activities in many countries have an impact on R&D expenses of the local firms and some of these companies directly compete with MNCs (UNCTAD, 2006). In addition, MNCs through joint ventures and R&D collaborations with local firms provide ample opportunities for the latter to learn how to conduct R&D and how to make it a commercial success. Therefore, one would expect that FDI positively affects the R&D spending of incumbent firms. Moreover, the superior technological knowledge brought into the economy through FDI can leak out to domestic firms through various channels. If domestic firms learn the better technology from MNCs, then this may also lead to more innovation activity. Aghion et al. (2005) argue theoretically and provide evidence that FDI stimulates innovative activity in the firms competing neck-on-neck with their foreign firms.

Third objective is particularly important as not all incumbents are uniformly affected by the FDI entry, and not all incumbents react to entry homogenously. As follows from Schumpeterian growth theory that advanced entry may induce innovation in incumbents close to the frontier, and this will trigger productivity growth in them. Entry may also reduce the expected rents from doing R&D for incumbents residing further from the frontier and hence retard innovation and eventually encumber their productivity growth. This suggests that spillovers arising from FDI/MNC entry may not equally benefit the incumbents. These spillovers will rather be conditioned by the location of incumbent with respect to the technology frontier. Building on this theoretical construct, we attempt to provide an empirical analysis of how spillover effects on innovative activities across incumbents vary depending on the proximity to/distance from the frontier. In particular, based on their closeness or remoteness to their own industry frontiers, how incumbent patenting and *tfp* growth reacts to FDI.

3.2. Hypothesis Development

The literature documents that the presence of MNCs stimulate the innovation and productivity of the local counterparts particularly those of competitors (Javorcik et al., 2008). The entry of MNCs into the host country encourages the indigenous firms to undertake innovations to safeguard its' market share. Introduction of new technologies brought in by MNCs trigger the competition in the local market compelling local firms to undertake R&D and adopt innovation at higher pace. Besides, incumbent firms gain from innovation and productivity spillovers spawned by activities of MNCs in the host country. It is reasonable to argue that apart from productivity augmentation, tacit knowledge embedded in employees is intrinsically important for technology transfer and to generate innovation output. This is supported by empirical findings of Liu et al. (2010), and Filatotchev et al. (2011). To sum up, the literature suggests that innovation spillovers from inward FDI (captured by foreign capital participation) could occur through demonstration and competition effects, augmented by training and labour mobility between MNEs and indigenous firms. Therefore, we propose:

Hypothesis 1: FDI generates positive innovation and productivity spillovers for incumbent firms acting as rivals to MNCs.

Unlike horizontal or intra-industry FDI-related spillovers, the literature on innovation spillovers arising from vertical FDI is nascent. It has been documented that backward and forward linkages that MNCs, while operating in the host country, develop with the local incumbents are important means of knowledge and technology transfer to the latter (Havranek & Irsova, 2011). Empirical evidence suggests that MNEs help domestic firms improve product quality, productivity, process technologies, delivery, as well as offer technical assistance, training, management and operation advice (Javorcik et al., 2008; Blalock & Simon, 2009). In order to retain the competitive edge in the host country, MNCs make every effort to protect and minimize the leakage of technology to their local rivals. However, MNCs have incentive to transfer knowledge to firms residing in the supplying sectors because diffusing knowledge along the supply chain may help in the creation of diverse supply sources of improved inputs at lower prices. Moreover, to avoid any holdup problems arising from sourcing from a particular supplier, MNCs help multiple prospective suppliers to set up production facilities (Klein et al., 1978; Williamson, 1985). Besides, facilitating innovations through training in organization and management, MNCs assist local suppliers to diversify by finding additional customers. Furthermore, interactions with foreign buyers' helps local firms create new marketing practices and obtain product details that are important for building innovation abilities (Figueiredo et al., 2013). Therefore, MNCs operating in final goods market or downstream sectors through backward linkages may help firms' in upstream sectors to engage in innovative activities and improve their productivity.

Turning to the transaction linkages between local buyers and foreign suppliers (i.e. forward linkages with FDI), local firms can have access to a variety of inputs with technical complexity (Markusen & Venables, 1999; Javorcik, 2004). The forward linkages may encourage domestic firms to adopt new technologies and solve contract implementation problems (Gow & Swinnen, 1998). As manufacturers in less developed countries tend to lack the ability to achieve economies of scale and incentive to invest in

R&D, having access to more innovative inputs from foreign suppliers is a way to update final products (Javorcik et al., 2008).

More importantly, in developing countries where firms tend to launch products with incremental improvement, technology transferred from MNCs in supplying sectors is important for domestic manufacturers to access innovation and produce technologically complex products (Javorcik et al., 2008). Training from foreign suppliers enhances local firms' abilities to innovate such as training to introduce technical and organizational innovation, product design and development (Figueiredo et al., 2013). We therefore postulate:

Hypothesis 2: FDI through backward and forward linkages generate positive innovation and productivity spillovers for incumbents acting as suppliers and clients to the MNCs operating downstream and upstream respectively.

Furthermore, the magnitude of the spillovers from backward and forward linkages with FDI may vary. The existing literature finds that linkages backing up the supply chain (backward linkage with FDI) appear to lead to greater spillovers than that from vertical linkages down the value chain (forward linkages with FDI). For example, Javorcik (2004) and Kugler (2006) observe positive spillovers from backward linkages with FDI but no spillovers from forward linkages in Lithuania and Colombia, respectively. In a meta-analysis, Havranek & Irsova (2011) summarize that productivity spillovers from vertical linkages are significant, but the magnitude is larger from backward FDI than from forward FDI. There are three possible reasons to explain the differences in the magnitude of vertical FDI spillovers. First of all, FDI into emerging or developing countries are likely to be export-oriented (Blalock & Gertler, 2008). These MNCs may not serve domestic customers in host countries. Hence, the linkages between domestic buyers and foreign suppliers are weak and domestic firms may have few opportunities to learn. Second, domestic buyers can have access to a variety of inputs from foreign suppliers to upgrade final products. However, for the buyers that have limited absorptive capacity or not motivated to innovate and are not likely to receive technology benefits from the forward linkages with MNCs. On the contrary, domestic suppliers can have strong incentives to improve efficiency and upgrade technologies in order to win contracts from MNEs. For instance, domestic suppliers in Mexico need to be able to cope with low profit margins because MNCs have strong bargaining power to plummet down prices (Javorcik, et al., 2008). Third, MNCs that establish forward linkages with local buyers may be motivated by accessing distribution channels in a host country. Domestic firms could receive benefits such as improved revenue and expand firm size due to increased demand (Kubny & Voss, 2014). However, the benefits may not be in terms of training and technical assistance that directly shape domestic buyers' technologies. Much of the productivity based literature has struggled to show the differences in backward and forward spillovers from FDI. Driffield et al. (2002) and Driffield & Jindra (2012) for example argue that productivity is an extremely imperfect way of capturing this, as increased technological progress in suppliers may encourage the MNCs to push down the prices, thus depressing value-added or output based measures of productivity. We, therefore, hypothesize that:

Hypothesis 3: Innovation and productivity spillovers spawned through backward linkages with FDI are more evident than generated through forward linkages. In other words, FDI spillovers strongly manifest on local firms supplying to downstream MNCs than local clients buying from upstream MNCs.

Although the presence of MNCs provides a potential for knowledge spillovers and thus indirectly affects the innovation and productivity of indigenous firms, the actual effects, however, are conditional upon the receiving party's characteristics (country, industry and firm). For instance, heterogeneity of the incumbents plays an important role in the absorption of spillovers. Firms with high productivity are better able to recognize the new knowledge and decipher complex technologies brought in by MNCs than ones with low levels of productivity. The existence of high absorptive capacity is an important condition for turning the potential knowledge spillovers into actual knowledge spillovers. The degree of technological gap between MNC affiliates and the local counterparts also conditions the potential of spillovers arising from inflows of FDI. In the sectors where the productivity differential or technology gap between foreign entrants and incumbents is small, the benefits from FDI are more than where this gap is huge. For instance, Glass & Saggi (1998) claim that technology gap between foreign firms and their domestic counterparts is related to absorptive capacity. The lesser technology gap between foreign entrants and existing incumbents reflects the high absorptive capacity of the latter and hence their potential to absorb possible spillovers. Pearce (1999) argues large technology gap reflect poor technical build-up and mimic capacity and hence lesser possibility for incumbents to learn from much advanced foreign firms. However, Findlay (1978) argues that relative backwardness of the host country firms indicate more scope for FDI spillovers to occur. The large technology difference between foreign firms and their domestic counterparts implies more pressure on latter and therefore, greater need for them to adopt new technologies. Another factor related to the constructs of absorptive capacity and technology gap that is believed to affect the capacity of incumbents to assimilate spillovers arising from advanced foreign firms is their location in the productivity distribution. In other words, in a distribution of productivity, location of incumbents' vis-à-vis to the industry's best practice frontier influences the probability of positive spillover benefits to them. Incumbents located near to the frontier may receive more benefits than ones located away from it. The likelihood that location of an incumbent conditions the spillovers it receives from MNC affiliates can be explained with the help of two factors. First, the level of absorptive capacity possessed by incumbent firms as producing ‘near or at’ the frontier is a signal of high absorptive capacity and hence a higher ability to assimilate spillovers relatively easily than the firms producing at the lower end of the frontier. Second as suggested by Aghion et al. (2001), that incumbent innovation and productivity growth is correlated with foreign presence through escape-competition and discouragement effects.[5] The twin effects emphasize that FDI induces innovation in sectors that are close to the technology frontier but impedes it in sectors that are further behind the frontierTherefore, based on this theoretical background, we hypothesize that:

Hypothesis 4: As opposed to incumbents located further behind the best practice frontier, FDI has a positive effect on innovation and productivity of incumbents situated close to the frontier.

3.3. Conceptual Framework: FDI, Innovation and Productivity

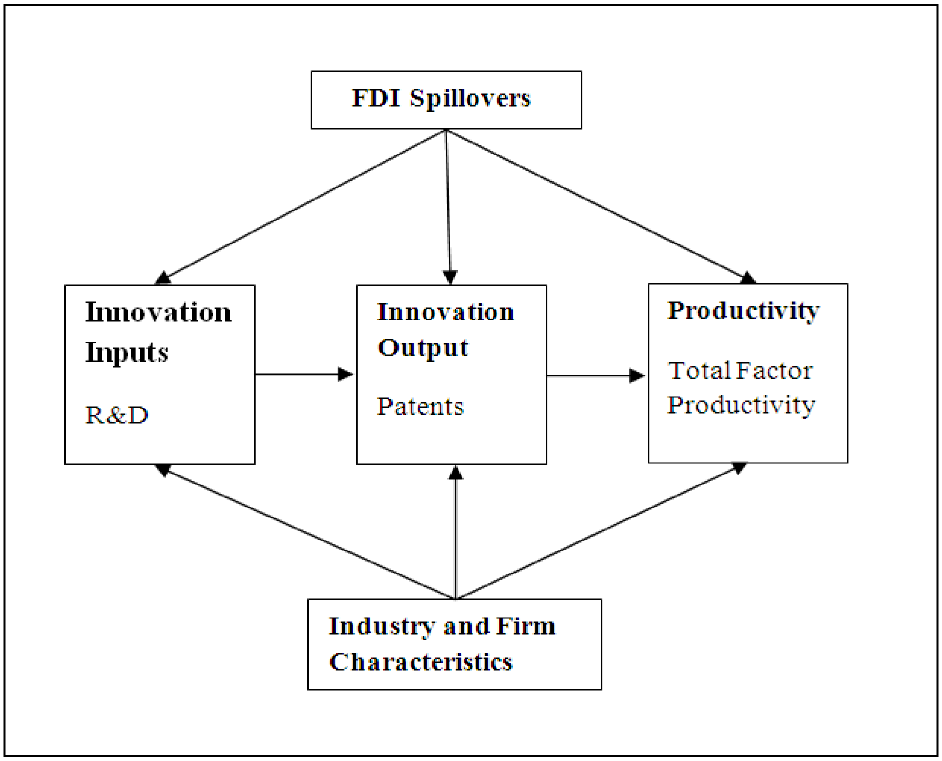
The manufacturing sector is a key industry in India, with many of its firms facing not only national, but also global competition. In order to survive the competition, firms need to constantly improve their productivity performance. Improvements in the productivity can be achieved through many ways such as reduction in cost of production, growth in capital and labour, and introduction of innovations in the form of new products or processes. Among all the factors augmenting productivity of a firm or an industry, innovation is a promising, although risky, endeavour to open new paths of growth process. More specifically, investment on innovation, if successfully made, augment the stock of knowledge in a firm which may lead to development of new products or processes and eventually

[5] The escape-competition effect states that MNCs can have positive effect on incumbents’ performance, innovation incentives and innovation activities if the incumbents are sufficiently close to the frontier. These high productivity firms can escape adverse effects of MNCs by innovating. The essence of discouragement effect is that foreign presence could reduce innovation incentives and eventually moderate productivity growth if incumbents are far from the frontier, as they have no hope of surviving the competition from foreign firms.

raising the firm's output through increased productivity (Hall et al., 2010). However, the relationship between innovation and productivity is not simple but complex and contingent on multiple factors. The first problem that researchers face in deriving the innovation-productivity relationship is the challenging task of measuring innovation. For reasons of data availability, the empirical works, thus far, have mostly used two measures to gauge innovation activity: R&D spending and patent counts. Both of these innovation measures, although frequently used in the empirical literature, have positive and negative attributes. As pointed out by Hall (2011) that both R&D and patents as indicators of innovation largely relate to technological innovation and are best suited for measuring innovation in the manufacturing sector than other areas of economic activity such as services sector. R&D expenditure as an input to innovation actually symbolizes a decision variable measuring the size or level of innovation activity at the firm level, it, however, is unable to represent the innovation success. The advantage with R&D spending is that it is comparable across firms, industries and countries because it is denominated in currency units. The patent counts as a measure of innovation scores over R&D expenditure in the sense that unlike R&D, it is able to capture the successful innovations and therefore can be treated as a better proxy of innovation output. As argued by Griliches (1990), patents can be used as either an output or an input indicator of innovative efforts. When patent statistics are used as an output measure these are an indicator of the success of the underlying inventive activity, while when patents are used as an input measure they represent efforts that have been put into the creation of a new product or process and, as such, patents are related to R&D expenditure statistics. The problem inherent in patent counts is that only a few of them are associated with highly valuable inventions and most describe inventions of little value. Another issue with patent counts as measure of innovation relates to is their sectoral variability, i.e. the extent of their innovation coverage varies by sector, with sectors like pharmaceuticals and instruments making heavy use of patents while other sectors use them to a very small extent.

Coming back to the relationship between innovation and productivity, it has been documented that innovation is an important ingredient in the *tfp* growth. By linking the *tfp* growth rate to innovation, endogenous growth models shed light on the determinants of *tfp* growth. R&D subsidies and an abundance of skilled labor reduce the marginal cost of conducting R&D and increase the rate of innovation development and therefore, the *tfp* growth rate. The determinants of productivity and productivity growth have been largely documented for industrial countries, where innovation is widely regarded as the key to growth. Firms invest in R&D to develop new products and processes. By investing in research, patenting and licensing they stay at the cutting edge of technologies. The theoretical approach supporting this indirect relationship is the R&D Capital Stock Model (Griliches, 1979). This model stresses that R&D enhance the innovations achievements, and these improve firms' performance. Empirical evidence of this indirect relationship could be found in Duguet (2006). While analyzing French manufacturing firms, he observed that R&D activities foster radical and incremental innovations but only radical innovations increased the firm productivity. Wolff and Pett (2006), analyzing US manufacturing firms noticed that R&D expenditures affected product and process improvements but only product improvements enhanced firm growth. While analyzing the mediating role of innovation outputs between R&D and firm performance, Hall and Bagchi-Sen (2002) observed that R&D fostered both product and process innovation; nevertheless, product innovations positively affected firm performance measured as turnover growth. There are some studies that considered both innovation inputs and outputs as determinants of the firm productivity; however, they did not considered the sequential effect R&D, innovations and firm productivity. However, the exception is the study of Crepon et al. (1998). The study proposes an original empirical approach to the problem of assessing both the innovation impacts of research and the productivity impacts of innovation and research. Crepon et al. (1998), explicitly account for the fact that it is not innovation input (R&D) but innovation output that increases the productivity. We also take the same line of approach to study the link between innovation and productivity. However, we introduce other important factors into the analysis that are believed to be important determinants of both innovation and productivity. As an extension to the Crepon et al. (1998) CDM model, we augment it by introducing FDI as an exogenous factor influencing the innovation and the production activities of firms. The model can be perceived as a multi-step model comprising several equations depicting the successive links between innovation expenditure, innovation output and productivity. In each of the equations, the industry level FDI variables enter as exogenous to capture the impact of FDI-related spillovers on innovation and productivity. First equation in our model is the innovation expenditure equation linking R&D with FDI and some firm and industry specific factors believed to determine the R&D expenditure at the firm level. Equation second specified as the innovation output equation, links innovation output of a firm with its R&D expenditure, FDI and other factors seen as determinants of innovation activity. Third equation is the productivity equation, which relates firm level productivity changes with innovation output, FDI and other variables assumed to influence productivity. The reason for inclusion of R&D as an exogenous variable in innovation output equation and the incorporation of innovation output as an exogenous variable in productivity equation is to explicitly account for the fact that R&D affects innovation output and innovation output influences the changes in productivity. Firms invest in R&D to develop process and product innovations, which in turn may contribute to their productivity. Since in all the three relationships depicted in the diagram 3.1 the nature of data varies, accordingly, we use different empirical strategies to derive the estimates. The empirical strategies and the issues related to them are dealt in the next chapter.

Figure 3.1: Conceptual Model for Empirical Analysis



Source: Author's adaptation from Crepon et al. (1998)

Chapter 4

Econometric Specifications and Data

Empirical investigations on spillover effects generated by the FDI inflows are susceptible to multiplicity of limitations arising from the complexity in quantifying and interpreting the spillovers, disentangling the various spillover channels and measuring the magnitude of spillovers occurring through each channel. However, since the debate on spillover effects on host country's innovation and productivity has taken a central stage, researchers are using the latest econometric tools as an attempt to capture the impact of spillovers on several aspects of industrial activity. This study is devoted to analyse the impact of FDI spillovers on two important aspects of industrial activity—innovation and productivity. Owing to the differences in nature of data utilized and measures adopted to capture innovation and productivity at firm level, each of the aforementioned aspects requires a different methodological treatment. However, there are substantial commonalities as well ranging from the approach followed to measure the spillovers, constructing the focal variables to the selection of the sample. The approach employed to overcome the econometric issues like heteroscedasticity and endogeneity may broadly remain same throughout the study, though there may be changes in terms of controls used, depending upon the nature of dependent variables, hypotheses tested and objectives pursued. Therefore, in this chapter, we discuss the basic econometric methodology adopted to analyse spillovers on innovation and productivity.

The chapter is organized as follows. Section 4.1 discusses the basic empirical framework for analysing the spillovers on innovation and productivity. Section 4.2 illustrates the process of sample extraction from the population of firms. Final section of the chapter provides information on data sources as well demonstrates the construction of variables used in this thesis.

4.1. The Empirical Strategy

Figure 3.1 presented in chapter 3 lays out a schematic diagram showing the general structure of our econometric model. It comprises three equations, one each for innovation expenditure, innovation output and productivity. In the first equation we will consider the R&D behaviour of firms by bifurcating it into two sub-equations. In the first sub-equation, R&D enters as a dummy taking a value 1 for firms reporting their R&D expenditure and 0 otherwise. The second R&D equation takes into consideration the actual R&D intensity of the firms reporting their R&D expenditure. Both of these equations include FDI-variants as explanatory variables. In the innovation equation, the innovation output is measured by the number of patents granted to an incumbent. The extended specification includes other firm-specific factors as explanatory variables influencing patenting activity at the firm level. The final equation measures the change in *tfp* at the firm level as a function of FDI spillovers and innovation activity and its extended specification incorporates all the firm-specific controls believed to have a bearing on the *tfp*.

4.1.1. The Innovation Expenditure Equations

To analyse the R&D behaviour of incumbents, we rely on the Heckman's (1974, 1976, and 1979) two-step model consisting of two equations-selection equation and an outcome equation. While the former depicts whether or not, a firm engages in research activities and latter accounts for the magnitude or intensity of research activities at the firm level. More specifically, the former describes the relationship between a binary participation decision (e.g., the decision to invest in R&D) and a set of covariates. While latter describes the correlation between the outcome of interest (R&D intensity here) and a vector of the covariates.

The selection equation, in our case refers to the decision to invest in R&D, is formulated as:

$$s_i^* = \gamma z_i + v_i \qquad (4.1)$$

Where s_i^* is an unobserved latent variable measuring the predicted utility of engaging in R&D, γ is a vector of parameters, z_i is a vector of exogenous variables and v_i is an error term.

To account for the fact that we only observe what the firms report as innovation effort, we estimate the following selection equation which describes the propensity of firms to invest in innovation:

$$s_i = \begin{cases} 1 & if\ s_i^* = \gamma z_i + v_i > 0 \\ 0 & otherwise \end{cases} \qquad (4.2)$$

Where s_i is a binary variable equal to one for firms reporting R&D expenditure and zero for firms without R&D expenditure. We explain the propensity of firms to invest in R&D as a function of firm characteristics as well as time specific and industry specific effects.

Further, conditional on investing in innovation (R&D) we estimate the innovation expenditure intensity as follows:

$$y_i = \begin{cases} s_i^* = \beta x_i + u_i & if\ s_i = 1 \\ 0 & otherwise \end{cases} \qquad (4.3)$$

Where y_i designates innovation expenditure intensity or R&D intensity of a firm, β is a vector of parameters x_t is a vector of exogenous explanatory variables and, u_i is the error term. The difference between x_i in (4.3) and z_i in (4.2) is that z_i contains all the variables in the vector x_i plus some more variables (unless otherwise stated). We also assume that z_i (and thus x_i) is always observable, regardless of whether we observe y_i.The random error terms u_i and v_i in the above equations are normally distributed jointly as:

$$\begin{bmatrix} u_i \\ v_i \end{bmatrix} \approx N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix} \cdot \begin{pmatrix} 1 & \rho \\ \rho & \sigma_v^2 \end{pmatrix}\right] \qquad (4.4)$$

Since s_i (the process influencing the decision to invest in R&D) cannot be noticed, we only observe it when a firm decides to invest in R&D. The R&D intensity is zero when a firm decides not to undertake any R&D, and it takes a positive value when it decides to undertake R&D. Selection bias arises when we estimate model (4.3) taking into account only observable R&D firms $(when\ s_i = 1)$ and avoiding ones which for some reason don't report their R&D expenses. Applying ordinary least squares (OLS) in such situations will, therefore, lead to biased estimates (Heckman, 1979). Heckman two-step estimation strategy takes care of the selection bias. It involves estimating the selection equation parameters (γ) using the probit model (with R&D dummy as dependent variable) by the method of maximum likelihood. The estimation gives inverse Mills ratio (λ_m) from the selection equation

$$\lambda_m = \frac{\phi(z'\gamma)}{\Phi(z'\gamma)} \qquad (4.5)$$

Where $\phi(\omega'\gamma)$ and $\Phi(\omega'\gamma)$ are the probability density function and cumulative distribution function for a standard normal random variable. The second step involves adding the inverse Mills ratio to the response equation (i.e. R&D intensity equation) to obtain estimates free of selectivity bias.

We now have a fully parametric expression for the expected value of y_i, conditional on observable z_i, and selection into the sample $(s_i = 1)$.

$$E(y_i | z_i, s_i = 1) = \beta x_i + \beta_\lambda \lambda(z_i \gamma) \qquad (4.6)$$

Where β_λ measures the covariance between u_i and v_i. Equation (4.6) tells us that the expected value of y_i, given z_i and observability of y_i $(i.e.\ s_i = 1)$ is equal to βx_i, plus an additional term which is the product of the covariance of the error terms β_λ and inverse Mills ratio evaluated at $z_i \gamma$.

4.1.2. The Innovation Output Equation

The next equation in our model is an innovation function which specifies the relationship between innovation outputs (i.e. the number of patents granted to a firm) with a set of covariates which among others include the R&D expenditure of the firm, spillovers from FDI and other firm and industry specific variables. The patent grant is essentially a count variable taking on non-negative integer values. The discrete non-negative nature of the patent counts makes linear regression models (LRMs) unable to provide the best fit of the count data. Hence, such models are deemed to be inappropriate to handle count variables. The ineptness to handle counts is the underlying assumption of LRM such as normality of residuals and linear adjustment of the data that is no longer fulfilled. The usual way to deal with count data is to consider the Poisson regression model (Hausman et al. 1984).

Let p_{it} be the number of patent grants received by a firm in a year, and then p_{it} will have a Poisson distribution with parameter θ_{it} such that the probability to observe that a firm i receiving p_{it} patent grants conditional on exogenous variables (x_{it}) is given by:

$$P(p_{it} / x_{it}) = \frac{\theta_{it}^{\,p_{it}} e^{-\theta_{it}}}{p_{it}!}, \qquad p_{it} = 0,1,2,3,.... \qquad (4.7)$$

The parameter θ_{it} symbolizes the mean as well as the variance of the patent counts since for a Poisson model mean is always equal to the variance, i.e., $E(p_{it}) = Var(p_{it})$. The explanatory variables (x_{it}) enter the model by specifying a Poisson parameter θ_{it} such that $\theta_{it} = \exp(x_{it}\beta)$ where unknown parameter vector β is to be estimated. The conditional mean function of patent counts, given the exogenous variables, is therefore specified as:

$$E(p_{it} / x_{it}) = \exp(x_{it}\gamma) \qquad (4.8)$$

4.1.3. The Productivity Equation

The last equation measures the change in *tfp* to be a function of innovation output, FDI spillovers and other firm and industry specific controls. The productivity equation takes the following form:

$$\Delta y_{it} = \beta_1 p_i + \beta_2 x_{3i} + u_{3i} \qquad (4.9)$$

The dependent variable Δy_{it} in (4.9) is the change in *tfp* at incumbent level computed through malmquist productivity index (MPI). The right-hand side of (4.9) have all exogenous and control variables including patent count as an explanatory variable.

4.2. Econometric Issues

In the analysis of FDI spillovers we are faced with a number of econometric problems that have the tendency to render the parameter estimates biased. These problems emanate from various sources ranging from the nature of the dataset used to measurement errors committed while computing certain variables, omission of some important variables from the econometric model and simultaneity. Since, these issues pose serious doubts on the precision and consistency of coefficient estimates, and therefore need specific remedial measures for allaying the reservations on empirical findings. The main econometric problems that we face, among others include the following:

Heteroscedasticity: In an OLS regression model the assumption is that the residuals are independent and normally distributed with constant variance. Heteroscedasticity is said to occur when the variance of the unobservable error conditional on independent variables, is not constant. In particular, the variance of the error may be a function of independent variables. This will mean that standard errors are large resulting in less statistical power. In particular, as our dataset consists of firms with different sizes, error terms may be heteroskedastic, hence not satisfying the property of efficient estimator. Thus, it is necessary to correct for heteroscedasticity by using White's heteroscedasticity consistent estimator (HCE).

Selectivity: In case of R&D expenditure the dependent variable can only be measured or observed when the individual firm participates in R&D activities and as well reports it. If the subpopulation is non-randomly drawn from the overall population, straightforward regression analysis leads to inconsistent estimators. This problem is well known as sample selection bias. In this thesis the nature of data is such that it gives rise to the problem of selectivity. Specifically the possible selectivity bias arises from the fact that many firms, owing to lack of a mandatory disclosure of R&D expenditure, do not report R&D expenditure. When a firm does not report R&D expenditure, it is not clear if it does not spend anything on R&D or chooses not to report it because it is below a certain threshold. For instance, in India the generally accepted disclosure norm under the Indian Companies Act, 1956, as amended from time to time, requires companies to report all those heads of expenditure, which account for more than 1% of their turnover (Kumar & Aggarwal, 2005). Since R&D expenditure often accounts for less than 1% of turnover, it is at the discretion of the management to report it or not. Although, many companies do report R&D expenditure even if it is less than 1% of turnover, yet the lack of mandatory disclosure of R&D in accounts causes a source of bias. Since, selectivity problem renders the estimates inaccurate; therefore, as mentioned above in subsection 3.3.1., this study relies on Heckman two-step selection model to account for selection bias.

Endogeneity: Another concern that we face in our empirical analysis is the problem of endogeneity. It arises, when one or more explanatory variables in the model are correlated with the error term. In the presence of endogeneity, the usual OLS estimates tend to be biased. Endogeneity is driven by several factors like omitted variable bias, simultaneous causality bias and errors-in-variables bias, all of which affect the consistency of estimates. In presence of endogeneity, an estimate may appear to adequately reflect the hypothesized relationship under study, but it will be inconsistent and will not reflect the true population parameter because the observed correlation may be far off from the true relation; that is, the true relation could be higher, lower, zero, or of a different sign from the observed association.

Endogeneity is a likely concern in this study as well and hence needs specific attention. There is a possibility that some of the variables are endogenous. For instance, foreign investors tend to invest in sectors with a higher level of R&D or high productivity and hence FDI may gravitate towards such sectors giving rise to reverse causality and hence to the endogeneity in the model. To solve the problem of endogeneity, we rely on the instrumental variable technique. Despite the fact that identifying instruments which truly reflect the changes in endogenous variables is very difficult, the study has come up with instruments, which we believe determine the variation in endogenous variables. More about the problem of endogeneity, the remedies adopted to address it and the identification of instruments used is elaborated as follows:

4.2.1: Identification and instruments

The criticism levelled against the existing empirical studies on FDI spillovers is that these failed to control for unobserved heterogeneity and endogeneity. In particular, they fail to control the tendency of the foreign firms' gravitating towards high productivity or more innovative industries/firms. The problem of endogeneity if unchecked may render the estimates downwardly biased. Several studies have attempted to address the issue of unobserved heterogeneity and endogeneity by allowing for time specific effects and controlling for unobserved time-invariant firm-specific effects. However, controlling for unobservable individual, time-invariant specific heterogeneity and for time effects is unlikely to solve the problem of endogeneity, since industry-specific, time-varying changes of the incumbent performance may still affect FDI. Even, lagged measures of FDI cannot completely wipe out the problem of endogeneity provided that the investors are able to anticipate changes occurring in the distribution of incumbent performance leading to relative changes in the FDI inflows across sectors.

Some of the existing studies that adopt an instrumental variable technique to address the problem of endogeneity, for instance, include Aghion et al. (2009); Haskel et al. (2007) and Vahter (2010). For instrumenting FDI entry into the UK, Aghion, et al. (2009) use policy reforms at UK level and European level that changed entry costs and affected entry differently across industries and over time. Haskel et al. (2007) employ FDI inflows to the US as an instrument for inward investments by MNCs in the UK, arguing that variations in FDI inflows to the UK are related to the changes in inward FDI of US. Similarly, Vahter (2010) while examining the productivity impact of FDI on Estonian firms adopt FDI inflows to other Central and Eastern European (CEE) transition economies as an instrument for inwards investments in Estonia, maintaining that variations in FDI inflows across different CEE counties are correlated. The latter set of studies, however, can be questioned on the basis of exogeneity condition imposed by the authors. The assumption that variations in FDI activity in one country are correlated with the changes in FDI in others seems to be unrealistic. More, recently Crescenzi et al. (2015) while analysing the impact of FDI on innovative performance of UK firms through intra-industry effects, controlled for endogeneity issue by instrumenting FDI with a measure of sectoral export orientation. The instrument can be criticised on the ground that, apart from being correlated with FDI, it may directly affect the changes in productivity or innovative performance of firms and hence, may not pass the test of a reliable instrument.

This study attempts to address the endogeneity issue by developing an alternative instrumental variable approach based on the ease of doing business ratings of India compiled from various doing business reports (DBRs) of World Bank. The study, unlike others, comes up with instruments for different categories of FDI. Earlier works have used data on industry-wise aggregate FDI inflows to analyse the impacts on domestic productivity or innovation hence, a single instrument to address the reverse causality issue. However, the endeavour of this study is to examine the impact of different FDI types on domestic innovation and accordingly requires at least one instrument for each FDI category.

Horizontal FDI at the three-digit NIC-level is instrumented by starting business ratings which reflect the overall investment climate of a country. Better investment climate of host country acts a pull factor for inward foreign investment. The rationale behind instrumenting horizontal FDI by starting business ratings is that most of horizontal FDI is market seeking. The driving force of market-seeking FDI, apart from market size, is how easily foreign investors can establish a business in the host country. The starting business ratings based on components such as a number of procedures, associated time and cost, and minimum capital requirements to start a business capture various aspects of business climate in a country. A better performance of a host country on these measures definitely makes it a desirable destination for foreign investment.

Most of the vertical FDI is efficiency seeking aimed at reducing production costs for MNCs. This type of FDI, specifically backward FDI, is mainly driven by relatively lower factor costs, that is, locations with low- priced inputs or lower labour costs are a favourite destination for this category of investment. Based on this logic, backward FDI is instrumented by hiring and firing index taken from various issues of DBR. The index reflects costs associated with hiring and firing of labour in India and changes therein over the years. The index is expected to reflect relative labour costs and hence can be considered as a predictor of backward FDI. In the case of forward FDI, the foreign affiliates operating in host country draw inputs from their parent companies, thus staying after the parent in the production chain (Protsenko, 2003; Ramondo et al., 2011). The process of drawing inputs from parents is likely to get influenced by the trading costs across destinations. If trading costs, for example, import costs are lower in a destination country, the likelihood of hosting more foreign companies' increases than if imports costs are relatively higher. Keeping this in view, we instrument forward FDI by the cost to import. We expect a negative correlation between forward FDI and cost to import implying countries with lower import costs are favourite destinations for forward FDI.

Besides, addressing endogeneity with instrumental variable technique we incorporate lagged values of endogenous variables in the econometric model. A common practice to address the problem of endogeneity is to replace the contemporaneous values of suspected endogenous variables with the lagged values. The rationale for the practice is to avoid the use of poor-quality instrumental variables to address endogeneity. However, lagging endogenous variables can only reduce the endogeneity; it cannot completely wipe out the problem. Therefore, it is wise to use reliable instruments to obtain estimates purged of endogeneity.

4.3. The Sample

The study is conducted to investigate the impact of FDI on innovative and productivity performance of firms operating in Indian manufacturing sector. It covers a period of 14 years spanning from 2000 to 2013. Econometric analysis is based on a micro-level (firm level) dataset comprising 520 firms belonging to 17- three-digit manufacturing industries. The sample comprises firms from high-tech, medium-tech and low-tech sectors, thereby removing the bias of including firms from a specific sector only. However, the sample is not evenly distributed across industries. The majority of the firms in the sample are either from high-tech or medium- tech industries, with a relatively less number of firms coming from low-tech industries. The selection of the sample is guided by the availability of the data. From the database, we select the firms whose main activity is in manufacturing and are listed on the Bombay Stock Exchange over the period 2000-2013. This yields a total of 927 firms. Subsequently, based on missrecorded and missing data, we exclude several manufacturing firms from our initial sample. First, we delete about 135 firms with extremely missrecorded data, lowering the sample to 792 manufacturing firms[6]. In the next step, we exclude another 233 manufacturing firms that do not report data on the relevant variables like total assets, and leverage for at least three consecutive years, reducing the sample size further to 559 firms. Finally, to minimize the influence of outliers, we winsorize all firm-level variables at the 1% level at both the tails of distribution[7]. The final sample, therefore, comprises of 520 firms.

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[6] All extreme data points which seem not to be a part of series and could not be verified through the individual reports of companies are treated as missrecorded data.

[7] Winsorizing is a technique of transforming statistical data by limiting extreme values in the data so as to reduce the effect of possibly spurious outliers. It involves setting all outliers to a specified percentile of the data, for example, a 90% winsorization would see all data points below the 5th percentile set to the 5th percentile, and the data above the 95th

The composition and break-up of the sample by industry is presented in Table 4.1.We have 14 years of observation per firm; hence, the maximum number of firm years is 7280.

We classify the firms into four categories – (i) R&D spending and patents, (ii) R&D spending and no patents, (iii) Patents but no R&D spending, and (iv) neither R&D spending nor patents. The break-up of firms across industries shows that of the 520 firms that consecutively report their R&D expenses, 323 firms have innovation output in the form of patents implying a little over 62% of the firms in our sample indulge in innovation activities. As can be seen from table 4.3, most of the firms with patents come from chemical and chemical products followed by pharmaceuticals, machinery, other transport equipment and electric equipment. Another 197 firms despite undertaking R&D do not have patents. The number of firms falling in the category of 'patents but no R&D' is zero which signifies that spending on R&D is a prerequisite for having innovation output in the form of patents. The number of firms that neither report their R&D expenditure, nor have received any patents is 233.

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percentile set to the 95th percentile. Winsorized estimators are usually more robust to outliers than the more standard forms.

Table 4.1: Distribution of the sample across Industries

NIC Code	Industry Group	Initial no. of firms	Firms with miss- recorded data	Firms with missing data	Winsorize at 1% level/Final no. of firms
10	Food Products	73	15	19	37
12	Tobacco Products	07	01	02	04
13	Textiles and Wearing Apparel	76	15	23	31
15	Leather and Related Products	37	03	13	17
17	Paper and Paper Products	31	11	11	10
19	Coke and Petro Products	31	04	17	10
20	Chemicals and Chemical Products	124	13	17	94
21	Pharmaceuticals	103	09	21	63
22	Rubber and Plastic Products	39	03	07	28
23	Non-Metallic Mineral Products	54	08	12	34
24	Basic Metals	59	14	20	21
25	Fabricated Metal Products	34	06	11	14
26	Computer, Electronics and Optical Products	57	11	15	27
27	Electric Equipment	49	04	08	37
28	Machinery	68	07	10	48
29	Motor Vehicles	41	04	18	17
30	Other Transport Equipment	44	07	09	28
	Total	927	135	233	520

Table 4.2: Breakup of Sample into Domestic and Foreign Firms

NIC Code	Industry Group	Final Sample*	Domestic Firms	Foreign Firms	Foreign Firms (%)
10	Food Products	37	30	07	18.9
12	Tobacco Products	04	03	01	25.0
13	Textiles and Wearing Apparel	31	24	07	22.6
15	Leather and related Products	17	14	03	17.6
17	Paper and Paper Products	10	08	02	20.0
19	Coke and Petro Products	10	07	03	30.0
20	Chemicals and Chemical Products	94	81	13	13.8
21	Pharmaceuticals	63	45	18	28.6
22	Rubber and Plastic Products	28	24	04	14.3
23	Non-Metallic Mineral Products	34	29	05	14.7
24	Basic Metals	21	17	04	19.0
25	Fabricated Metal Products	14	12	02	14.3
26	Computer and Electronics Products	27	17	10	37.0
27	Electric Equipment	37	27	10	27.0
28	Machinery	48	37	11	22.9
29	Motor Vehicles	17	09	08	47.1
30	Other Transport Equipment	28	19	09	32.1
	Total	520	403	117	22.5

Note: A firm with foreign promoters' equity share of 10% or more is designated as a foreign firm.
**This particular sample size is used for patenting and tfp equations while as for R&D equation the sample size is 753.*

Table 4.3: Industry wise distribution of firms on R&D and Patent basis (2000-2013)

Industry code	Industry Name	Firms with R&D*	Both R&D & Patents	R&D but no Patents	Patents but no R&D	Neither R&D nor patents	Firms with exports
10	Food Products	37	15	22	0	19	33
12	Tobacco Products	04	03	01	0	02	04
13	Textiles and Wearing Apparel	31	17	14	0	23	25
15	Leather and Related Products	17	05	12	0	13	15
17	Paper and Paper Products	10	06	04	0	11	07
19	Coke and Petro Products	10	06	04	0	17	06
20	Chemicals and Chemical Products	94	69	25	0	17	58
21	Pharmaceuticals	63	48	15	0	21	55
22	Rubber and Plastic Products	28	12	16	0	07	18
23	Non-Metallic Mineral Products	34	15	19	0	12	23
24	Basic Metals	21	16	05	0	20	17
25	Fabricated Metal Products	14	09	05	0	11	09
26	Computer, Electronics and Optical Products	27	17	10	0	15	23
27	Electric Equipment	37	21	16	0	08	25
28	Machinery	48	33	15	0	10	42
29	Motor Vehicles	17	07	10	0	18	11
30	Other Transport Equipment	28	23	05	0	09	20
	Total	520	323	197	0	233	391

*Source: CMIE-Prowess database. * Firms continually reporting their R&D expenditure for seven years from 2000-2013.*

The patenting activity across different industries is analyzed using the information on patent grants from various IPO (Indian patent office) annual reports. IPO publishes patent information on the basis of different technology fields. Total number of patents granted under various fields of technology from 2000-2013 stood at 78,125. Since IPO classifies patents on the basis of various technological fields, therefore, we do not have direct information on patents granted to various manufacturing industries, so we need to locate the technological fields of various companies and their sectors of affiliation. After harmonizing various technology fields with NIC 2008 and matching the data, we arrived at a figure of 44,057 which implies that out of total patents granted under various technology fields during the period from 2000-2013 nearly 57% of the grants belong to Indian manufacturing sector. Total patent grants to manufacturing sector and their industry wise distribution is provided in Table 4.4. As can been seen from the reported figures, the number of patents granted to chemical sector is highest among all. A total of 18,044 patents were granted to applications relating to chemical industry which approximately accounts for 41 % of the total grants to manufacturing sector. It is followed by computer, electronics and optical products which together account for around 19% (8435) of total grants to manufacturing. The next in order of importance is pharmaceuticals with 6862 (15.57 %) grants followed by electrical equipment industry with 5666 (12.86%) grants. Patent grants to the low-tech manufacturing which comprise textile, food, tobacco, paper & paper products, basic metals, fabricated metals, non-metallic minerals and plastic and rubber products account for just over 6% of overall grants to manufacturing. Among the low-tech industries food products followed by non-metallic minerals and basic metals have shown some patenting activity. The triad together constitutes roughly around 4.23% of the total patents granted to manufacturing sector during the period 2000-2013. The contribution of the rest of the low-tech industries to the overall patenting landscape is just above 1%. It is clear from the above analysis that most of the patenting activity (over 93%) in manufacturing is confined to the high-tech manufacturing which encompass industries like pharmaceuticals, machinery, computer sciences and electronics, electrical equipment, automobiles and components parts and chemical and chemical products.

Of the total patents granted to manufacturing sector during 2000-2013, 19.45% of (8,567) grants are covered by our sample. As we traverse across sample, it becomes evident that firms belonging to chemical and chemical products industry have maximum number of patent grants followed by pharmaceuticals, computer and electronics, electric equipment and machinery. Patenting activity, however, is comparatively low across all industries belonging to low-tech manufacturing. Since, we have divided total sample into two sub- groups. One, consisting of domestic firms only and second, involving firms having part of their equity held by foreigners. Thus it becomes customary to explain patenting behaviour of both the sub-groups. The patent grants to the sub sample of domestic and foreign firms as a ratio to total sample grants is around 36:64 implying that 36% patents have gone to domestic firms as opposed to 64% grants to foreign firms. However, intra- group variation in patent grants across industries reveals chemical and chemical products followed by pharmaceuticals and computer, electronics and optical products have received maximum patents. These three industries together constitute more than half (nearly 52%) of total patents received by sample. This roughly indicates that most of patenting activity in Indian manufacturing sector is concentrated in these industries.

Inter-group comparison in patents indicates that in most of the low-tech industries, barring food products, domestic firms outclass foreign firms in terms of patent grants. However, this does not hold for high-tech industries in which most of the patents have been granted to foreign firms.

The probable reason could be the substantial foreign presence in these industries compared to low-tech industries where the number of foreign firms operating is much lesser. Looking at the patents shared between domestic and foreign firms as a percentage to total patents granted to sample firms across various industries, once can see in pharmaceutical sector, around 72% grants belong to foreign firms. Similarly, in machinery and motor vehicle industry roughly 76% of patents have been granted to foreign firms. The other industries where this percentage is tilted toward foreign companies include computer, electronics and optical products, chemical and chemical products, electrical equipment and food products.

Table 4.4: Patent grants to sample firms as percentage of total grants

Industry	Total grants	Sample grants	Sample grants to total grants (industry-wise %)
Food Products	1078	577	53.53
Tobacco Products	30	22	73.33
Textiles and Wearing Apparel	332	53	15.96
Leather and Related Products	23	18	78.26
Paper and Paper Products	19	14	73.68
Coke and Petro Products	155	112	72.26
Chemicals and Chemical Products	18044	1856	10.29
Pharmaceuticals	6862	1448	21.10
Rubber and Plastic Products	291	88	30.24
Non-Metallic Mineral Products	471	358	76.01
Basic Metals	319	248	77.74
Fabricated Metal Products	53	10	18.87
Computer, Electronics and Optical Products	8435	1032	12.23
Electric Equipment	5666	838	14.79
Machinery	1061	815	76.81
Motor Vehicles	752	636	84.57
Other Transport Equipment	466	442	94.85
Total	44057	8567	19.45

Source: Various IPO annual reports.

Table 4.5: Percentage grants to the subsample of domestic and foreign firms

Industry	Grants to sample firms	Grants to domestic firms	Grants to foreign firms	% grants to domestic firms	% grants to foreign firms
Food Products	577	174	403	30.16	69.84
Tobacco Products	22	13	9	59.09	40.91
Textiles and Wearing Apparel	53	34	19	64.15	35.85
Leather and Related Products	18	12	6	66.67	33.33
Paper and Paper Products	14	10	4	71.43	28.57
Coke and Petro Products	112	78	34	69.64	30.36
Chemicals and Chemical Products	1856	626	1230	33.73	66.27
Pharmaceuticals	1448	414	1034	28.59	71.41
Rubber and Plastic Products	88	67	21	76.14	23.86
Non-Metallic Mineral Products	358	280	78	78.21	21.79
Basic Metals	248	214	34	86.29	13.71
Fabricated Metal Products	10	8	2	80.00	20.00
Computer, Electronics and Optical Products	1032	363	669	35.17	64.83
Electric Equipment	838	260	578	31.03	68.97
Machinery	815	203	612	24.91	75.09
Motor Vehicles	636	159	477	25.00	75.00
Other Transport Equipment	442	166	276	37.56	62.44
Total	8567	3081	5486	35.96	64.04

Source: Various IPO annual reports

4.4. The Database

The data for the study comes from various sources. For innovation analysis, we use data on patent grants compiled from the various issues of the patent office journal, the official gazette of the Indian Patent Office (IPO) administered by the Office of the Controller General of Patents, Designs & Trade Marks. The information on patent applications, patent grants, designs, and trademarks is made public in the form of monthly publications.

Other firm level data comes from comes from Prowess CMIE database. The database provides firm-level data compiled from annual reports of the firms listed on the Bombay Stock Exchange. The Prowess data contains financial information on over 8000 companies (including 4500 services and construction companies) which are listed on the stock exchanges as well as major unlisted public limited companies having sales more than US $0.25 million. In addition, if an entity is not listed, it qualifies for inclusion in the database if the average sum of sales and total assets is more than or equal to US $5 million as per the latest audited financial results. Accordingly, firms in the sample generally do not include the smallest firms due to the requirements for firms to be included in Prowess. Thus, in effect, the sample is skewed towards large Indian firms. The database contains detailed information on the financial performance of these companies culled out from their profit and loss accounts, balance sheets and stock price data.

An important feature of the study is that it employs a series of national input-output tables to work out the intra- and inter-industry linkages. This is unlike the previous empirical studies that calculate such linkages using a fewer input-output tables. The national input-output tables are taken from World Input-Output Database (WIOD).

4.5. Construction and Description of Variables

4.5.1. Variable Specification for Innovation Expenditure Equations

4.5.1.1. Dependent Variables

We are looking to investigate the impact of FDI spillovers on the incumbents' likelihood to engage in innovation as well as on the size of innovation effort, accordingly we take two dependent variables in the innovation expenditure equation. The variables are described as follows:

R&D Dummy (x_{it}^{d})**:** The variable represents the decision of a firm to invest in R&D. It takes a value of 1 if the firm decides to carry out R&D and reports the same in its annual financial statement. The variable takes on a value 0 if a firm does not undertake any R&D or undertakes it but for some unknown circumstances do not choose to report it.

R&D Intensity (x_{it}^{i})**:** It measures the magnitude of the innovation expenditure for the firms reporting their R&D in the annual financial statements. The variable is calculated as the proportion of R&D spending to the annual firm sales. The size of R&D expenditure is generally considered as an important input to the innovation output function. The level of R&D by a firm represents its' ability or effort to develop new products and processes or improve existing products through the application and adaptation of the external technology stock (Cohen & Levinthal, 1990).

4.5.1.2. Focal Independent Variables

The FDI spillover variables are the variables of interest in this thesis. The variables remain same all through the empirical chapters. Based on the previous research the spillover variables are constructed as:

Horizontal FDI (hfd_{jt} ***)*:** is one of our explanatory variables representing the presence of foreign firms at the industry level. It measures the share of output accounted by the foreign firms in the total output of the industry. To gauge the extent of horizontal spillovers, the horizontal FDI in industry *j* at time *t* is worked out as follows:

$$hfd_{jt} = \frac{\sum_{i=1}^{m} Y_{it}^{f}}{\sum_{i=1}^{n} Y_{it}}$$

Where Y_{it}^{f} is the output of foreign firm *i* in industry *j* in year *t* and Y_{it} is the output of firm *i* in industry *j* in year *t*.

Backward FDI (bfd_{jt}): is the share of total output of an industry that is sold to foreign firms in downstream industries.[8] It is a proxy for the foreign presence in the industries that are being supplied by sector *j*. It is intended to capture the extent of potential contacts between domestic suppliers and MNCs customers.[9] To construct this variable we follow Blalock & Gerter (2005).

$$bfd_{jt} = \sum_{k=j} \alpha_{jk}\, hfd_{kt}$$

Where α_{jk} is the proportion of industry *j's* output supplied to industry *k* taken from a series of input-output tables. It is assumed that the greater the proportion of output supplied to any industry with MNC presence, the greater the degree of linkages between foreign and local firms. Inputs supplied within the sector are excluded, since this effect is already captured by horizontal FDI variable.

[8] Firms with an equity share of 10% or more held by non-residents are designated as foreign firms or foreign affiliates. This is in accordance with 10% threshold norm as set by the OECD.

[9]To illustrate the Backward FDI, let's consider there are 3 industries such as wheat flour milling, pasta production, and baking. Suppose that half of the wheat flour industry's output is purchased by the bakery industry and the other half is purchased by the pasta industry. Further, assume that the bakery industry does not have any foreign factories but that foreign factories produce half of the pasta industry output. The calculation of the Backward FDI for flour industry would be 0.25=0.5(0.0) + 0.5 (0.5).

Forward FDI (ffd_{jt}): is the weighted share of output in upstream sector produced by foreign affiliates. The variable is calculated in a similar way as backward FDI, except that goods produced by foreign affiliates for exports are excluded (Javorcik, 2004) since domestic customers do not capture spillover from these intermediates

$$ffd_{jt} = \sum_{k \neq j} \alpha_{jk} \frac{\left[\sum_{j \in kt} \left(Y_{it}^{f} - Y_{it}^{ef} \right) \right]}{\left[\sum_{j \in kt} \left(Y_{it} - Y_{it}^{e} \right) \right]}$$

Where α_{jk} represents the share of inputs purchased by industry j from industry k in total intermediate inputs sourced by sector j. Y_{it}^{e} and Y_{it}^{ef} respectively symbolize industry and foreign affiliates output that is being exported. As before, inputs supplied within the sector are excluded.

Proximity to the Frontier $(prxm_{it})$ **:**Based on Schumpeterian competition outlined in Acemoglu et al., (2006) and Aghion et al., (2009) one could expect that increase in MNC entry has positive effects on incumbents' performance, innovation incentives and innovation activities if the incumbents are close to the productivity frontier. It could also be expected that if incumbents are far away from the productivity frontier of the sector, then the entry of MNCs will reduce innovation incentives of, these firms and thereby have a negative effect on their productivity. We measure the distance from the best practice frontier of a firm in terms of its relative technical efficiency (TE). The relative technical efficiency implies that a firm which is most efficient would be 100% efficient and efficiency of other firms would be measured relative to it. We take inverse of the distance function to arrive at the proximity to frontier.

4.5.1.3. Controls Variables

Besides, a set of explanatory variables, the innovation expenditure equation incorporates some firm and industry specific controls that are believed to influence the R&D behaviour of firms. Guided by the previous literature on the choice of the control variable, we include the following variables as controls in innovation expenditure equations.

Firm Size (lns): Large firms are able to spread the fixed capital over large sales volume due to the availability of greater financial resources. Moreover, they can hedge uncertainty and risk of failure by undertaking a variety of R&D. Following Sasidharan & Kathuria (2011), we measure the firm size as the share of firms' sales to the median sales in the industry. The empirical evidence from numerous studies on the nature of relationship between firm size and innovation remains inconclusive. For instance, Lall (1983) found the firm size to have significant positive impact on R&D intensity, Katrak (1989, 1990) noted that increase in size led to a less than proportional increase in the R&D expenditure of Indian firms. Similarly Kumar and Saqib (1996) claim that probability of undertaking R&D increases with the firm size only up to a certain threshold. Majumdar, (2011) argues in favour of non-linear relationship between firm size and R&D. Therefore, to detect a non-linear relationship between firm size and R&D, we introduce size square term in our analysis.

***Export Intensity (ep)*:** Export-oriented firms, in general, face intense competition in the international markets. As a result, they need to produce technologically superior and quality products, which is feasible if they are more R&D intensive. Empirically, Braga and Willmore (1991) have shown a positive relation between export orientation and R&D intensity. Lileeva & Trefler (2010) show further evidence from micro data that exporting is correlated with investment in R&D and innovation. Following Kathuria (2002), we measure export intensity as exports as a ratio of total sales turnover.

Import Intensity (im): Evidence suggests that enterprises with high import intensity have a higher probability of indulging in R&D activities than non-importers because some adaptive R&D is usually undertaken by the firms to remodel and reconfigure the imported technologies to adapt to local conditions (Nelson, 2004). However, there is also a perception that more capital imports may build a dependence culture, thereby dampening the in-house R&D efforts (Katrak, 1989). To capture the impact of capital imports on innovation, we measure import intensity as capital imports as a ratio of total sales turnover.

Age (lnag): As for the effect of a firms age on innovation, two hypotheses are plausible. The first one stipulates that with age, a company will accumulate the experience and knowledge necessary to innovate. This suggests not only a positive relationship between firm age and innovation but also that the innovations of older companies would have more influence than those of younger ones (Sorensen & Stuart, 2000). The second assumption suggests that older firms develop established procedures and routines that create a resistance to the integration of major external advances and thus represent a barrier to innovation (Freel, 2003). To capture the impact of age on the innovation and productivity, we measure firm age as the number of years since its incorporation. To examine whether or not innovation increases monotonically with age, this study includes square of the age in the analysis.

Profitability (lnprf): Profitability is believed to significantly affect R&D behaviour of a firm. However, the link between profitability and R&D intensity can be either positive or negative. Based on the Schumpeterian views, it can be argued that firm profitability enhance R&D intensity as retained earnings are a major funding source for R&D (Grabowski, 1968). The retained earnings have an edge over external funding in that it involves lower transaction costs. This argument may be particularly important for those Indian facing severe liquidity constraints. Empirical evidence for the Schumpeterian suggestion of a positive relationship between profitability and innovation efforts is, however, slim. Contrary to Schumpeterian view, an alternative 'failure-inducement' hypothesis highlighted by Antonelli (1989) proposes that firms with losses or below average profits may have a higher incentive to undertake R&D as it can help their survival in the market. In other words, the hypothesis states that firms make innovative efforts when their performance falls below a minimum threshold, resulting in a negative relationship between profitability and R&D expenditures. To analyse the relationship between profitability and R&D, we measure the firm profitability as profits before tax.

Capital Intensity (lnk): Since R&D is a capital-intensive activity, we expect firms that are relatively capital intensive to be more likely to be involved in R&D. Earlier studies, such as Czarnitzki & Kraft (2004) and Basant & Mishra (2014) confirm that higher capital intensity leads to higher R&D spending. However, Kumar (1987) in the case of India found a negative relationship between capital intensity and R&D intensity. Kumar argues that there is a tendency among Indian firms to neglect R&D investment. Net fixed assets are taken as a proxy for capital intensity.

Leverage (lv): The existing empirical literature suggests that a firm's financial position through the availability of financial resources, affects its R&D investment capacity. It has been suggested that R&D activities tend to be financed via internally generated funds as opposed to borrowing from financial institutions and that high levels of debt negatively affect R&D (Hall, 1990; Del Canto & Gonzalez 1999; Ghosh, 2009). Due to information asymmetries, firms prefer to finance their R&D projects via internal funds, which is also known as pecking order hypothesis (Myers & Majluf 1984). High levels of debt may hinder R&D activities as debt holders do not favour R&D. In this study, we use firm leverage measured by the debt to total assets ratio, to capture the impact of the firm's financial position on its R&D intensity.

Market Concentration (hhi): Among industry specific variables, the competition effect is more likely to influence the R&D and innovation. The empirical literature has attempted to examine the relationship between market concentration and R&D based on the Schumpeterian school of thought that oligopolistic market structure is conducive for innovative activities. In a study of Indian industries, Kumar (1987) found that market concentration had an adverse effect on R&D activities. The study attributes this phenomenon to lack of competition and entry barriers. The situation may be altogether different in the post-1991 period, where opening up and delicensing has resulted in increased competition from imports as well as the entry of foreign and domestic firms. However, post liberalization studies such as Kumar and Saqib (1996), Prasad (1999) and Basant (2013) also confirms negative relationship between higher concentration and efforts to innovate. In other words, these studies signify the importance of competition in innovation. In the present exercise, we use the Hirschman–Herfindhal index *(hhi)* as a measure of concentration to assess the effect of competition. HHI equals the sum of the squared market shares of each firm in the industry.

Location Dummy (lc): The variable captures effect of the cluster on the R&D behaviour of a firm. As documented by Krugman (1991) fims located in industrial clusters tend to invest more on innovative activities. Clustering, through collaboration and knowledge spillovers, incentivises firms to undertake innovative activities. Even the new economic geography literature provides evidence of a positive relationship between innovativeness and clustering (Feldman, 2000). Therefore, to capture the location effect on R&D, we use a dummy which takes a value 1 provided a firms location falls within any of the major industrial clusters and 0 otherwise.

Industry Dummy (id): The variable captures industry specific effect, if any, on the patenting activity of the firms. The variable takes a value of 1 for innovation sensitive industries and 0 otherwise.[10]

When we incorporate all these variables in the Heckman's model discussed in subsection 4.2.1, selection equation with R&D dummy (rd_{it}^{d}) as dependent variable looks like:

$$\begin{aligned} rd_{it}^{d} = {} & \alpha_k \sum_{i}^{k} fdi_{jt-1} + \alpha_1 prxm_{it-1} + \alpha_m \sum_{i}^{m} fdi_{jt-1} prxm_{jt-1} + \alpha_2 \ln sz_{it-1} + \alpha_3 ep_{it} \\ & + \alpha_4 im_{it-1} + \alpha_5 \ln k_{it} + \alpha_6 v_{it} + \alpha_7 \ln pr_{it} + \alpha_8 \ln ag + \alpha_9 hhi_{it} + \alpha_{10} rdl \\ & + \alpha_{11} dlc + id + td + \mu_{it} \end{aligned} \tag{4.10}$$

The outcome equation with R&D intensity (rd_{it}^{i}) as dependent variable is written as follows:

$$\begin{aligned} rd_{it}^{i} = {} & \alpha_k \sum_{i}^{k} fdi_{jt-1} + \alpha_1 prxm_{it-1} + \alpha_m \sum_{i}^{k} fdi_{jt-1} prxm_{jt-1} + \alpha_2 \ln sz_{it-1} + \alpha_3 ep_{it} \\ & + \alpha_4 im_{it-1} + \alpha_5 \ln k_{it} + \alpha_6 v_{it} + \alpha_7 \ln pr_{it} + \alpha_8 \ln ag + \alpha_9 hhi_{it} \\ & + \alpha_{10} rdl + + id + td + \mu_{it} \end{aligned} \tag{4.11}$$

Where dependent variable R&D intensity denoted as (rd_{it}^{i}) is the R&D expenditure of *i*th firm as a proportion of its sales in *t*th year. The explanatory variables which we suspect are endogenous enter with lag (one period lag) in above equations. A common practice to address the problem of endogeneity is to replace the contemporaneous values of suspected endogenous variables with the lagged values. The rationale for the practice is to avoid the use of poor-quality instrumental variables to address endogeneity. However, lagging endogenous variables can only

[10] There is substantial heterogeneity in the degree of innovation across industries. Traditional industries tend to have fewer innovative firms while as high-tech industries such as electronics, auto and auto-parts, chemical, pharmaceuticals have more of such firms.

reduce the endogeneity; it cannot completely wipe out the problem. Therefore, it is wise to use reliable instruments to obtain estimates purged of endogeneity.

One major concern with Heckman's procedure that has remained a point of contention is the identification of parameter estimates through the nonlinearity of inverse Mills ratio. However, this ratio is often linear for certain ranges of the index, giving rise to identification problem. To address this issue, the inclusion of an additional explanatory variable(s) in the first step is important for identification of estimates in the second step[11]. However, it is desirable that the inclusion variable(s) is a good predictor of the dependent variable in selection equation but is not associated with a dependent variable in the response equation (Little and Rubin, 1987). Yet, it is hard to find such variable(s) in reality. In our case, location (*lc*) of a firm is likely to influence the decision to invest in R&D but not the R&D intensity. Hence we include the location as an independent variable in the selection equation and exclude it from the response equation[12]. The variable enters as a dummy in the selection equation, taking value 1 for the firms located in industrial clusters and 0 otherwise.

[11]The degree of identification becomes weak if there are no exclusion restrictions, i.e., if no variables that are in selection equation are excluded from response equation. In these cases estimates get identified through non-linearity of inverse Mills ratio. As this ratio is often linear, however, the degree of identification is often weak giving rise to inflated second step standard errors and unreliable estimates in second step.

[12]Location affects the decision to undertake R&D but it may not affect the level of R&D since latter is primarily a function of market structure (Sasidharan and Kathuria, 2011). Being located in an industrial cluster may serve as an incentive to undertake R&D so as to benefit from knowledge spillovers. Moreover, there is more interaction between employees in clusters, and hence faster information flow, than if units are dispersed.

4.5.2. Variable Specification for Innovation Equations

4.5.2.1. Dependent Variable

***Patent Grants (p_{it})*:** is the dependent variable representing the number of patents received by a firm *i* at time *t*. The variable is used to measure the innovative output of a firm.[13] Patent counts indicate the level of new-to-the-market knowledge that is open to the public and therefore deemed a contribution to the public knowledge pool in a national innovation system (Furman, Porter, & Stern, 2002). At the same time, there is empirical literature suggesting a stylized knowledge production function (KPF) estimation based on patent counts (Crespi et al., 2007; Greunz, 2005; Hausman et al., 1984; MacGarvie, 2006; Salomon & Shaver, 2005). The reason to use patent grants as a proxy for innovation output arises out of the fact that that data on more appropriate measures like new product sales is not available in the Indian context. The data on patent grants have been compiled from various publications of Indian patent office (IPO).

4.5.2.2. Focal Independent Variables

As mentioned in the subsection 4.5.1.2 that the variables of interest remain same all through the empirical equations of the thesis.

4.5.2.3. Control Variables

Since the nature of the dependent variable in innovation output equation differs from the one in the innovation expenditure equation, so the control variables included in the former may differ from the controls incorporated in the latter equation. Some of the control variables, which least affect the patenting activities at firm level are dropped from innovation output

[13] Patent grants as a measure of innovation despite their flaws have several advantages. Most obviously they represent a direct outcome of innovation rather than R&D expenditure which is an input to innovation. Besides, they provide considerable information regarding invention allowing better understanding of the quality and quantity of innovation, and potentially its allocation by location or sector, over a significant period of time.

equation, however, the ones believed to have a strong bearing on innovation output are retained. Further, based on the literature, an additional control related to intellectual property regime is introduced to capture the impact of patent policy on the innovation. The variable is described as follows:

Patent Policy Dummy (dpp): Patent policy dummy is used to account for the impact of product patent law on the innovative performance of firms. In India, product patents were first introduced in 2005 and to capture its impact on firm patenting, we use a dummy that takes a value of 1 for 2005 onwards and 0 otherwise.

The final innovation output equation after incorporating dependent, independent and control variables can be written as:

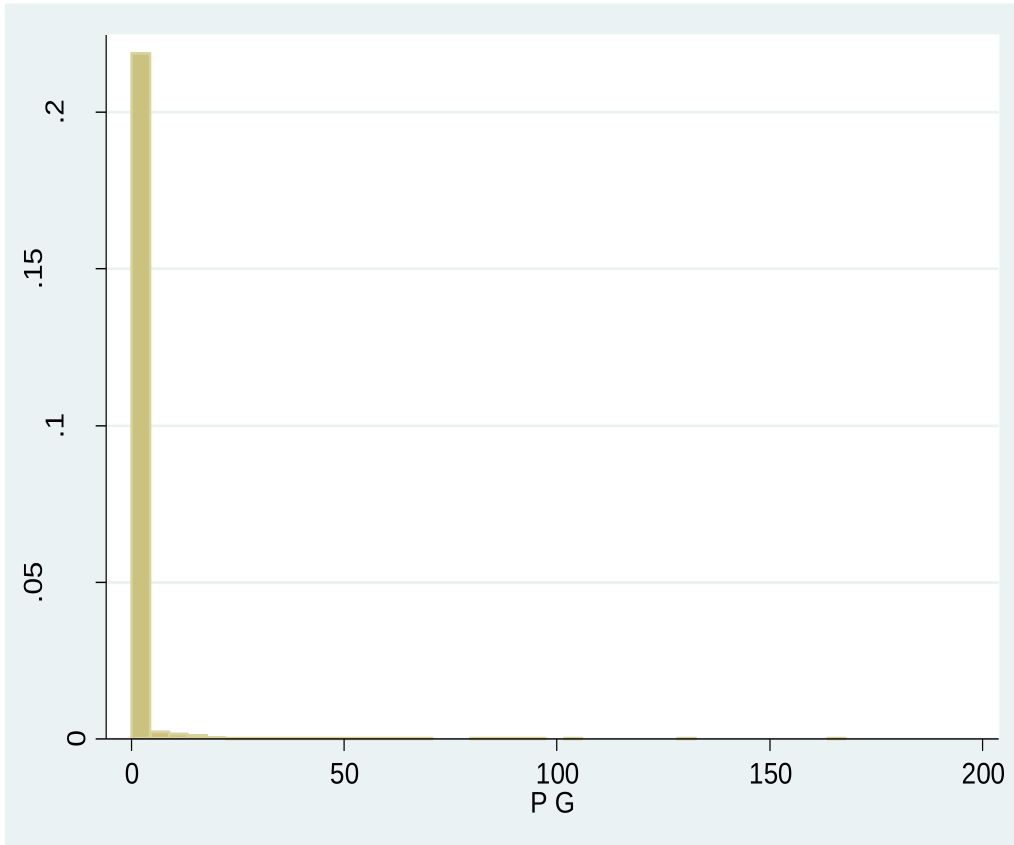
$$E(p_{it} / \sum_{i}^{k} fd_{jt-1}....) = \exp(\gamma + \gamma_1 \sum_{i}^{k} fd_{jt-1} + \gamma_2 prxm_{it-1} + \gamma_3 \sum_{i}^{m} fd_{jt-1} prxm_{it-1} + \lambda c_{ij} + \omega_t + \upsilon_i) \qquad (4.12)$$

In (4.3a), the variables of interest include FDI variables $(\sum fd_{jt-1})$, proximity to the technology frontier $(prxm_{it-1})$, and their interactions $(\sum fd_{jt-1} prxm_{it-1})$. The term c_{ij} is a set of firm and industry specific controls, ω_t denotes year-specific effects and υ_i is for firm-specific effects. The subscripts i, j and t indicate incumbent firms, industries, and time respectively.

Although Poisson is a standard model for handling count data but the restrictive property of equidispersion, i.e., equality between first two moments makes it less applicable for practical purposes. In practice, the property of equidispersion rarely holds since patent counts show over dispersion (mean being greater than variance); thereby making the estimates obtained through Poisson regression biased (Gourieroux et al., 1984). The consequence of over-dispersion is the underestimation of standard errors which in turn results in inflated statistical significance. However, the Poisson estimates will still be asymptotically consistent. A further issue with Poisson modelling is that it does not allow for unobserved heterogeneity in the relationship between patent counts and explanatory variables. The negative binomial regression model (negbin) provides a better alternative to get around the issues associated with Poisson modelling for patent counts. The negative binomial estimator not only allows for the conditional mean to be different from conditional variance, but it also assumes that conditional mean is a product of a deterministic term and an error term that follows a gamma distribution.

The preponderance of zeros in our patent count sample raises yet another concern. The zero observations possibly result from two different data generating processes: firms that do not innovate at all and that attempt to innovate but fail to generate patents. The economic significance of the two types of zeros is quite different. Since our data set have excessive zeros, unusually more than would naturally be predicted by the standard count models such as Poisson and negbin (Lambert, 1992). Therefore, it is more appropriate to employ zero-inflated Poisson (ZIP) and zero-inflated negbin (ZINB) models for estimation purposes as they are better able to handle a large number of zero observations, thereby increasing the precision of estimates.

Figure 4.1: Frequency distribution of patent grants



Source: Author's own summary

4.5.3. Variable Specification for Productivity Equation

In conjunction with innovation spillovers arising from FDI, this thesis also investigates the productivity spillovers generated by such inflows. To gauge the spillovers on firm level productivity, we use *tfp* as a measure of productivity and record the changes happening in it as a result of spillovers from FDI.

4.5.3.1. Dependent Variable

Total Factor Productivity (tfp): tfp change is computed by MPI. MPI measures the productivity changes along with time variations and can be decomposed into changes in efficiency and technology with DEA like nonparametric approach. Productivity decomposition into technical change and efficiency catch-up necessitates the use of a contemporaneous version of the data and the time variants of technology in the study period. Following Fare et al. (1994) the output oriented MPI can be expressed as:[14]

$$MPI_O = \left[\left(\frac{d_o^t(x_{t+1}, y_{t+1})}{d_o^t(x_t, y_t)} \right) \left(\frac{d_o^{t+1}(x_{t+1}, y_{t+1})}{d_o^{t+1}(x_t, y_t)} \right) \right]^{1/2} \quad (4.13)$$

Above expression is the geometric mean of two output oriented Malmquist tfp indices. One index uses period t technology and the other period t+1 technology. It represents the productivity of a firm/producer with input-output combination (x_{t+1}, y_{t+1}) relative to the input-output combination (x_t, y_t). If the value of MPI turns out to be greater than one *(MPI > 1)* it means a positive *tfp* growth of the firm from period *t* to *t+1*.

4.5.3.2. Focal Independent Variables

It includes all the spillover variables as mentioned in the subsection 4.5.1.2 under the heading focal independent variables.

4.5.3.3. Control Variables

All the controls included in the innovation output equation also feature in the productivity equation.

In order to establish that FDI affects incumbent productivity growth and that the extent of this effect depends on the location of the incumbent vis-a-vis to the technology frontier, the productivity equation takes the following functional form:

---

[14] The subscript *o* in (4.13) denotes the orientation of MPI model. We use output oriented MPI, the input oriented MPI can be defined in a similar way as output oriented MPI presented here.

$$\Delta y_{it} = \beta_0 + \beta_1 prxm_{it-1} + \beta_2 p_{it-1} + \beta_k \sum_{i}^{k} fd_{jt-1}$$
$$+\beta_m \sum_{i}^{m} fd_{jt-1} prxm_{it-1} + \gamma c_{ij} + \omega_t + \upsilon_i \qquad (4.14)$$

The dependent variable Δy_{it} in (4.14) is the change in *tfp* at incumbent level computed through MPI. The right-hand side of (4.14) apart from including all exogenous and control variables that are in (4.12) also includes patent count as an explanatory variable.

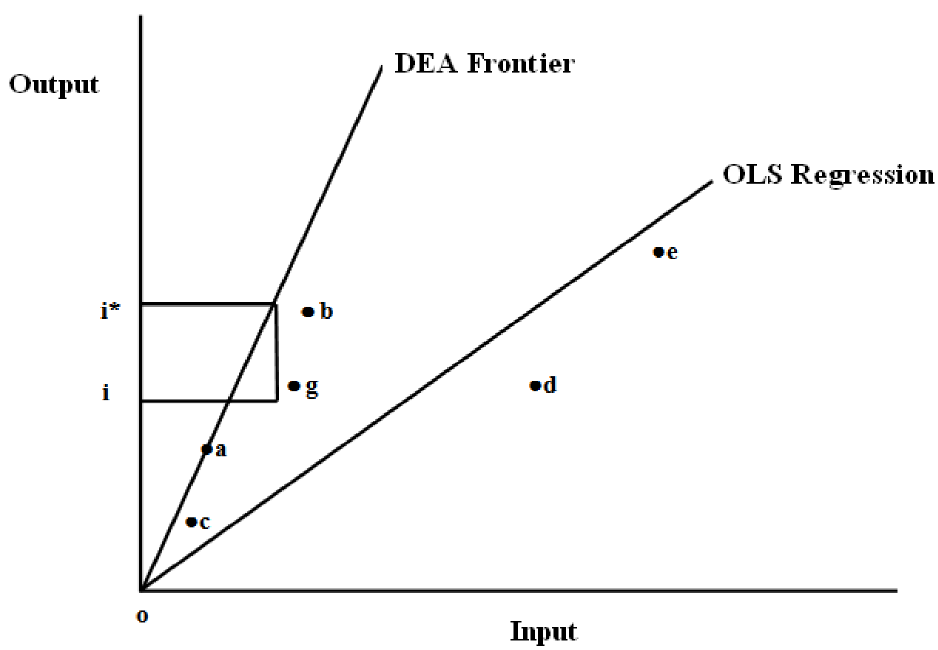
4.5.4. Constructing best practice frontier: Data Envelopment Analysis (DEA)

Frontier analysis evaluates the efficiency of a firm regarding distance from the industry's efficient frontier. The efficient frontier is a function that indicates the maximum attainable level of output corresponding to a given quantity of inputs. It represents the maximum quantum of output(s) that is produced from a specific amount of input(s) (e.g., labour and capital). Each firm's relative efficiency, based on the distance between the firm's actual output and the estimated "best practice" frontier is expressed as the ratio of the firm's observed output relative to the fully efficient output.

The method for computing technical efficiency of firms and thereby generating a best practice frontier for any industry or sector through a mathematical optimization model goes under the descriptive title of DEA. It employs linear programming technique to construct a frontier over the observed data such that the constructed frontier envelops all the data points as tightly as possible. In other words, DEA frontier is a linear surface or "piecewise hyper-plane" extrapolated from all efficient firms in the sample such that the inefficient firms are "enveloped" by the frontier.

To get the flavour of DEA, in figure 4.2 we analyse the simplest case of a single-output and single-input model. We compute the technical efficiency scores under the output-oriented DEA approach.[15] The X-axis and Y-axis respectively measure input and output quantities. Figure 4.2 depicts DEA frontier as a line emanating from origin *o*, passing through point 'which correspond to the highest ratio of output to input. The area below the frontier consists of feasible yet inefficient input–output combinations. The points (*b* to *g*) lying below frontier, therefore, symbolize inefficient producers/firms, while as *a* represent efficient producer/firm since it lies on the frontier.[16]

Figure 4.2: DEA Frontier



The OLS regression line with the intercept set at *o* is also drawn in Figure 1. Apart from not allowing for the inefficiency, OLS assumes that

[15] In DEA, there are two approaches to compute the efficiency of a producer/firm. One input oriented approach and other output oriented approach. In the former the distance from the frontier is computed horizontally while as in latter it is computed vertically.

[16] We assume the production technology has constant returns-to-scale (CRS) which means that a proportional change in a firm's inputs should lead to the same proportional change in a firm's outputs.

deviations from the mean input-output correspondence are purely random and would, therefore, underestimate the frontier.

The efficiency scores for firms *b* to *g* is measured by their distance to the frontier. For instance, the efficiency score for firm *g* is calculated as *oi* divided by oi^* which is the ratio of observed output level (what a firm produces) to the efficient output level (what it can produce). The value of the efficiency index for each firm ranges between 0 and 1, hence providing an indication of the degree of inefficiency of the firm. A value closer to 1 meaning more efficient while as a value closer to zero signifies the inefficiency of the firm. The value of unity indicates a firm is fully efficient and therefore located at best frontier.

Table 4.3: Description of Variables

Dependent Variables	*Description*	*Data Source*
R&D Dummy	=1, for firms reporting positive R&D =0, for firms not reporting or reporting 0 R&D	
R&D intensity	Expenditure on R&D as a proportion on firm's sales	PROWESS
Innovation	Number of patents granted to a firm over the period.	IPO
Total Factor Productivity change	MPI computed using DEA	
Independent Variables		
Proximity to the Frontier	Inverse of the distance function calculated using DEA	
Horizontal FDI	Ratio of the output of foreign firms to industry output.	PROWESS
Backward FDI	Share of the total output of an industry that is sold to foreign firms in downstream industries calculated using Input-Output tables.	WIOD
Forward FDI	Foreign share of total output of an industry that is sold to domestic firms in downstream industries calculated using Input-Output tables.	WIOD
Size	Share of firm sales to industry median sale:	PROWESS
Age	Year of incorporation.	PROWESS
Export Intensity	Exports to sales turn-over.	PROWESS
Import Intensity	Imports to sales turn-over.	PROWESS
Profitability	Profits before tax	PROWESS
Capital Intensity	Net fixed assets	PROWESS
Leverage	Firm debt as a proportion of sales	PROWESS
R&D labs Dummy	=1, for firms having their R&D labs registered with DSIR =0, otherwise.	
Herfindhal Index	Hirschman-Herfindhal Index measuring concentration computed as sum of square of market shares in four digit industry	
Location Dummy	=1, for firms located in industrial clusters =0, otherwise	

Chapter 5

Empirical Results and Discussions

This chapter presents the empirical estimates obtained from utilizing various econometric models. The key dependent variables as mentioned in chapter 3 are innovation and *tfp*, we have used two measures of innovation namely R&D expenditure and patent grants. Accordingly, we report the results related to these two measures of innovation as well as on the *tfp* in this chapter. As discussed in the framework, we will present the results segregated on the basis of ownership. Further, we will also present the results conditioned for the incumbents' proximity to the best practice frontier.

The chapter has four main sections. Section 5.1 discusses the empirical estimates on R&D obtained from utilizing Heckman's two-step estimation procedure. The empirical estimates related to patent grants computed from Poisson and Negative Binomial models are presented in section 5.2. In section 5.3, we present empirical estimates on *tfp* obtained from fixed effect regression model. The final section of the chapter 5, discusses the empirical results on innovation and *tfp* in light of incumbents' proximity to the best practice frontier.

5.1. Empirical Results on Innovation Input (R&D)

Table 5.1 provides the descriptive statistics of the key variables comprising innovation expenditure equation. We also carried out a test of difference of means between foreign firms and domestic firms utilizing t-test. We find significant variations in most of the variables. For instance, variables like R&D intensity, firm size, export intensity, import intensity, and capital intensity shows considerable inter-firm differences. On average foreign firms are less R&D intensive than domestic firms. There exist significant differences in export intensity of domestic and foreign firms, former, on an average, having higher export intensity than the latter.

It reflects that foreign firms operating in India mostly invest to cater to the domestic market. Like export intensity, import intensity of foreign firms seems to be lower vis-à-vis domestic firms, suggesting greater dependency of domestic firms on imports from abroad. Regarding firm size, foreign firms on an average are relatively large in size. The mean age of foreign firms appears to be higher than local firms. The reason for such an observation is the way age is calculated. We calculate age as number of years since the year of incorporation of a firm. Thus a firm incorporated, for example, in year 1950 may not have any foreign equity until 2000 but foreign investors hold 10% or more equity in it after 2000. This particular firm although becoming foreign only after 2000, will turn out to be older than a domestic firm that is incorporated, say, in the year 1955 and has no foreign equity until now. Same applies to other firms comprising the sample. In order to view the difference we have also calculated the age of the firms on the basis of year in which these become foreign and the same are reported in the last row of Table 5.1. This is one of the reasons that average age of foreign firms is higher than domestic firms. Foreign firms also seem to be more capital intensive than their domestic counterparts. Lastly no significant differences exist between the two groups of firms in terms of profitability and leverage.

As one of the main concerns of our study is to evaluate the R&D behavior of incumbent firms, it is perhaps imperative to provide year wise details regarding R&D intensity of both the groups of firms for the period 2000-2013. Table 5.2 reports R&D intensity of domestic as well as foreign firms. R&D intensity of domestic firms is higher than that of foreign firms. However, the differences are statistically significant only for the year 2000 and 2001. The statistics reflect that R&D intensity of domestic firms goes down marginally from the year 2000 to 2004, but it picks up from 2005 onward, whereas there is an increase although marginal in R&D intensity of foreign firms throughout the study period. The possible reason for foreign firms being less R&D intensive than domestic firms could be that MNCs undertake most of their R&D in labs situated in the headquarters. The purpose behind centralizing R&D is to reduce internal transaction costs associated with R&D coordination across units. It further helps MNCs to maintain the secrecy of technologies and minimize the leakages to rivals that otherwise increase with decentralized research. Thus, MNC affiliates operating in the host country instead developing their own technologies prefer to import them from the parent company and then adopt them to host country effort which require less R&D.

Table 5.1: Summary statistics and differences in means

Variable	All firms		Domestic firms		Foreign firms	
	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
R&D Intensity (rd_{it})	0.017	0.051	0.015*	0.054	0.013*	0.027
Export Intensity (ep_{it})	0.255	0.263	0.243*	0.254	0.141*	0.309
Import intensity (im_{it})	0.164	0.242	0.172*	0.186	0.147*	0.390
Log size ($lnsz_{it}$)	3.436	11.212	3.395*	9.320	3.594*	17.56
Log capital(lnk_{it})	2.882	7.932	1.972*	5.041	4.891*	9.261
Leverage (lv_{it})	1.054	2.494	1.162	6.125	0.942	1.783
Log Profitability ($\ln pr_{it}$)	2.231	1.032	2.380	1.131	2.161	0.982
Log age ($lnag_{it}$)	1.550	0.741	1.471	0.263	1.825	0.921
Log age ($lnag_{it}$)#					1.091	0.203

**indicates significant differences in means, based on t-test with unequal variances.*
** shows calculated t > tabulated t at 0.01 level.*
 # Age of firms based on the foreign equity infusion year.

Table 5.2:R&D intensity of domestic and foreign firms

Year	Domestic Firms	Foreign Firms
2000	1.13*	0.67*
2001	1.09*	0.69*
2002	0.97	0.73
2003	0.99	0.79
2004	0.96	0.76
2005	1.03	0.78
2006	1.05	0.82
2007	1.07	0.86
2008	1.10	0.89
2009	1.13	0.86
2010	1.17	0.93
2011	1.19	0.96
2012	1.15	1.02
2013	1.16	1.07

*Note: *indicates significant difference at 1% level in means, based on t-test with unequal variances.*

5.1.1. Empirical Results for Full Sample

This subsection discusses the results obtained while estimating the equations (4.10 and 4.11) using Heckman's two-step estimation procedure. The dependent variable in Equation (4.10) is a binary (taking values 0 and 1), thus probit model would be appropriate for estimation purpose. We are interested in estimating not only the impact of FDI spillovers on R&D behavior of all firms (entire sample) but of the subsamples of domestic firms and foreign firms as well. From the theoretical point of view, it is important to see whether the impact of FDI on foreign firms' investment in R&D is different from the domestic firms. Foreign firms may invest less in R&D as these firms have access to the resources of parent firm that may give then some advantage over the domestic firms. Alternatively, foreign firms may invest more in R&D than domestic firms because of the advantages offered by the access to financial resources abroad, enabling them to invest more in R&D. Accordingly, to empirically verify the difference, we run three separate regressions, one, for the entire sample, and one each for the subsamples of domestic and foreign firms.

The empirical results for the full sample are reported in Table 5.3. The negative and significant value of Mills lambda is a clear indication of the existence of selection bias. Therefore, estimates need to be corrected for selection bias.

Empirical estimates on the link between horizontal FDI spillover variable *(l_1hfd)* and R&D in both the selection and the outcome equations reflect positive and significant influence on the decision to invest in R&D as well as on R&D intensity for the incumbents competing with MNCs in the same sector of activity. There could be three main reasons for this result. One is the existence of a positive externality that gets generated from MNCs activity and spills over to their rivals through worker mobility and imitation. Two competition effect associated with FDI compels incumbents to undertake R&D so as to survive the competition. Third, FDI incentivize incumbents to undertake R&D since incumbents cannot realize the benefits generated by MNCs activities without undertaking any R&D. Absorbing external knowledge or technology require tremendous engineering efforts and costly investments on the part of incumbent firms.

Like horizontal spillover variable *(l_1hfd)*, the coefficient estimates on the backward spillover variable *(l_1bhf)* exhibit a positively significant impact on the likelihood to engage in R&D as well as on the extent of R&D. The impact on latter, however, is relatively stronger than former. The results suggest that the R&D activities of incumbent firms' active in the supplying sectors benefit from the presence of MNCs in the product market. A potential explanation for positive backward spillovers could be that incumbent firms residing in the upstream sectors and acting as suppliers to MNCs receive a number of benefits in the form of supplier assistance programmes from the MNCs subsidiaries.

Contrary to the horizontal and backward spillovers, the estimated coefficients on forward spillover variable *(l_1ffd)* are insignificant across all specifications, which imply lack of any benefits to the firms operating as clients in downstream sectors. Although FDI through backward linkages generate spillovers for firms residing in upstream sectors but no such spillovers seem to arise through forward linkages for firms producing in downstream sectors.

The selection equation shows that export intensity marginally affects the probability of a firm investing in R&D. In outcome equation, the coefficient of export intensity is statistically significant, implying as opposed to firms that serve only domestic consumers, export-oriented firms spent more on R&D. The finding is supported by the descriptive in Table 4.3 which shows that most of R&D doing firms indulges in export activities. Of the 520 firms reporting their R&D expenses, more than 75% (391) are exporters. Export-oriented firms, in general, face intense competition in the international markets. Hence, to remain viable in competitive foreign markets, such firms must innovate. However, innovating necessitates continual spending on R&D. Import intensity neither affects the decision to invest in R&D nor does it impact the R&D intensity of incumbent establishments in our sample. The possible reason for such a finding could be substitutability between imported embodied technologies and local R&D which tend to decrease later cancelling out the increase in R&D due to complementarity between imports and R&D. The net result is no significant impact on R&D.

The estimated coefficients in selection as well as outcome equations, confirm a non-linear relationship between firm size and R&D. The result matches with some of the previous empirical findings like that of Kumar & Aggarwal (2005), Pradhan (2002) & Siddharthan (1988). Firm size marginally depresses the R&D intensity but the impact of its square term on R&D intensity appears to be positively significant, giving a U-shaped relation between size and R&D. This U-shaped relation indicates that initially up to a certain threshold, firm size reduces the R&D intensity but latter goes up once that threshold is crossed over. This threshold level is estimated to be $7.02 million in terms of net sales implying R&D intensity decreases in relation to size in firms smaller than threshold size while it increases with size in firms larger than the estimated threshold size.

Like firm size, the relationship between firm age *(lnag)* and propensity to invest in R&D is also non-linear suggesting that the tendency to invest in R&D initially goes down with age but rises after a certain threshold in age is reached. The outcome model also shows that firm age shares a non-linear relation with R&D intensity. The finding suggests that R&D intensity as well as probability of undertaking R&D initially decline with age; nevertheless both subsequently rise as firms realize the need to improve their products and processes in the face of competition, consistent with the evidence from India (Ghosh 2009; Golder & Renganathan 1998).

In the selection equation, profitability *(lnprf)* comes up with a positive but with a slightly less significant coefficient reflecting that the profitability of firms marginally affects the decision to undertake R&D. However, the impact of profitability *(lnprf)* on R&D intensity appears to be positive and significant suggesting that profitability is vital for R&D spending and that firms prefer to finance their R&D projects using internal funds rather than financing them through external borrowings. As, R&D is a risky endeavor with uncertain and probabilistic efficiency improvements or benefits, banks are reluctant to finance such projects of firms by providing them loans (Ghosh, 2012). The above argument also backs our finding regarding the impact of leverage on R&D. It can be seen that the impact of leverage on both R&D intensity and decision to invest in R&D is not very significant. The positively significant coefficient of capital intensity indicates the importance of physical capital in R&D; it reveals that R&D is a capital intensive activity and hence capital intensive firms undertake more R&D than their counterparts with low capital base.

The effect of concentration captured by *hhi* on R&D intensity is negative and significant. Increase in competition (reduction in concentration) increases the R&D level of firms in that industry. This suggests that FDI entry weakens the concentration, developing an apprehension in incumbents to defend their market shares. To protect their market shares, incumbents respond by increasing their R&D levels. The location variable *lc* which captures the location effect is significant at 1% level, affirming the significance of location as a factor prompting firms to undertake R&D.

Table 5.3: Heckman's two-step estimation results for full sample

Independent Variables	Linearity in size and age				Non-linearity in size and age			
	Selection equation (R&D dummy)		Outcome equation (R&D intensity)		Selection equation (R&D dummy)		Outcome equation (R&D intensity)	
l_1hfd_{jt}	0.161**	(0.074)	0.116*	(0.065)	0.173**	(0.079)	0.120*	(0.060)
l_1bfd_{jt}	0.193**	(0.078)	0.142***	(0.053)	0.198**	(0.081)	0.148***	(0.059)
l_1ffd_{jt}	0.066	(0.058)	0.091	(0.085)	0.072	(0.063)	0.096	(0.088)
ep_{it}	0.013**	(0.006)	0.886***	(0.014)	0.014*	(0.009)	0.892***	(0.019)
l_1im_{it}	0.017	(0.011)	0.101	(0.095)	0.015	(0.012)	0.108	(0.098)
lns_{it}	-0.022	(0.075)	-0.068	(0.087)	-0.043**	(0.019)	-0.121*	(0.091)
$lnsz^2_{it}$					0.098***	(0.041)	1.102***	(0.399)
$lnag_{it}$	-0.059	(0.064)	-0.179	(0.151)	-0.069*	(0.057)	-0.183*	(0.149)
$lnag^2_{it}$					0.262***	(0.094)	0.572***	(0.285)
$lnprf_{it}$	0.084	(0.054)	0.133***	(0.031)	0.088*	(0.052)	0.152***	(0.037)
lvg_{it}	0.011	(0.007)	0.039	(0.033)	0.018	(0.013)	0.041	(0.034)
lnk_{it}	0.066	(0.047)	0.173**	(0.076)	0.074	(0.061)	0.182**	(0.087)
hhi_{it}	-1.612*	(0.687)	-0.681***	(0.009)	-1.157*	(0.673)	-0.871***	(0.007)
Rdl	0.257***	(0.092)	0.303***	(0.017)	0.248***	(0.056)	0.349***	(0.029)
Dlc	0.018***	(0.006)			0.013***	(0.004)		
Mills lambda	-2.264***	(0.794)			-3.903***	(0.845)		
obs.	10542		7280		10542		7280	

*Note: Standard errors are in parentheses. *, **, *** denote significance at 10%, 5% and 1% levels respectively. Industry and year dummies included. The prefix l_{1i} is associated with some of the variables symbolizes their one period lag*

5.1.2. Empirical Results for the Subsample of Domestic and Foreign Firms

The estimations reported in Table 5.4 provide support to our hypothesis which proposes that FDI entry increases the likelihood of domestic firms to increase the investment spending on R&D. The estimated coefficient on the horizontal spillover variable *(l_1hfd)* is significant at 5% level in selection equation; however, the significance of l_1hfd in the outcome equation is established only at 10% level implying a lesser impact of FDI on R&D intensity relative to its impact on the probability of investing in R&D. The estimated coefficients in selection model suggest that 1% increase in the foreign presence in an industry raises the propensity to undertake R&D by 0.11 percentage points. It indicates that an increase in foreign presence ratchets up the competition in the domestic market, to survive the competition local firms respond by opting to invest in R&D. The finding matches with that of Anwar & Sun (2013) which claims that demonstration and competition effects arising from the presence of MNC subsidiaries spur local firms to engage in R&D. The estimated coefficients on the backward spillover variable in both the equations are positively significant suggesting that the presence of MNCs in the host country through the creation of backward linkages help local suppliers to engage in R&D. Unlike horizontal and forward spillover variables, the coefficient estimates on forward spillover variable are insignificant in both the equations implying lack of spillovers on the R&D activities of local firms operating downstream.

Among control variables, firm profitability, capital intensity, and export intensity have significant positive coefficients. Firm profitability is seen as a source of internal funding to finance the R&D projects of domestic firms. As mentioned earlier, lack of external funding to finance risky ventures like R&D makes firms to depend on internal sources of funding. Our results suggest that highly leveraged firms do spend on R&D. Since R&D activities are characterized by long duration and need large capital investment. Internal financing is not always sufficient enough to meet the financial needs of R&D activities and enterprises often need to utilize external financing to supplement funds for R&D activities. This holds specifically for new high-tech firms because it is difficult for them to meet their fund demands through the endogenous financing means (Wang et. al., 2016). Moreover, enterprise shareholders had an incentive to invest in risky projects with debt as they try to transfer some risk to creditors (Jensen & Meckling, 1976).

Findings suggest capital intensive domestic firms invest more on R&D since R&D activities demand more capital therefore relatively capital intensive firms are likely to undertake R&D. As far as export intensity is concerned, we find that firms serving international markets have a higher probability to invest in R&D as well as a higher R&D intensity. The outward orientation of firms in terms of a higher proportion of exports significantly increases the need for an in-house R&D effort to compete at the international front. Moreover, exposure to international markets is likely to raise the returns to R&D due to the increased market size (Zimmerman, 1987), hence enticing firms to invest more in R&D. Import intensity seems not to determine the R&D intensity of firms, and it also appears not to influence the decision to invest in R&D activities. As mention earlier, possibility of substitution and complementary part canceling out each other could be factor leading to such a finding.

Firm age and size both are non-linearly related with both propensity to spend on R&D and R&D intensity. Industry concentration measured by *hhi* adversely affects the inducement to invest implying firms in more concentrated markets invest less on R&D. As expected, domestic firms with registered R&D labs are more R&D intensive relative to ones whose R&D labs are not registered with DSIR.

Table 5.4: Heckman's two-step estimation results for subsample of domestic firms

Independent Variables	Linearity in size and age				Non-linearity in size and age			
	Selection equation (R&D dummy)		Outcome equation (R&D intensity)		Selection equation (R&D dummy)		Outcome equation (R&D intensity)	
l_1hfd_{jt}	0.112**	(0.051)	0.072**	(0.035)	0.114**	(0.054)	0.077**	(0.038)
l_1bfd_{jt}	0.131***	(0.048)	0.093**	(0.044)	0.137***	(0.053)	0.097**	(0.048)
l_1ffd_{jt}	0.021	(0.018)	0.013	(0.011)	0.026	(0.019)	0.019	(0.015)
ep_{it}	0.029*	(0.016)	0.502***	(0.179)	0.039*	(0.021)	0.542***	(0.184)
l_1im_{it}	0.068	(0.047)	0.098**	(0.043)	0.072	(0.055)	0.117**	(0.049)
$lnsz_{\ it}$	-0.042	(0.033)	-0.115	(0.109)	-0.057*	(0.029)	-0.128	(0.113)
$lns^2_{\ it}$					0.148**	(0.065)	1.189**	(0.513)
$lnag_{it}$	-0.078	(0.083)	-0.189	(0.135)	-0.086	(0.092)	-0.197	(0.150)
$lnag^2_{\ it}$					0.337***	(0.118)	0.669**	(0.293)
$lnprf_{it}$	0.051*	(0.028)	0.098***	(0.019)	0.077*	(0.041)	0.109***	(0.032)
lvg_{it}	0.019	(0.015)	0.048**	(0.021)	0.025	(0.018)	0.059**	(0.027)
lnk_{it}	0.063	(0.047)	0.081**	(0.037)	0.079	(0.058)	0.096**	(0.042)
hhi_{it}	-0.119*	(0.066)	-0.253**	(0.128)	-0.142*	(0.085)	-0.293**	(0.139)
Rdl	0.309***	(0.058)	0.356***	(0.039)	0.335***	(0.083)	0.389***	(0.042)
Dlc	0.082***	(0.017)			0.095***	(0.021)		
Mills lambda	-3.761***	(0.508)			-3.982***	(0.713)		
obs.	8470		5642		8470		5642	

*Standard errors are in parentheses. Standard errors are bootstrapped at 1500 repetitions. *, **, *** denote significance at 10%, 5% and 1% levels respectively. Industry and year dummies included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

Table 5.5 provides a summary of the estimated results for foreign firms operating in Indian manufacturing sector. The analysis unfolds a positive relation between R&D activities of foreign firms and FDI, implying that higher the FDI in industry, the greater the tendency of existing foreign firms to undertake R&D. The evidence from selection and outcome equations (Row 1 of Table 5.5) indicates the strong impact of intra-industry spillovers on the decision to invest in R&D as well as on the R&D intensity of the firms having part or all of their equity held by foreign investors. The findings suggest that although horizontal FDI has a substantial positive influence on the decision to engage in R&D, however, the impact on the level of R&D is relatively less strong. Our results refute the findings of Anwar & Sun (2014) that confirm a depressing impact of increased foreign entry on the R&D activities of foreign firms operating in Chinese manufacturing sector. The reason for the results obtained in the present study could be that the response of existing foreign firms in the host country to the escalation of competition caused by increased FDI by enhancing the R&D outlay.

The findings for control variables are almost similar to those of domestic firms. Profitability, capital intensity, and export intensity have a significant positive influence on R&D intensity of foreign affiliates. Similarly, firm size and age show a non- linear U- shaped relation with R&D intensity and the decision to invest in R&D. However, there are certain differences between two sets of results; for instance, the coefficient of import intensity that was insignificant in case of domestic firms turns significant for foreign firms. There is a probability that foreign firms may be importing from their parent organizations some embodied technology that may require further R&D to adapt to the local conditions. The effect of concentration captured by *hhi* appears not to be very significant on the R&D behavior of foreign firms whereas the same was marginally significant for domestic firms. Another glaring difference in empirical estimates between domestic and foreign firms is the estimates on leverage.

While the domestic firms lack access to external finance but foreign firms seems to borrow from financial institutions to finance their R&D activities. The increased access to external finance of the latter can be attributed to their reputation and credibility in the financial markets. However, unlike foreign firms, domestic firms seem not to enjoy so much credibility; therefore, it is tough for them to get external finances. Further, MNC affiliates are worldwide known for the innovations and successful R&D projects hence financial institutions do not deter to extend loans to these firms.

Table 5.5: Heckman's two-step estimation results for subsample of foreign firms

Independent Variables	Linearity in size and age				Non-linearity in size and age			
	Selection equation (R&D dummy)		Outcome equation (R&D intensity)		Selection equation (R&D dummy)		Outcome equation (R&D intensity)	
l_1hfd_{jt}	0.092^{***}	(0.036)	0.059^{**}	(0.029)	0.096^{***}	(0.041)	0.065^{**}	(0.033)
l_1bfd_{jt}	0.107^{*}	(0.053)	0.099^{*}	(0.054)	0.123^{*}	(0.061)	0.115^{*}	(0.068)
l_1ffd_{jt}	0.017	(0.014)	0.011	(0.009)	0.023	(0.019)	0.013	(0.011)
ep_{it}	0.075^{**}	(0.034)	0.112^{***}	(0.010)	0.091^{**}	(0.039)	0.143^{***}	(0.022)
l_1im_{it}	0.039	(0.031)	0.156^{**}	(0.083)	0.071	(0.059)	0.181^{**}	(0.094)
lns_{it}	-0.014	(0.009)	-0.087	(0.069)	-0.038	(0.027)	-0.099	(0.073)
lns^2_{it}					0.132^{***}	(0.016)	0.273^{***}	(0.059)
$lnag_{it}$	-0.129	(0.123)	-0.204	(0.193)	-0.152	(0.139)	-0.218	(0.201)
$lnag^2_{it}$					0.619^{***}	(0.174)	0.710^{***}	(0.218)
$lnprf_{it}$	0.213^{*}	(0.112)	0.279^{**}	(0.131)	0.264^{*}	(0.145)	0.311^{**}	(0.142)
lvg_{it}	0.041^{**}	(0.019)	0.093^{***}	(0.021)	0.062^{**}	(0.024)	0.091^{***}	(0.033)
lnk_{it}	0.029^{*}	(0.017)	0.089^{**}	(0.037)	0.042^{*}	(0.026)	0.118^{**}	(0.078)
hhi_{it}	-0.227^{*}	(0.153)	-0.316^{**}	(0.138)	-0.288^{*}	(0.157)	-0.379^{**}	(0.165)
Rdl	0.187^{**}	(0.085)	0.212^{**}	(0.093)	0.198^{**}	(0.089)	0.238^{**}	(0.109)
Dlc	0.014^{*}	(0.008)			0.019^{*}	(0.010)		
Mills lambda	-2.079^{**}	(0.891)			-2.110^{**}	(0.947)		
obs.	2072		1638		2072		1638	

*Standard errors are in parentheses. Standard errors are bootstrapped at 1500 repetitions. *, **, *** denote significance at 10%, 5% and 1% levels respectively. Industry and year dummies included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

There is a possibility that some of variables in the Equations (4.10) and (4.11) are endogenous. In order to address the problem of endogeneity, we estimate Equations (4.10) and (4.11) by means of Instrumental regression using starting a business index (SBI), labour hiring index (LHI) and Trading cost index (TCI) as the instruments for horizontal, backward and forward FDI spillover variables. However, before running the IV-regression, it is imperative to check whether the suspected endogenous variables are really endogenous or not. Durbin-score and Wu-Hausman's econometric tests are employed to detect the endogeneity of the regressors of interest. The p-value of both the test statistics reported in Table 5.6 confirms that FDI spillover variables are endogenous. The study further employs a battery of econometric procedures to assess the relevance and validity of the instruments. Tables 5.7 and 5.8 provide the first stage regression coefficients and summary statistics as a testimony for the relevance of the instruments. The reported first stage regression statistics like R^2 and F-values establish the relevance of instruments. However, relying absolutely on R^2 and F-statistic may not be enough to ascertain the reliability of instruments. A better measure to identify the applicability of instrument variables is to compute partial R^2 and Shea partial R^2 values (Shea 1997 & Baum et al. 2003). The values of partial R^2 and Shea partial R^2 reflect the variance of endogenous variables that is explained by their instruments. Higher values of these statistics indicate stronger instruments that exhibit less bias when the instruments are strongly correlated with the endogenous variable. Further, if the values of partial R^2 and Shea partial R^2 are close to each other or the difference between two is small then the instruments are believed to be strong enough to explain the endogenous regressors.

Table 5.6: Tests of endogeneity

Durbin (score) chi^2 (3)	=81.321(p=0.000)
Wu-Hausman F (3, 6873)	= 26.168(p=0.000)

Table 5.7: First stage regression results

Dep. Var.	Horizontal FDI	Backward FDI	Forward FDI
Starting business ratings $(SBR)^I$	0.079^{***} (0.024)		
Labour Hiring index $(HI)^I$		0.103^{***} (0.039)	
Trading costs index $(TCI)^I$			0.067^{**} (0.029)
Other exogenous variables	Yes	Yes	Yes
Time effects	Yes	Yes	Yes
Establishment effects	Yes	Yes	Yes

*Robust standard errors are in parentheses. ***, **,* denote significance at 1, 5 and 10 percent levels respectively. Super script I associated with SBR, HI and TCI indicates inverse of these variable.*

Table 5.8: First-stage regression statistics

Test Statistic	R^2	Adjusted R^2	Partial R^2	Shea's Partial R^2	F (3,6877)	Prob >F
l_1hfd_{jt}	0.519	0.519	0.397	0.327	1487.384	0.000
l_1bfd_{jt}	0.833	0.833	0.803	0.697	9568.528	0.000
l_1ffd_{jt}	0.337	0.332	0.256	0.171	787.491	0.000

The prefix l_1 associated with the variables symbolizes their one period lag.

Tables 5.9, 5.10 and 5.11 respectively report the IV estimations for all sample categories. As compared to estimates presented in Table 5.3, IV-Probit estimates reported in Table 5.9 exhibit certain changes in terms of significance and magnitude of coefficients for some of the variables. For instance, horizontal spillover variable which was significant at 5% level in both the selection and outcome equations in previous regression (Row1, Table 5.3) is now significant only at 10% level. Similarly, the coefficient estimates on backward spillover variable show a substantial decrease both in terms of magnitude and significance. The significance of the backward variable was earlier established at 1% level across all the specifications (Row 2, Table 5.3) but now significance drops to 5% level in both the selection as well as in the outcome equation. Some of the controls like location and registered R&D lab dummy also show some changes when compared to the previous estimates.

For the subsample of domestic firms the coefficient estimates on horizontal and backward variables were significant at 5 and 1 per cent levels in previous regression, however, the IV estimates for the same are now significant at 10% and 5% levels, indicating a drop both in magnitude and significance of coefficients. Likewise, for the subsample of firms with foreign ownership the horizontal spillover variable becomes less significant in the IV model. The findings from IV-regression are controlled for endogeneity bias and therefore, should be preferred over the estimates obtained from Probit estimation. Results obtained through Probit estimation are provided for comparative analysis.

Table 5.9: IV- regression estimation results for full sample

Independent Variables	Linearity in size and age				Non-linearity in size and age			
	Selection equation (R&D dummy)		Outcome equation (R&D intensity)		Selection equation (R&D dummy)		Outcome equation (R&D intensity)	
l_1hfd_{jt}	0.109*	(0.072)	0.086*	(0.048)	0.118*	(0.089)	0.093*	(0.058)
l_1bfd_{jt}	0.169**	(0.078)	0.123**	(0.061)	0.163**	(0.080)	0.127**	(0.062)
l_1ffd_{jt}	0.057	(0.053)	0.087	(0.081)	0.060	(0.057)	0.093	(0.091)
ep_{it}	0.011*	(0.006)	0.795***	(0.023)	0.014*	(0.009)	0.842***	(0.039)
l_1im_{it}	0.019	(0.013)	0.128	(0.093)	0.025	(0.021)	0.149*	(0.097)
lns_{it}	-0.011	(0.017)	-0.087	(0.082)	-0.036*	(0.020)	-0.113*	(0.071)
lns^2_{it}					0.107**	(0.053)	1.003**	(0.48 6)
$lnag_{it}$	-0.048	(0.062)	-0.165	(0.133)	-0.063	(0.069)	-0.173	(0.141)
$lnag^2_{it}$					0.283***	(0.088)	0.548**	(0.272)
$lnprf_{it}$	0.083*	(0.053)	0.143***	(0.038)	0.094*	(0.058)	0.159***	(0.048)
lvg_{it}	0.017*	(0.009)	0.038	(0.031)	0.023*	(0.013)	0.049	(0.044)
lnk_{it}	0.069	(0.055)	0.163**	(0.073)	0.077	(0.058)	0.202**	(0.093)
hhi_{it}	-0.488*	(0.269)	-0.949**	(0.387)	-0.524*	(0.295)	-0.982**	(0.387)
Rdl	0.245**	(0.098)	0.312***	(0.024)	0.257**	(0.109)	0.329***	(0.048)
Dlc	0.021**	(0.009)			0.022**	(0.011)		
Mills lambda	-2.317***	(0.467)			-2.413***	(0.498)		
obs.	10542		7280		10542		7280	

Standard errors are in parentheses. Standard errors are bootstrapped at 1500 repetitions., **, *** denote significance at 10%, 5% and 1% levels respectively. Industry and year dummies included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

Table 5.10: IV- regression estimation results for the subsample of domestic firms

Independent Variables	Linearity in size and age				Non-linearity in size and age			
	Selection equation (R&D dummy)		Outcome equation (R&D intensity)		Selection equation (R&D dummy)		Outcome equation (R&D intensity)	
l_1hfd_{jt}	0.103^{*}	(0.055)	0.069^{*}	(0.039)	0.109^{*}	(0.058)	0.074^{*}	(0.039)
l_1bfd_{jt}	0.129^{**}	(0.058)	0.087^{**}	(0.043)	0.131^{**}	(0.056)	0.091^{*}	(0.045)
l_1ffd_{jt}	0.023	(0.020)	0.017	(0.014)	0.031	(0.022)	0.023	(0.019)
ep_{it}	0.028^{*}	(0.019)	0.496^{***}	(0.187)	0.035^{*}	(0.019)	0.526^{***}	(0.193)
l_1im_{it}	0.063	(0.049)	0.096^{**}	(0.047)	0.068	(0.058)	0.112^{**}	(0.051)
lns_{it}	-0.037	(0.031)	-0.117	(0.106)	-0.052^{*}	(0.031)	-0.123	(0.110)
lns^2_{it}					0.141^{**}	(0.068)	1.170^{**}	(0.518)
$lnag_{it}$	-0.077	(0.087)	-0.181	(0.143)	-0.082	(0.090)	-0.186	(0.152)
$lnag^2_{it}$					0.333^{***}	(0.124)	0.648^{**}	(0.292)
$lnprf_{it}$	0.051^{*}	(0.028)	0.098^{***}	(0.019)	0.077^{*}	(0.041)	0.109^{***}	(0.032)
lvg_{it}	0.026	(0.021)	0.049^{**}	(0.018)	0.031	(0.021)	0.053^{**}	(0.024)
lnk_{it}	0.054	(0.051)	0.077^{**}	(0.039)	0.072	(0.059)	0.089^{**}	(0.043)
hhi_{it}	-0.123^{*}	(0.064)	-0.257^{**}	(0.131)	-0.143^{*}	(0.085)	-0.284^{**}	(0.142)
Rdl	0.297^{***}	(0.063)	0.341^{***}	(0.051)	0.327^{***}	(0.087)	0.373^{***}	(0.049)
Dlc	0.077^{***}	(0.021)			0.081^{***}	(0.027)		
Mills lambda	-3.704^{***}	(0.486)			-3.961^{***}	(0.691)		
obs.	8470		5642		8470		5642	

Standard errors are in parentheses. Standard errors are bootstrapped at 1500 repetitions., **, *** denote significance at 10%, 5% and 1% levels respectively. Industry and year dummies included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

Table 5.11: IV- regression estimation results for the subsample of foreign firms

Independent Variables	Linearity in size and age				Non-linearity in size and age			
	Selection equation (R&D dummy)		Outcome equation (R&D intensity)		Selection equation (R&D dummy)		Outcome equation (R&D intensity)	
l_1hfd_{jt}	0.080**	(0.038)	0.058**	(0.027)	0.091**	(0.044)	0.067**	(0.032)
l_1bfd_{jt}	0.098*	(0.051)	0.092*	(0.057)	0.117*	(0.066)	0.111*	(0.069)
l_1ffd_{jt}	0.022	(0.017)	0.016	(0.011)	0.027	(0.021)	0.019	(0.013)
ep_{it}	0.072**	(0.036)	0.107***	(0.013)	0.088**	(0.040)	0.138***	(0.029)
l_1im_{it}	0.033	(0.027)	0.152**	(0.076)	0.069	(0.054)	0.173**	(0.085)
lns_{it}	-0.019	(0.011)	-0.083	(0.064)	-0.043	(0.035)	-0.097	(0.070)
lns^2_{it}					0.128***	(0.019)	0.268***	(0.063)
$lnag_{it}$	-0.124	(0.119)	-0.197	(0.182)	-0.147	(0.134)	-0.211	(0.193)
$lnag^2_{it}$					0.608***	(0.179)	0.701***	(0.227)
$lnprf_{it}$	0.203*	(0.116)	0.272**	(0.139)	0.258*	(0.146)	0.307**	(0.147)
lvg_{it}	0.044**	(0.019)	0.089***	(0.028)	0.067**	(0.026)	0.090**	(0.037)
lnk_{it}	0.031*	(0.016)	0.093**	(0.037)	0.043*	(0.024)	0.123*	(0.082)
hhi_{it}	-0.230*	(0.159)	-0.311**	(0.138)	-0.291*	(0.159)	-0.368**	(0.167)
Rdl	0.184**	(0.086)	0.204**	(0.094)	0.195**	(0.091)	0.232**	(0.112)
Dlc	0.019*	(0.011)			0.024**	(0.011)		
Mills lambda	-2.063**	(0.843)			-2.104**	(0.937)		
obs.	2072		1638		2072		1638	

Standard errors are in parentheses. Standard errors are bootstrapped at 1500 repetitions., **, *** denote significance at 10%, 5% and 1% levels respectively. Industry and year dummies included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

The key findings from the estimations on R&D are summarized as follows:

1. Spillovers generated by horizontal and backward FDI positively influence the likelihood of investing in R&D. The spillover impact, on tendency to engage in R&D, from horizontal FDI, however, appears to be relatively strong for firms with foreign equity. In case of backward spillovers a reverse trend to that of horizontal spillovers is visible. The spillovers generated via backward linkages have a strong positive influence on propensity to engage in R&D for domestic suppliers than their foreign counterparts operating as suppliers in upstream sectors.

2. Again, spillovers from horizontal FDI strongly influence R&D intensity of firms with a part or all of their equity held by foreigners. The finding signals that intra-industry MNC activity complements the R&D activities undertaken by incumbent firms, particularly the R&D activities of the firms with foreign ownership and operating as rivals to MNC affiliates.

3. Finally, R&D intensity of incumbents acting as suppliers to downstream MNC affiliates is positively affected by spillovers generated by backward FDI. The effect is relatively robust on R&D intensity of domestic suppliers as opposed to foreign suppliers active in domestic upstream sectors. The empirical findings are indicative of the fact that MNC affiliates' active in downstream product market source part of the intermediate inputs from local suppliers. However, to become potential suppliers to downstream MNCs, local producers, as demanded by latter, need to improve the quality of intermediate goods which requires some investment in R&D, skills and organizational practices.

Therefore, based on our empirical results, we conclude that spillovers generated by FDI positively influence the tendency to engage in R&D as well as the extent of R&D undertaken by incumbents. A further inference that emerges from the findings is that FDI induces incumbents to undertake R&D, irrespective of their ownership. Moreover, results convey that status of a firm does matter in realization of spillovers. As opposed to clients, suppliers and rival firms seem to grasp FDI-related spillovers.

5.2. Empirical Results on Innovation Output (Patent Grants)

One of the objectives of the thesis is to examine the impact of FDI on the innovation output. Exploiting data on patent grants, the purpose is to examine whether presence of MNCs can act as a catalyst to stimulate incumbent firms' innovation activities in India. As evident from the empirical results on firm level R&D that part of the variation in R&D of incumbent firms is determined by MNCs activities in the host country which in other words imply the existence of positive spillover on the local research activities. In view of the fact that spillovers generated by FDI transpire on the local R&D activities, the possibility of them manifesting on the innovation output cannot be ignored.

5.2.1. Empirical Results for Full Sample

To capture the impact of FDI spillovers on the patenting activities of manufacturing firms operating in India, we estimate a patent production function in which dependent variable, the number of patent grants received by a firm *i* at time *t*, is modelled as a function of horizontal, backward and forward FDI along with certain industry and firm-specific controls. Since dependent variable is a count variable taking only discrete non-negative values, it is likely to generate non-linearities and thereby making usual linear regression models inappropriate for estimation purpose. The discrete non-negative nature of the patent counts necessitates the use of Poisson and negative binomial models for empirically estimating the relationship that patent counts share with its' determinants. Since the dataset on patent grants contain excess zeros ZIP and ZINB are more appropriate to handle preponderance of zeros than standard count models.

The impact of FDI spillovers on patenting activity is analysed for the incumbent firms active in the same three-digit sector as the MNC as well on the firms operating in upstream and downstream sectors. The descriptive statistics of the variables are given in Table 5.12.

Table 5.12: Descriptive statistics of the variables incorporated in innovation and productivity equation

Variable	Mean	SD	Min	Max
Patent Grants (pg_{it})	1.17	4.77	0.00	168.00
Proximity to Frontier (l_1prxm_{it})	0.04	0.17	0.01	0.93
R&D Intensity (l_1rd_{it})	0.01	0.05	0.001	0.07
Horizontal FDI (l_1hfd_{jt})	0.25	0.16	0.01	0.58
Backward FDI (l_1bfd_{jt})	0.38	0.54	0.05	0.49
Forward FDI (l_1ffd_{jt})	0.12	0.23	0.02	0.37
Export intensity (ep_{it})	0.25	0.05	0.00	0.89
Import intensity (l_1im_{it})	0.16	0.26	0.00	0.95
Firm size (lns_{it})	3.43	0.71	1.10	6.26
Firm age ($lnag_{it}$)	1.55	0.28	1.00	109.00
Total Factor Productivity (tfp_{it})	1.05	5.27	0.05	4.23

Empirical estimates obtained from ZIP and ZINP models are reported in Table 5.13 where the impact of lagged FDI is related to the patents received by incumbent firms operating in the same three-digit sector as MNC as well as the firms that operate in vertically related sectors. Since spillovers from FDI may take some time to manifest on innovation output of incumbent firms. We incorporate the lagged values of FDI spillover variables in the regression model to capture the time elapse between MNCs activities and realisation of spillovers by incumbents.

Estimates reported in the Table 5.13 (Rows 1 and 2) show patenting at firm level is positively related to the MNC activities taking place in the Indian manufacturing sector. The estimated coefficients on horizontal FDI (l_1hfd) are significant at 5% level across all specifications, suggesting the existence of positive intra-industry spillovers generated by the activities of MNC affiliates but realized by rival incumbents competing with former in the same field of activity. The occurrence of within industry positive horizontal spillovers may be attributed to the learning that takes place through mobility of R&D personnel and other skilled workers, or through demonstration and competition effects. The departure of R&D personnel from MNCs to other rival firms can prove handy in developing new products and processes when these personnel start working with other firms or establish their own business ventures. There is empirical evidence supporting the occurrence of spillovers through worker mobility. For instance, Balsvik (2009) while focusing on labor mobility within Norwegian manufacturing find that during 1990-2000 14,400 workers left MNCs for non-MNCs. A similar evidence of worker mobility comes from Ghana where entrepreneurs and skilled staff from multinationals moved away to open up their own firms (Gorg & Strobl, 2005). This implies that these entrepreneurs bring with them some of the knowledge accumulated in the multinational which can be usefully applied in the new domestic firm.

As compared to firms directly competing with foreign affiliates, the impact on the innovation activities in firms linked through backward linkages and acting as suppliers to the latter are strongly impacted upon by the presence of foreign affiliates in the downstream industries. The coefficient estimates on backward FDI *(l_1bfd)* appear significant at 1% level in both ZIP and ZINB specifications (Row 2, Table 5.13), implying existence of inter-industry effects in Indian manufacturing sector. The results are reflective of the fact that backward FDI (linkages between downstream foreign affiliates and their upstream suppliers) enhance the innovative performance of the firms working in the supplying sectors. One potential explanation for such a finding is that MNCs help local suppliers to ameliorate their production process by providing them necessary assistance in the form of employee training and technology. Our result corroborates with Javorcik (2004), and Blalock & Gentler (2008). The authors report the existence of spillovers from vertical FDI via backward linkages. In contrast to backward FDI, coefficients on forward FDI *(l_1ffd)* are significant at 10% level; however, the significance disappears upon the inclusion of controls in the regression (Row 3 of Table 5.13). This implies forward FDI hardly has any impact on the patenting activity of firms operating in downstream sectors. The probable reason could be the complex nature of inputs supplied by foreign producers to the downstream domestic firms which may cause difficulties to the latter in integrating them into the production chain.

The coefficient on R&D intensity *(l_1rd)* is positive and significant across all the specifications, indicating a strong positive association between R&D and the number of patents received at the firm level. The impact of export intensity on innovation is statistically significant, suggesting that exporting firms patent more relative to firms that serve only local markets. The finding matches with Braga & Willmore (1991), for Brazil, Kumar, & Saqib (1996), for India, and Siedschlag & Zhang, (2015), for Ireland. The latter group of authors claim that exporting firms are more likely to implement product innovations than non-exporting firms. Size, as well as age positively impacts the patenting behaviour implying relatively bigger and older firms receive relatively more patents than the small young firms.

We do not find results in support of the assumption that stronger patent laws induce greater patenting activity. The estimated coefficient on the dummy denoting introduction of product patents is negative but marginally significant across all specifications, implying that stronger patent laws, although slightly, deter the patenting activity in firms operating in Indian manufacturing sector. However, for the subsample of foreign firms the coefficient on patent product dummy is negative but insignificant suggesting no detrimental effect on the patenting activities of foreign firms. Caution needs to be exercised while interpreting the coefficients on patent policy. As evident from figure 1.5, patent grants show a sudden spurt in 2005-06, the year product patent regime was introduced in India. However, this rise couldn't sustain for too long as patent grants recorded a dip in 2008. The grants further plummeted in 2010 and since then continued to rise at a stable rate. In light of these facts, we cannot conclude whether introduction of product patent regime has deterred the patenting activity or spurred it.

Table 5.13: ZIP and ZINB Estimates for Patent Counts (Full Sample)

Dep. var. Patent Grants	(1) ZIP	(2) ZINB	(3) ZIP	(4) ZINB
l_1hfd_{jt}	0.032^{**} (0.012)	0.027^{**} (0.010)	0.021^{**} (0.009)	0.013^{**} (0.005)
l_1bfd_{jt}	0.068^{***} (0.025)	0.072^{***} (0.02)	0.058^{***} (0.016)	0.073^{***} (0.024)
l_1ffd_{jt}	0.041^{*} (0.026)	0.032^{*} (0.020)	0.029 (0.023)	0.033 (0.027)
l_1rd_{it}			0.065^{***} (0.011)	0.056^{***} (0.014)
lns_{it}			0.204^{***} (0.089)	0.194^{***} (0.083)
ep_{it}			0.013^{**} (0.006)	0.011^{**} (0.004)
l_1im_{it}			0.029 (0.025)	0.027 (0.022)
$lnag_{it}$			0.018^{***} (0.002)	0.013^{***} (0.002)
Dpp			-0.121^{*} (0.087)	-0.114^{*} (0.081)
log-likelihood	-4463.72	-1714.96	-4182.94	-1678.24
obs.	7280	7280	7280	7280

*Standard errors are in parentheses. ***, **,* denote significance at 1, 5 and 10 per cent levels respectively. The log- likelihood values for the ZIP and ZINB models include the log -likelihood of the logit model. Industry effects, firm fixed effects and time effects included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

5.2.2. Empirical Estimates on Subsample of Domestic and Foreign Firms

Besides analysing the impact of FDI spillovers on the patenting behaviour of all the incumbents (domestic as well as foreign) comprising our sample, we also report the empirical results when the analysis is done separately for the subsample of domestic and foreign firms. Analysing them separately is important since spillovers may not affect the patenting behaviour of domestic and foreign firms uniformly. The later may have access to technology and knowledge of the parent company thus making it relatively easy for them to absorb the new knowledge and technical know-how flowing into the host country as a result of FDI. Tables 5.14 and 5.15 report the estimates for domestic and foreign firms respectively. One significant difference that we observe in the estimates is that the patent policy dummy which appears to have a significant negative impact on the patenting activities of domestic firms now turns insignificant for the foreign firms operating in Indian manufacturing sector. The result is interesting since domestic firms for their innovation predominantly depend on the imitation and reverse engineering of foreign technologies and a weak IPR regime encourage them to actively engage in such activities. However, owing to implementation and enforcement of property rights which are at par with international standards domestic firms are unable to emulate the products and processes of foreign firms, hence cannot benefit from the imitation channel. Moreover, enforcement of strong patent regime not only makes imitation difficult, but it also requires incumbent firms to curtail these activities so as to avoid any litigation issues.

Table 5.14: ZIP and ZINB patent count estimates for the subsample of domestic firms

Dep. var. Patent Grants	(1) ZIP	(2) ZINB	(3) ZIP	(4) ZINB
l_1hfd_{jt}	0.022^{**} (0.010)	0.019^{**} (0.009)	0.017^{**} (0.007)	0.016^{**} (0.005)
l_1bfd_{jt}	0.048^{***} (0.015)	0.042^{***} (0.011)	0.058^{***} (0.016)	0.053^{***} (0.014)
l_1ffd_{jt}	0.024^{*} (0.019)	0.029^{*} (0.021)	0.020 (0.017)	0.023 (0.021)
l_1rd_{it}			0.061^{***} (0.023)	0.048^{***} (0.018)
lns_{it}			0.190^{***} (0.078)	0.176^{***} (0.059)
ep_{it}			0.009^{**} (0.003)	0.008^{**} (0.003)
l_1im_{it}			0.017 (0.015)	0.012 (0.009)
$lnag_{it}$			0.014^{***} (0.004)	0.010^{***} (0.004)
Dpp			-0.092^{*} (0.049)	-0.081^{*} (0.043)
log-likelihood	-4318.32	-1521.46	-3987.52	-1543.19
obs.	5642	5642	5642	5642

*Standard errors are in parentheses. ***, **,* denote significance at 1, 5 and 10 per cent levels respectively. The log-likelihood values for the ZIP and ZINB models include the log -likelihood of the logit model. Industry effects, firm fixed effects and time effects included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

Table 5.15: ZIP and ZINB patent count estimates for the subsample of foreign firms

Dep. Var.	(2)	(4)	(6)	(8)
Patent Grants	ZIP	ZINB	ZIP	ZINB
l_1hfd_{jt}	0.047** (0.019)	0.036** (0.015)	0.029** (0.012)	0.031** (0.011)
l_1bfd_{jt}	0.074** (0.035)	0.049** (0.023)	0.063** (0.026)	0.047** (0.021)
l_1ffd_{jt}	0.017* (0.012)	0.013* (0.009)	0.011 (0.009)	0.011 (0.007)
l_1rd_{it}			0.098*** (0.029)	0.091*** (0.024)
lns_{it}			0.258*** (0.052)	0.234*** (0.039)
ep_{it}			0.033** (0.016)	0.031** (0.014)
l_1im_{it}			0.037 (0.030)	0.032 (0.028)
$lnag_{it}$			0.049*** (0.022)	0.041*** (0.018)
dpp			-0.090 (0.073)	-0.084 (0.081)
log-likelihood	-3152.97	-1598.02	-3820.72	-1481.53
obs.	1638	1638	1638	1638

*Standard errors are in parentheses. ***, **,* denote significance at 1, 5 and 10 per cent levels respectively. The log- likelihood values for the ZIP and ZINB models include the log -likelihood of the logit model. Industry effects, firm fixed effects and time effects included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

The empirical findings reported above deserve more in-depth investigation. As mentioned in the chapter 4 that the panel estimation may exacerbate endogeneity concerns in the analysis. If, and as suggested by the previous studies, reverse causality has the tendency to lead to a downward bias in the estimated coefficients, so we can expect a significant underestimation of the effect of interest in the above regressions. To tackle the problem of potential endogeneity, we replace the suspected endogenous variables with their instruments as discussed in chapter 4.

The IV-estimates provided in Table 5.16 are expected to be cleansed of endogeneity. We observe significant improvements in the significance level of coefficient estimates after controlling for the endogeneity of the regressors of interest. Like significance levels, coefficient estimates also improved in their magnitude. For instance, horizontal FDI was significant at 5%, but the significance of the regressor substantially lowers upon the inclusion of controls in the regression models (Table 5.13, Row 1). However, after controlling for endogeneity, the impact of horizontal FDI appears significant at 5% across all the specifications (Row 1, Table 5.16). Further, the coefficient estimates of the regressor are rather strong in magnitude when compared to coefficients reported in Table 5.13 (Row 1). Likewise the coefficients on backward FDI besides being relatively stronger, now turn out to be significant at 1% level through all specifications (Row 2, Table 5.16), despite of whether we introduce controls or not in the regression models. However, coefficient estimates of forward FDI continue to show a lower significance even after controlling for its potential endogeneity.

The IV estimates for the subsample of domestic and foreign firms reported in Tables 5.17 and 5.18, remain more or less same from their ZIP and ZINB estimates presented in Tables 5.14 and 5.15 respectively. However, comparison of the IV estimates of the two subsamples reveals some interesting things. First, strong innovation spillovers are realised by the domestic firms acting as suppliers to MNC affiliates than those domestic firms which compete with foreign affiliates in the same sector of activity. The evidence that local suppliers benefit more than domestic rivals implies strong backward spillovers as opposed to spillovers arising from horizontal FDI. Second, as compared to domestic firms, the incumbents with foreign equity appear to derive equal benefits from both horizontal and backward FDI, which implies irrespective of their status the firms with foreign ownership receive positive innovation spillovers from activities of MNCs. Third, the foreign owned firms operating downstream receive positive innovation spillovers, although meagre, from forward FDI, however, no such spillovers manifest on innovation activities of domestic firms operating downstream. Positive forward effect on innovation out of foreign firms confirms that as opposed to domestic firms, former are better equipped to utilise more complex technologies or components parts supplied by upstream foreign producers.

Table 5.16: IV estimates of patent grants for the full sample

Dep. Var. Patent grants	(1) ZIP	(2) ZINB	(3) ZIP	(4) ZINB
l_1hfd_{jt}	0.046** (0.019)	0.039** (0.017)	0.043** (0.021)	0.033** (0.014)
l_1bfd_{jt}	0.083*** (0.031)	0.065*** (0.026)	0.089*** (0.035)	0.071*** (0.028)
l_1ffd_{jt}	0.039* (0.025)	0.036* (0.019)	0.044 (0.035)	0.042 (0.031)
l_1rd_{it}			0.076*** (0.021)	0.062*** (0.013)
lns_{it}			0.278*** (0.079)	0.216*** (0.046)
ep_{it}			0.017** (0.008)	0.023** (0.011)
l_1im_{it}			0.024 (0.019)	0.029 (0.022)
$lnag_{it}$			0.024** (0.010)	0.026** (0.011)
dpp			-0.152* (0.093)	-0.159* (0.099)
log-likelihood	-1576.26	-1421.93	-1438.69	-1308.28
Instruments	*SB,HI,TC*	*SB,HI,TC*	*SB,HI,TC*	*SB,HI,TC*
obs.	7280	7280	7280	7280

*Standard errors are in parentheses. ***, **,* denote significance at 1, 5 and 10 per cent levels respectively. The log- likelihood values for the ZIP and ZINB models include the log -likelihood of the logit model. Industry effects, firm fixed effects and time effects included. SBI, HI, and TC are instruments denoting starting a business in India, hiring index and trading costs respectively.The prefix l_1 associated with some of the variables symbolizes their one period lag.*

Table 5.17: Estimates of patent grants for the subsample of domestic firms

Dep. Var. Patent grants	(1) ZIP	(2) ZINB	(3) ZIP	(4) ZINB
l_1hfd_{jt}	0.049** (0.022)	0.044** (0.018)	0.046* (0.024)	0.038* (0.021)
l_1bfd_{jt}	0.087*** (0.031)	0.073*** (0.025)	0.091*** (0.033)	0.076*** (0.029)
l_1ffd_{jt}	0.042 (0.031)	0.039 (0.029)	0.047 (0.036)	0.052 (0.038)
l_1rd_{it}			0.078*** (0.025)	0.066*** (0.019)
lns_{it}			0.229** (0.093)	0.202** (0.098)
ep_{it}			0.021*** (0.006)	0.025*** (0.009)
l_1im_{it}			0.024 (0.019)	0.029 (0.022)
$lnag_{it}$			0.029** (0.012)	0.031** (0.014)
Dpp			-0.167* (0.087)	-0.173 (0.091)
log-likelihood	-1553.94	-1398.73	-1418.26	-1289.03
Instruments	SB,HI,TC	SB,HI,TC	SB,HI,TC	SB,HI,TC
obs.	5642	5642	5642	5642

*Standard errors are in parentheses. ***, **,* denote significance at 1, 5 and 10 percent levels respectively. The log- likelihood values for the ZIP and ZINB models include the log -likelihood of the logit model. Industry effects, firm fixed effects and time effects included. SBI, HI, and TC are instruments denoting starting a business in India, hiring index and trading costs respectively. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

Table 5.18: IV estimates of patent grants for the subsample of foreign firms

Dep. Var. Patent grants	(1) ZIP	(2) ZINB	(3) ZIP	(4) ZINB
l_1hfd_{jt}	0.032** (0.014)	0.028** (0.011)	0.037** (0.017)	0.031** (0.013)
l_1bfd_{jt}	0.051** (0.025)	0.049** (0.021)	0.063** (0.029)	0.058** (0.028)
l_1ffd_{jt}	0.029* (0.016)	0.026* (0.018)	0.036* (0.023)	0.034 (0.025)
l_1rd_{it}			0.064** (0.026)	0.053** (0.023)
lns_{it}			0.243*** (0.061)	0.197*** (0.039)
ep_{it}			0.028*** (0.010)	0.031** (0.013)
l_1im_{it}			0.018 (0.015)	0.022 (0.017)
$lnag_{it}$			0.029** (0.019)	0.033** (0.015)
dpp			-0.162 (0.102)	-0.168 (0.113)
log-likelihood	-1353.96	-1271.28	-1367.87	-1238.61
instruments	SB,HI,TC	SB,HI,TC	SB,HI,TC	SB,HI,TC
obs.	1638	1638	1638	1638

*Standard errors are in parentheses. ***, **,* denote significance at 1, 5 and 10 percent levels respectively. The log-likelihood values for the ZIP and ZINB models include the log -likelihood of the logit model. Industry effects, firm fixed effects and time effects included. SBI, HI, and TC are instruments denoting starting a business in India, hiring index and trading costs respectively. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

The main findings from the estimations on patent grants can be summarized as follows:

1. Innovation activities of incumbent firms are positively influenced by the presence of MNC subsidiaries in both upstream and downstream industries of Indian manufacturing sector.
2. Domestic suppliers through backward linkage channel receive significant innovation spillovers from their downstream MNC clients which eventually help them to receive more patent grants.
3. The impact of the implementation of product patent policy on the patent grants of domestic firms appears to be negative and somewhat significant as opposed to that of foreign owned firms operating in India.

5.3. Empirical Estimates on Productivity (*tfp*)

Innovation is believed to be among the factors which determine the productivity at firm level; hence anything affecting innovation can also be expected to affect the productivity. As evident from the aforementioned empirical results on innovation, that spillovers generated by FDI have a profound impact on the R&D and patenting activities of the supplier and rival firms of MNC subsidiaries. So following the logic that innovation is an important ingredient of productivity, it may not be out of place to analyse if the spillover effects manifest on the productivity of incumbent firms. This section is devoted to analyse the results on *tfp* obtained from fixed effect estimator.[17] This section first presents the results for whole sample and then exercise is repeated for the subsample of domestic and foreign firms.

5.3.1. Empirical Results for Full Sample

In Table 5.19, we describe the effect of FDI on incumbent on *tfp* growth. Columns 1 and 2 show estimates of the variables of interest from standard FE model whereas Columns 3 and 4 report empirical estimates obtained from the IV-FE approach. The empirical results across all specifications reflect a positive and significant correlation of FDI variables with the subsequent *tfp* growth in incumbents. The estimated coefficients for both the horizontal FDI (l_1hfd) and backward FDI (l_1bfd) appear significant across all specifications. The IV estimates on l_1hfd shows a marginal decrease in magnitude (columns 3 and 4 in Table 5.19), however, the significance level remains same from FE specification to IV specification. The significance level for l_1bfd remains constant at 1% throughout although with a slight rise in the magnitude of estimates in IV specification. This suggests that foreign presence not only spurs the productivity growth in the firms operating in upstream sectors, but it also improves the productivity of the firms active in the same three-digit sector as MNC. The statistical significance of l_1hfd and l_1bfd suggests the existence of intra as well as inter-industry productivity spillovers in Indian manufacturing sector. In contrast to l_1hfd and l_1bfd, coefficients on forward FDI (l_1ffd) appear insignificant across all model specifications, suggesting

[17] We have tested for random effect and fixed effect specifications. The value of the Hausman test static is 169.891 (p=0.000) reflecting that FE model is preferable.

a lack of productivity spillovers on firms operating in downstream sectors.

Our analysis now turns to the relationship between innovation and the productivity of firms. It is believed that innovative firms are more productive than non-innovative firms. Policy-makers and researchers widely acknowledge that innovation is essential for increasing productivity (Rosenbusch et al., 2011). However, while a positive correlation between product innovation and firms' performance has been established for European firms; evidence for developing countries has been mixed (Mohnen & Hall, 2013). The variable l_1pg representing the count of patent grants is introduced in the regression to capture the impact of innovation on the firm productivity. Our results point to a strong positive relationship between innovation and firm level productivity. One unit rise in l_1pg on an average leads to an increase of 29% in *tfp* and this effect has a high degree of statistical significance. The estimated effect, however, is slightly modest when computed through IV regression. These results can be interpreted as: first, innovation in existing firms can both increase the efficiency and improve the goods they offer, thus increasing demand as well as reducing costs of production. [18] The empirical evidence in case of German manufacturing panel claims that the average

[18] According to Levin and Reiss (1988), firms spend money on R&D to perform process and product innovation which have different impacts on the firms' demand and cost conditions. Process innovations reduce the production costs per unit while product innovation widens the scope of pricing.

reduction in unit costs due to process innovation was about 6-7% in the late 1990s which fell to 3.4% in 2014 (Rammer 2016). The highest average unit cost reduction is found in manufacturing of computer, electronic and optical products, followed by manufacturing of automobiles, mechanical engineering and telecommunications. Second, innovating firms are likely to grow more than non-innovating firms and new entrants with better products to offer are likely to displace existing inefficient firms with a concomitant increase in productivity levels.

Among the controls, unlike size and import intensity, export intensity determines the change in firm-level *tfp*, implying that exporting is strongly associated with the improvements in productivity. The estimated coefficient on export intensity is statistically significant at 1% level in standard FE model but the significance level of the estimate is somewhat smaller when computed using IV regression. The results suggest a unit increase in export sales ratio is associated with more than 1% increase in *tfp*. The impact of firm age although insignificant in the standard FE specification turns out marginally significant in the IV specification.

Table 5.19: FE and FE-IV estimates on *tfp* for the full sample

Dep. Var. Δtfp_{it}	(1) FE	(3) FE	(5) FE-IV	(6) FE-IV
l_1hfd_{jt}	1.421^{***} (0.553)	1.582^{***} (0.598)	1.291^{**} (0.612)	1.253^{**} (0.619)
l_1bfd_{jt}	1.159^{***} (0.436)	1.162^{***} (0.441)	1.173^{**} (0.479)	1.194^{**} (0.485)
l_1ffd_{jt}	0.319 (0.397)	0.332 (0.402)	0.262 (0.527)	0.268 (0.534)
l_1pg_{it}		0.294^{***} (0.113)		0.272^{**} (0.117)
lns_{it}		0.117 (0.129)		0.119 (0.153)
ep_{it}		0.013^{***} (0.003)		0.011^{**} (0.005)
l_1im_{it}		0.013 (0.010)		0.018 (0.011)
$lnag_{it}$		0.083 (0.067)		0.079^{*} (0.049)
Dpp		-0.011 (0.013)		-0.012 (0.037)
R^2	0.085	0.091	0.049	0.011
F-Statistic/Wald-Chi^2	9.78	6.24	163.62	167.93
Prob>F/Prob>Chi^2	0.00	0.00	0.00	0.00
obs.	7280	7280	7280	7280

*Standard errors are in parentheses. ***, **,* denote significance at 1, 5 and 10 per cent levels respectively. Firm fixed effects and time effects included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

5.3.2. Empirical Results for the Subsample of Domestic and Foreign Firms

We now move to the estimation of productivity spillovers for the sub group of domestic and foreign firms. The empirical results are reported in Tables 5.21 and 5.22 respectively. Like innovation, we find that FDI spillovers strongly determine the changes in *tfp* for both groups of firms. As evident from Columns 1 and 2 of Table 5.21, the coefficient on backward FDI is significant at 1% as opposed to horizontal FDI whose significance is established at 5% level. The magnitude of coefficients on backward FDI and horizontal FDI in Columns 5 and 6 of Table 5.21 suggests for domestic firms, the effect on *tfp* is relatively strong from backward FDI, again implying that local suppliers relatively reap more benefits from foreign presence than local rivals of MNC affiliates. The significance level of backward FDI shows a drop and is established at 5% level in the IV specifications (Columns 5 and 6, Table 5.21), however, the coefficients on horizontal FDI variables obtained through IV estimation, do not show any marked change in terms of significance. The estimated coefficients on backward FDI point out to the significant knowledge transfer to local firms operating upstream from the MNC clients producing final goods. In most developing countries, MNCs have access to cheap labour and raw materials, but suppliers seldom meet the quality standards, therefore, MNCs intentionally support the local suppliers by providing them technical assistance on product design, quality control, factory outlet, labour and inventory management and thus helping them to improve their productivity.

The coefficient on the forward FDI like its previous estimates does not show any signs of significance suggesting that domestic firms active in the final goods market don't receive any spillovers from the supplying industries with MNC presence. This result indicates a lack of second order positive effects on the domestic firms operating downstream. The implication of the result is that benefits in terms of improvement in product quality, reduction in production costs and other technological benefits, accruing to the firms in supplying sectors from their MNC clients seems not to flow (in the form of reduced prices) to downstream domestic clients sourcing from the sectors with foreign presence.

The estimates on patent grants (l_1pg) appear significant at 5% in one of the specifications, suggesting patenting activity in local firms helps them to improve their productivity. While export intensity significantly determine the productivity changes in domestic firms, the rest of the control variables do not have any impact on *tfp*. The coefficient on export intensity is positive and statistically significant at 1% level in FE estimation; however, the robustness of the coefficient slightly decreases in the IV estimation.

Turning towards the empirical results obtained for foreign firms (Table 5.21) operating in Indian manufacturing sector, we observe that improvements in *tfp* is primarily associated with horizontal FDI (l_1hfd) suggesting that firms having foreign promoters share in their equity receive significant intra-industry spillovers from the MNCs affiliates. The estimates on backward FDI (l_1bfd) although robust in basic FE specification turn out to be marginally significant after accounting for the possible endogeneity in the IV specification. The results indicate that foreign firms operating in intermediate goods sectors unlike their domestic counterparts receive lesser spillovers from their MNC clients. The estimates on forward FDI (l_1ffd) are insignificant across all specifications implying absence of any forward spillovers on *tfp* of foreign owned firms operating in downstream sectors.

Patenting in foreign owned firms is significantly associated with the improvements in their *tfp* levels. The robustness of the innovation variable is established across all model specifications. The findings suggest that, in case of foreign owned firms, an additional patent grant on an average leads to an increase of 16% to 19% in their *tfp*.

Incumbents engaged in exports exhibit significant improvements in *tfp* levels over the study period. The export intensity variable *(ep)* comes up with a positive effect that is significantly different from zero in case firms of with foreign ownership. Another control variable which emerges with a robust positive effect is the age of the firms (*lnag)*, implying relatively older firms are more productive than their young counterparts.

Table 5.20: Malmquist *tfp* changes of exporting and non-exporting firms

Δtfp_{it}	Exporting Firms			Non-exporting Firms		
Year	2003	2008	2013	2003	2008	2013
Entire Sample	0.98	1.01	1.08	0.94	0.96	1.06
Domestic Firms	0.93	1.03	1.07	0.87	0.94	1.02
Foreign Firms	1.09	1.11	1.18	1.01	1.08	1.12

Note: MPI value of greater than 1 implies improvement in productivity compared to previous year.

The key empirical results on productivity spillovers are summarized below:

1. Horizontal and Backward FDI spillovers significantly determine the change in *tfp* occurring at firm-level.

2. Besides spillovers, patent counts appear to be an important factor influencing the incumbents' *tfp* growth. The firms with more patent grants have high levels of *tfp* than ones with fewer grants.

3. Compared to foreign owned supplying firms, the variation in the *tfp* of upstream domestic firms is strongly determined by presence of MNC affiliates in the final goods sector.

4. Foreign affiliates in an industry through intra-industry spillovers improve the productivity levels of the rival firms irrespective of whether the rivals' ownership lies in domestic hands or had a part or all of equity held by the foreign promoters.

Table 5.21: FE and FE-IV estimates on *tfp* for the subsample of domestic firms

Dep. Var. Δtfp_{it}	(1) FE	(3) FE	(5) FE-IV	(6) FE-IV
l_1hfd_{jt}	1.473** (0.598)	1.418** (0.593)	1.393** (0.569)	1.359** (0.587)
l_1bfd_{jt}	1.168*** (0.412)	1.162*** (0.419)	1.143** (0.473)	1.139** (0.489)
l_1ffd_{jt}	0.325 (0.403)	0.331 (0.411)	0.288 (0.498)	0.296 (0.502)
l_1pg_{it}		0.281** (0.137)		0.269* (0.146)
lns_{it}		0.118 (0.135)		0.124 (0.159)
ep_{it}		0.015*** (0.005)		0.013** (0.006)
l_1im_{it}		0.017 (0.012)		0.019 (0.016)
$lnag_{it}$		0.086 (0.071)		0.075 (0.052)
Dpp		-0.019 (0.014)		-0.023 (0.039)
R^2	0.089	0.093	0.051	0.027
F-Statistic/Wald-Chi^2	10.23	8.62	169.98	171.82
Prob>F/Prob>Chi^2	0.00	0.00	0.00	0.00
obs.	5642	5642	5642	5642

*Standard errors are in parentheses. ***, **,* denote significance at 1, 5 and 10 per cent levels respectively. Firm fixed effects and time effects included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

Table 5.22: FE and FE-IV estimates on *tfp* for the subsample of foreign firms

Dep. Var. Δtfp_{it}	(1) FE	(3) FE	(5) FE-IV	(6) FE-IV
l_1hfd_{jt}	1.176** (0.487)	1.183** (0.495)	1.139** (0.518)	1.132** (0.521)
l_1bfd_{jt}	0.985** (0.471)	1.062** (0.479)	0.932* (0.487)	0.961* (0.493)
l_1ffd_{jt}	0.281 (0.345)	0.293 (0.348)	0.228 (0.359)	0.231 (0.362)
l_1pg_{it}		0.193*** (0.061)		0.176*** (0.068)
lns_{it}		0.169 (0.146)		0.144 (0.151)
ep_{it}		0.037** (0.015)		0.034** (0.017)
l_1im_{it}		0.026 (0.018)		0.022 (0.016)
$lnag_{it}$		0.099** (0.048)		0.087** (0.043)
dpp		-0.031 (0.024)		-0.028 (0.031)
R^2	0.092	0.096	0.055	0.029
F-Statistic/Wald-Chi^2	8.56	5.97	161.54	164.29
Prob>F/Prob>Chi^2	0.00	0.00	0.00	0.00
obs.	1638	1638	1638	1638

*Standard errors are in parentheses. ***, **,*denote significance at 1, 5and 10 per cent levels respectively. Firm fixed effects and time effects included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

5.4. Empirical Results on Proximity to Frontier and FDI Spillovers

In this section, we test the hypothesis that incumbents located near to the best practice frontier have better ability to absorb the FDI-related spillovers, hence may benefit more than the incumbents which are situated further away from the best practice frontier. The proposition implies that, as opposed to laggard firms, productivity growth and innovation is positively associated with FDI inflows in technologically advanced firms. The hypothesis is based on the theoretical exposition from Schumpeter growth theory which predicts that advanced entry will spur innovation incentives in sectors close to the technology frontier, where successful innovations allows incumbents to survive the threat, but discourages innovations in laggard sectors, where threat reduces incumbents' expected rents from innovating. Based on this theoretical prediction, we estimate the impact of FDI on innovation and productivity of incumbents that produce near the best practice frontier as well as on those firms which are located further away from the frontier.

Before, we start discussing the main results; it is worth commenting on the mean values of patent grants, efficiency scores and Malmquist *tfp* change provided in Table 5.23. The overall sample mean for patent grants is 1.27 implying that over the period each of the industry in our sample on an average has received just over one patent over the fourteen years period. However, there is a great deal of heterogeneity in the mean number of patent grants across the industries. The average is highest for computer, electronics and optical products with 2.73 grants followed by motor vehicles industry with 2.67 grants, pharmaceuticals with 2.64 grants and chemical and chemical products with 2.41 grants. The average grants for industries like fabricated metals, coke and petroleum, textiles, non-metallic minerals, leather and tobacco is well below the sample average. The average grants for fabricated metals is lowest with 0.05 grants followed by leather and related products 0.08 grants.

As mentioned before, the output-oriented DEA is employed to compute efficiency scores and Malmquist *tfp* change for 17 industries comprising the sample. As the DEA methodology demands, a separate DEA model for each of the 17 industries is estimated under the assumptions of homogeneity.[19] The number of firms under analysis for each industry, the mean efficiency scores for each industry and the mean value for Malmquist *tfp* change for each industry reported in Table 5.22 show a significant variation between the industries. The efficiency scores range between 0 and 1. Most of the industries under analysis show rates higher than 50% of the efficiency scores along the years of analysis. The highest score for technical efficiency is of the motor vehicle industry with an average score of 0.91 indicating that the industry is 9% inefficient. The score also indicates that the industry is 91% efficient. With the same level of resources, the industry can reach the best practice frontier by increasing its output level by 0.09 percentage points. The second highest efficiency score (0.85) is of other motor vehicle industry followed by basic metals. On the basis of the

[19] Three necessary conditions of homogeneity include; (a) the incumbents are engaged in the same process; (b) all incumbents are evaluated under the same measures of efficiency and; (c) all incumbents operate under the same conditions.

computed efficiency scores, the least efficient industry is non-metallic minerals with an average efficiency score of 0.18, followed by coke and petroleum with an average efficiency score of 0.19. The average efficiency score for overall sample is 0.58 with 11 industries out of 17 (64.70%) having their average efficiency scores falling in the range of 0.58 - 0.91. The low averages of efficiency scores for some of the industries in the sample indicate the presence of more inefficient firms in these industries.

The Malmquist *tfp* depicting the changes in *tfp* over a period has an overall sample average of 1.05 indicating an improvement in the overall *tfp* levels for the whole sample. However, average individual Malmquist *tfp* scores exhibit variations between different industries reflecting heterogeneous changes in *tfp* levels over the years. The industry with the highest improvement in *tfp* is electric equipment with the average Malmquist *tfp* change of 1.14, followed by chemicals and chemical products and motor vehicles each showing an average Malmquist *tfp* of 1.13. On the contrary, the industry with lowest average Malmquist *tfp* change is leather and related products with an average value of 0.79. The value of less than 1 for Malmquist *tfp* change indicates deterioration in *tfp* levels while as a value greater than one signify improvements in *tfp* levels. In our sample, most of the industries 10 out of 17 (58%) show an improvement in the *tfp* while as 7 out of 17 (42%) show a drop in the *tfp* levels over the study period.

Table 5.23: Mean of patent grants, efficiency scores and malmquist *tfp* change

Industry Code	Industry Group	No. of firms	Patent Grants	Efficiency Score	Malmquist *tfp* Change
10	Food Products	37	1.11	0.64	0.96
12	Tobacco	04	0.39	0.24	0.92
13	Textiles	31	0.52	0.49	0.98
15	Leather and related Products	17	0.08	0.32	0.79
17	Paper and Paper Products	10	0.10	0.81	1.11
19	Coke and Petro Products	10	0.80	0.19	1.01
20	Chemicals and Chemical Products	94	2.41	0.58	1.14
21	Pharmaceuticals	63	2.64	0.66	0.97
22	Rubber and Plastic Products	28	0.22	0.74	0.98
23	Non-Metallic Mineral Products	34	0.75	0.18	0.99
24	Basic Metals	21	0.84	0.81	1.05
25	Fabricated Metal Products	14	0.05	0.23	1.04
26	Computer, Electronics & Optical Products	27	2.73	0.75	1.09
27	Electric Equipment	37	1.82	0.72	1.18
28	Machinery	48	1.21	0.61	0.85
29	Motor Vehicles	17	2.67	0.91	1.13
30	Other Motor Equipment	28	1.53	0.85	1.03
	Total	520	1.27	0.58	1.05

5.4.1. Empirical Results on Innovation Input (R&D)

We start by considering the impact of FDI on R&D with a focus on how proximity to the best practice conditions the spillovers from FDI inflows. We have now introduced proximity variable and its interactions with FDI spillover variables in the equations on innovation expenditure to assess the impact of spillovers generated by foreign activities on the R&D of firms operating in proximity to the best practice frontier. The results for whole sample are reported in Table 5.24. In the selection equation, the coefficient estimates on horizontal spillover variable (l_1hfd) and backward spillover variable (l_1bfd) are positively significant indicating that FDI increases the probability of investing in R&D activities. The impact, however, is relatively strong for the firms residing in supplying sectors suggesting the flow of knowledge spillovers through backward linkages. The insignificant coefficient estimates on forward spillover variable (l_1ffd) reflect the absence of any such spillovers in the downstream sectors.

In the outcome equation, we observe similar results: horizontal spillover variable (l_1hfd) and backward spillover variable (l_1bfd) show a significant positive impact on the R&D intensity, which implies that both rivals, as well as suppliers of foreign affiliates, receive significant spillovers from the presence of MNCs in the host country. Like selection equation, the coefficient estimates on backward spillover variable (l_1ffd) in the outcome equation show no signs of significance reflecting non-existence of spillovers on incumbents acting as clients to MNC affiliates.

In order to assess if the spillovers are conditioned by the incumbents nearness to or farness from frontier, we allow the interaction between proximity and spillover variables in both the selection and outcome equations. The coefficients on interaction term of horizontal FDI and proximity (*l_1hfd*l_1prxm*) are positively significant at 5% level in outcome equation suggesting within an industry incumbent firms located near to the frontier increase their level of R&D expenditure as result of spillovers arising from foreign presence. As compared to R&D intensity, the significance of the impact of horizontal FDI on the likelihood of investing in R&D of the firms producing near to the frontier is established at only 10% level, which implies near to the frontier incumbents' tendency to invest in R&D, is moderately impacted upon by the foreign presence. The interaction term on backward FDI come up with statistically significant positive coefficients in both the equations implying that supplying firms situated near to the industry frontier improve their R&D intensity as a result of linkages with the foreign clients. The estimates also signify that such linkages also positively affect the tendency of suppliers to invest in R&D. These results suggest that the suppliers as well as rivals of MNCs having higher technical efficiency or residing near to the respective industry frontiers undertake more R&D than ones located at the lower end of the frontier. Like forward FDI spillovers, the interaction term between forward FDI variable and the proximity variable appears insignificant across all model specifications indicating lack of forward spillovers from FDI to downstream firms irrespective of their location vis-a-vis to the best practice frontier.

The exercise is repeated for the subsample of domestic and foreign owned firms in Tables 5.25 and 5.26 so as to see if the ownership has any effect in the realisation of spillovers by incumbents. In case of domestic firms, the proximity variable on interaction with horizontal and backward spillover variables show significance at 5% level in the outcome equation, however, the significance of estimates on interaction terms somewhat decreases in the selection equation. From the findings what emerges is that R&D intensity of domestic firms operating in proximity to the best practice frontier is positively affected by the presence of MNCs regardless of whether the domestic firms act as suppliers or rivals to the downstream MNC affiliates. For the foreign owned firms, the estimates on the interaction term of horizontal FDI and proximity variable *(l_1hfd*l_1prxm)* in the R&D intensity equation is statistically robust with positive sign confirming the existence of strong within-industry spillovers on the R&D intensity of firms producing near the best practice frontier and at the same time acting as competitors to the MNC affiliates. As opposed to the interaction term of horizontal FDI and proximity variable *(l_1hfd*l_1prxm)*, the statistical significance of the estimates on the interaction term of backward FDI and proximity variable is relatively *(l_1bfd*l_1prxm)* smaller implying a lesser impact on the R&D intensity of near frontier foreign owned firms operating in supplying sectors. The main difference in the empirical results on domestic firms and foreign owned firms is that former seems to benefit more from backward FDI while as latter derive maximum gain from the horizontal FDI. It further implies that intra-industry effects are more relevant for the innovation of firms owned by foreigners as opposed to inter-industry effects that are significant for the innovation of domestic firms.

Table 5.24: Heckman's Two-Step Estimation Results for the Full Sample

Independent Variables	Linearity in size and age		Non-linearity in size and age	
	Selection equation (R&D dummy)	Outcome equation (R&D intensity)	Selection equation (R&D dummy)	Outcome equation (R&D intensity)
$l1hfd_{jt}$	0.138** (0.065)	0.093** (0.043)	0.141** (0.063)	0.097** (0.046)
$l1bfd_{jt}$	0.181*** (0.074)	0.125** (0.059)	0.187*** (0.079)	0.129** (0.063)
$l1ffd_{jt}$	0.061 (0.058)	0.093 (0.091)	0.063 (0.058)	0.099 (0.094)
$l1prxm_{it}$	-0.122 (0.083)	-0.116* (0.076)	-0.129 (0.089)	-0.137 (0.092)
$l1hfd_{jt}*l1prxm_{it}$	0.166* (0.071)	0.148** (0.058)	0.174* (0.089)	0.151** (0.063)
$l1bfd_{jt}*l1prxm_{it}$	0.091** (0.039)	0.073** (0.028)	0.094* (0.047)	0.081** (0.034)
$l1ffd_{jt}*l1prxm_{it}$	0.114 (0.086)	0.103 (0.073)	0.124 (0.098)	0.109 (0.079)
ep_{it}	0.013* (0.008)	0.812*** (0.019)	0.017* (0.011)	0.893*** (0.027)
$l1im_{it}$	0.021 (0.019)	0.159* (0.089)	0.028 (0.025)	0.161* (0.093)
lns_{it}	-0.012 (0.019)	-0.091 (0.095)	-0.037* (0.021)	-0.118* (0.097)
lns^2_{it}			0.109** (0.057)	1.056** (0.048)
$lnag_{it}$	-0.053 (0.069)	-0.172 (0.128)	-0.068 (0.072)	-0.188 (0.139)
$lnag^2_{it}$			0.298*** (0.081)	0.562** (0.277)
$lnprf_{it}$	0.081* (0.053)	0.137*** (0.031)	0.093* (0.058)	0.153*** (0.039)
lvg_{it}	0.011* (0.006)	0.035 (0.029)	0.019* (0.010)	0.047 (0.041)
lnk_{it}	0.063 (0.048)	0.169** (0.072)	0.071 (0.053)	0.196** (0.089)
hhi	-0.483* (0.268)	-0.943** (0.378)	-0.519* (0.293)	-0.979** (0.383)
rdl	0.261*** (0.092)	0.319*** (0.019)	0.278*** (0.099)	0.338*** (0.036)
dlc	0.019** (0.009)		0.023** (0.009)	
Mills lambda	-2.472*** (0.489)		-2.618*** (0.513)	
obs.	10542	7280	10542	7280

Standard errors are in parentheses., **, *** denote significance at 10%, 5% and 1% levels respectively. Firm and time dummies included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

Table 5.25: Heckman's two-step estimation results for the subsample of domestic firms

Independent Variables	Linearity in size and age				Non-linearity in size and age			
	Selection equation (R&D dummy)		Outcome equation (R&D intensity)		Selection equation (R&D dummy)		Outcome equation (R&D intensity)	
l_1hfd_{jt}	0.144**	(0.071)	0.093**	(0.043)	0.149**	(0.067)	0.097**	(0.046)
l_1bfd_{jt}	0.196**	(0.078)	0.131**	(0.063)	0.192**	(0.073)	0.136**	(0.067)
l_1ffd_{jt}	0.068	(0.051)	0.102	(0.093)	0.072	(0.055)	0.112	(0.097)
l_1prxm_{it}	-0.127	(0.089)	-0.121*	(0.081)	-0.133	(0.092)	-0.139	(0.099)
$l_1hfd_{jt}*l_1prxm_{it}$	0.178*	(0.107)	0.154**	(0.067)	0.195*	(0.116)	0.166**	(0.078)
$l_1bfd_{jt}*l_1prxm_{it}$	0.113*	(0.068)	0.083***	(0.031)	0.119*	(0.073)	0.089***	(0.033)
$l_1bfd_{jt}*l_1prxm_{it}$	0.120	(0.097)	0.119	(0.093)	0.137	(0.102)	0.123	(0.098)
ep_{it}	0.017*	(0.010)	0.828***	(0.028)	0.022	(0.014)	0.913***	(0.039)
l_1im_{it}	0.026	(0.021)	0.165*	(0.092)	0.031	(0.027)	0.178*	(0.097)
lns_{it}	-0.028	(0.023)	-0.103	(0.099)	-0.033*	(0.018)	-0.121*	(0.101)
lns^2_{it}					0.123**	(0.061)	1.110**	(0.042)
$lnag_{it}$	-0.059	(0.072)	-0.176	(0.132)	-0.074	(0.078)	-0.192	(0.145)
$lnag^2_{it}$					0.315***	(0.108)	0.578**	(0.289)
$lnprf_{it}$	0.096*	(0.063)	0.156***	(0.046)	0.107	(0.079)	0.172***	(0.052)
lvg_{it}	0.013	(0.009)	0.039	(0.033)	0.022*	(0.012)	0.055	(0.047)
lnk_{it}	0.065	(0.053)	0.171**	(0.078)	0.077	(0.056)	0.203**	(0.095)
hhi_{it}	-0.488*	(0.274)	-0.947**	(0.386)	-0.524*	(0.299)	-0.981**	(0.389)
rdl	0.267***	(0.095)	0.323***	(0.024)	0.281***	(0.102)	0.344***	(0.039)
dlc	0.025**	(0.012)			0.027**	(0.014)		
Mills lambda	-2.369***	(0.465)			-2.537***	(0.501)		
obs.	8470		5642		8470		5642	

Standard errors are in parentheses., **, *** denote significance at 10%, 5% and 1% levels respectively. Industry and time dummies included. The prefix* l_1 *associated with some of the variables symbolizes their one period lag.*

Table 5.26: Heckman's two-step estimation results for the subsample of foreign firms

Independent Variables	Linearity in size and age		Non-linearity in size and age	
	Selection equation (R&D dummy)	Outcome equation (R&D intensity)	Selection equation (R&D dummy)	Outcome equation (R&D intensity)
l_1hfd_{jt}	0.126^{**} (0.057)	0.105^{**} (0.039)	0.129^{*} (0.069)	0.117^{***} (0.043)
l_1bfd_{jt}	0.158^{**} (0.078)	0.096^{**} (0.038)	0.169^{**} (0.073)	0.106^{**} (0.048)
l_1bfd_{jt}	0.034 (0.047)	0.057 (0.068)	0.042 (0.053)	0.071 (0.079)
l_1prxm_{it}	-0.079 (0.088)	-0.096 (0.082)	-0.094^{**} (0.085)	-0.105 (0.089)
$l_1hfd_{jt}*l_1prxm_{it}$	0.149^{**} (0.068)	0.126^{***} (0.032)	0.156 (0.071)	0.136^{***} (0.043)
$l_1bfd_{jt}*l_1prxm_{it}$	0.051^{*} (0.029)	0.042^{**} (0.018)	0.058^{*} (0.031)	0.053^{**} (0.023)
$l_1ffd_{jt}*l_1prxm_{it}$	0.064 (0.046)	0.058^{*} (0.035)	0.078 (0.054)	0.076^{*} (0.048)
ep_{it}	0.010^{*} (0.006)	0.723^{***} (0.017)	0.012^{*} (0.007)	0.774^{***} (0.023)
l_1im_{it}	0.014 (0.011)	0.127^{*} (0.073)	0.019 (0.021)	0.143^{*} (0.081)
lns_{it}	-0.016 (0.023)	-0.099 (0.088)	-0.043^{*} (0.028)	-0.124^{*} (0.082)
lns^2_{it}			0.127^{**} (0.061)	1.116^{**} (0.060)
$lnag_{it}$	-0.061 (0.075)	-0.184 (0.139)	-0.073 (0.079)	-0.189 (0.145)
$lnag^2_{it}$			0.275^{***} (0.092)	0.542^{**} (0.268)
$lnprf_{it}$	0.115^{**} (0.055)	0.152^{***} (0.059)	0.104^{**} (0.048)	0.178^{***} (0.067)
lvg_{it}	0.017^{*} (0.010)	0.039 (0.032)	0.026^{*} (0.016)	0.054 (0.044)
lnk_{it}	0.046 (0.037)	0.143^{**} (0.058)	0.054 (0.031)	0.169^{**} (0.062)
hhi_{it}	-0.297^{*} (0.191)	-0.387^{**} (0.178)	-0.328^{*} (0.193)	-0.396^{**} (0.185)
rdl	0.228^{***} (0.079)	0.274^{***} (0.036)	0.235^{***} (0.107)	0.282^{***} (0.047)
dlc	0.012^{**} (0.005)		0.018^{**} (0.010)	
Mills lambda	-2.265^{***}(0.419)		-2.47^{***} (0.492)	
obs.	2072	1638	2072	1638

Standard errors are in parentheses., **, *** denote significance at 10%, 5% and 1% levels respectively. Industry and time dummies included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

The key results from the estimations on the R&D are recapitulated below:

1. Incumbents having higher technical efficiency or residing near to the best practice frontier undertake more R&D than ones located at the lower end of the frontier. The result holds regardless of the status of incumbent, i.e., whether acting as supplier or rival to the MNC affiliates.

2. R&D intensity of domestic firms operating in proximity to the best practice frontier is positively affected by the presence of MNCs regardless of whether the former act as suppliers or rivals to the downstream MNC affiliates.

3. R&D intensity of foreign owned firms producing near to the frontier is positively affected by the presence of MNCs, however the impact is more pronounced when the former compete with the latter in the same sector of activity.

4. Unlike domestic firms, the R&D intensity of foreign owned firms operating downstream, albeit marginally, is positively influenced by spillovers from upstream sectors with foreign presence.

5.4.2. FDI Spillovers and Innovation Output (Patent Grants)

In Table 5.27 we present estimates obtained from ZIP and ZINB models. The empirical estimates of patent grants support the hypothesis that FDI stimulates the innovative performance of incumbents specifically when they are located near the best practice frontier. The impact is pronounced for incumbents operating in upstream sectors as well as for incumbents that operate in the same three-digit sector in which entry occurs. However, the impact seems to be insignificant for the firms operating in downstream sectors.

As the estimates show, the relationship between patent grants and horizontal spillover variable (l_1hfd) is positively significant indicating that the presence of FDI in the industry is associated with an increase in innovativeness. It reflects that incumbent firms acting as rivals to foreign affiliates possibly benefit either from the strong competitive pressure or due to the knowledge flows from FDI companies that result from the mobility of people and related spin-offs, demonstration effect and imitation. The estimates concerning vertical spillovers (impact from the foreign presence in upstream or downstream industries) reveal the positively significant impact on firms operating upstream and acting as suppliers to MNCs. However, firms operating downstream as clients to MNCs appear not to receive any innovation spillovers from FDI. Significant estimates on backward spillover variable (l_1bfd) imply that increased demand for intermediate inputs from MNCs enable local suppliers to operate at a more efficient scale. The positive coefficients on backward spillover variable (l_1bfd) also signify that MNCs encourage production of higher quality inputs by providing local suppliers with technical assistance, worker training, managerial and organizational support. Although foreign companies through backward linkages can improve the quality of inputs produced upstream as well as reduce the prices of such inputs, these spillovers, however, do not seem to pass through forward linkages to the firms operating downstream.

To analyse the role of proximity to frontier in FDI induced spillovers on incumbent innovation we allow for the interaction of spillover variables with proximity to the frontier. Two of the interaction terms turn out to be positively correlated with the incumbent patenting. The results suggest that spillovers on innovation materialize in case incumbents lie close to technology frontier and these incumbents happen to be ones with a higher technical efficiency. It indicates that technical efficiency of incumbents is a prerequisite for assimilating the technical know-how, marketing expertise and other benefits that accrue to the host country firms, as a result, of advanced foreign entry.

We also present the empirical results for the fragmented sample. Table 5.28 and 5.29 report the empirical estimates for domestic firms and foreign firms respectively. Estimates for domestic and foreign firms are almost similar, however, with some subtle differences. Horizontal spillover variable shows a relatively strong significance in the case of foreign firms than it does for domestic firms. It is suggestive of the fact that competition effect is more beneficial for foreign firms than domestic firms, for latter may be crowded out due to the escalation of competition resulting from the entry of advanced firms into the host market. Since existing foreign firms due to the high technical efficiency and absorptive capacity are relatively in a better position to face the competition than the domestic firms.

The main results are summarized as follows:

1. The results suggest that spillovers on innovation output materialize in case incumbents reside close to technology frontier, which implies that technically efficient firms having contacts with the MNC affiliates receive more patent grants as opposed to ones with lower technical efficiency.

2. The patenting activity of firms operating close to the frontier within the industry is positively affected from foreign presence but the impact is relatively strong for firms with foreign equity than ones without foreign equity.

3. In supplying sectors, incumbents receive innovation spillovers regardless of their ownership; however, ownership comes into play in downstream sector where firms with foreign ownership appear to receive spillovers than ones which are domestic.

Table 5.27: ZIP and ZINP estimates of patent counts for the full sample

Dep. Var. Patent grants	(1) ZIP	(2) ZIP	(3) ZIP	(4) ZINB	(5) ZINB	(6) ZINB
l_1hfd_{jt}	1.309** (0.728)	1.417** (0.704)	1.229** (0.752)	1.198***(0.350)	1.515***(0.521)	1.388***(0.451)
l_1bfd_{jt}	0.099***(0.019)	0.066***(0.014)	0.054***(0.012)	0.039** (0.013)	0.044** (0.017)	0.037** (0.019)
l_1ffd_{jt}	0.133* (0.118)	0.139 (0.126)	0.157 (0.123)	0.154 (0.132)	0.172 (0.161)	0.168 (0.157)
l_1prxm_{it}	-0.098**(0.055)	-0.107* (0.078)	-0.109* (0.086)	-0.044* (0.027)	-0.059* (0.035)	-0.051* (0.043)
$l_1hfd_{jt}*l_1prxm_{it}$		0.194***(0.069)	0.142***(0.074)		0.166***(0.099)	0.172***(0.092)
$l_1bfd_{jt}*l_1prxm_{it}$		0.127** (0.068)	0.133** (0.079)		0.153** (0.086)	0.139** (0.073)
$l_1ffd_{jt}*l_1prxm_{it}$		0.198 (0.191)	0.176 (0.163)		0.212 (0.209)	0.201 (0.198)
l_1rd_{it}			0.459***(0.166)			0.475***(0.147)
lns_{it}			0.199* (0.144)			0.174 (0.153)
ep_{it}			0.006* (0.003)			0.009** (0.003)
l_1im_{it}			0.019 (0.016)			0.012 (0.013)
$lnag_{it}$			0.064** (0.043)			0.086** (0.049)
dpp			-0.086 (0.081)			-0.092 (0.087)
Instruments	*SB,HI,TC*	*SB,HI,TC*	*SB,HI,TC*	*SB,HI,TC*	*SB,HI,TC*	*SB,HI,TC*
log pseudo-likelihood	-2365.55	-2338.99	-2211.95	-1163.17	-1160.01	-1141.82
wald chi^2	466.48	582.18	730.53	534.71	583.58	876.34
prob>chi^2	0.00	0.00	0.00	0.00	0.00	0.00
obs.	7280	7280	7280	7280	7280	7280

*Standard errors are in parentheses. ***, **,* denote significance at 1, 5and 10 per cent levels respectively. The log- likelihood values for the ZIP and ZINB models include the log -likelihood of the probit model. Firm fixed effects and time effects included. The prefix* l_1 *associated with some of the variables symbolizes their one period lag.*

Table 5.28: ZIP and ZINB estimates of patent counts for the subsample of domestic firms

Dep. Var.	(1)		(2)		(3)		(4)		(5)		(6)	
Patent grants	ZIP		ZIP		ZIP		ZINB		ZINB		ZINB	
l_1hfd_{jt}	0.997^{**}	(0.478)	1.123^{**}	(0.789)	1.876^{**}	(0.849)	0.819^{**}	(0.467)	1.643^{**}	(0.819)	1.449^{**}	(0.599)
l_1bfd_{jt}	0.588^{***}	(0.065)	0.547^{***}	(0.114)	0.869^{***}	(0.012)	0.584^{***}	(0.068)	0.522^{**}	(0.121)	0.854	(0.171)
l_1ffd_{jt}	0.659	(0.912)	0.773	(0.786)	1.447^{*}	(0.656)	0.673	(0.901)	0.619	(0.961)	1.089	(0.982)
l_1prxm_{it}	-0.074^{**}	(0.046)	-0.078^{*}	(0.063)	-0.093^{*}	(0.071)	-0.047^{**}	(0.028)	-0.055^{**}	(0.029)	-0.071^{*}	(0.059)
$l_1hfd_{jt}*l_1prxm_{it}$			0.091^{**}	(0.034)	0.097^{**}	(0.049)			0.126^{*}	(0.079)	0.272^{*}	(0.146)
$l_1bfd_{jt}*l_1prxm_{it}$			0.087^{**}	(0.044)	0.048^{**}	(0.117)			0.138^{**}	(0.077)	0.089^{**}	(0.023)
$l_1ffd_{jt}*l_1prxm_{it}$			0.510	(0.396)	0.286	(0.206)			0.201	(0.507)	0.156	(0.380)
l_1rd_{it}					0.577^{***}	(0.129)					0.675^{***}	(0.247)
lns_{it}					0.128	(0.127)					0.174	(0.183)
ep_{it}					0.009^{**}	(0.002)					0.013^{**}	(0.006)
l_1im_{it}					0.029	(0.026)					0.012	(0.013)
$lnag_{it}$					0.074^{*}	(0.069)					0.086^{*}	(0.079)
dpp					-0.061^{*}	(0.051)					-0.073^{*}	(0.064)
instruments	*SB,HI,TC*		*SB,HI,TC*		*SB,HI,IC*		*SB,HI,TC*		*SB,HI,TC*		*SB,HI,TC*	
log pseudo likelihood	-2252.61		-2239.20		-2191.72		-1071.32		-1065.41		-1048.02	
wald chi^2	458.14		572.51		709.28		511.63		569.21		847.07	
prob$>chi^2$	0.00		0.00		0.00		0.00		0.00		0.00	
obs.	5642		5642		5642		5642		5642		5642	

*Standard errors are in parentheses. ***, **,* denote significance at 1, 5and 10 percent levels respectively. The log- likelihood values for the ZIP and ZINB models include the log-likelihood of the probit model. Firm fixed effects and time effects included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

Table 5.29: ZIP and ZINB estimates of patent counts for the subsample of foreign firms

Dep. var. patent grants	(1) ZIP	(2) ZIP	(3) ZIP	(4) ZINB	(5) ZINB	(6) ZINB
l_1hfd_{jt}	0.532**(0.238)	0.563** (0.249)	0.576** (0.258)	0.493** (0.219)	0.504** (0.223)	0.519** (0.227)
l_1bfd_{jt}	0.398** (0.175)	0.407** (0.179)	0.421** (0.182)	0.373** (0.168)	0.382** (0.171)	0.394** (0.179)
l_1ffd_{jt}	0.153 (0.108)	0.167 (0.115)	0.179 (0.118)	0.113 (0.078)	0.119 (0.083)	0.138 (0.095)
l_1prxm_{it}	-0.034*(0.018)	-0.041 (0.026)	-0.047 (0.029)	-0.031* (0.016)	-0.037* (0.019)	-0.044* (0.023)
l_1hfd_{jt}*l_1prxm_{it}		0.129** (0.052)	0.137** (0.059)		0.106***(0.031)	0.117***(0.033)
l_1bfd_{jt}*l_1prxm_{it}		0.157** (0.062)	0.161** (0.067)		0.118** (0.049)	0.129** (0.053)
l_1ffd_{jt}*l_1prxm_{it}		0.061(0.038)	0.068* (0.039)		0.043 (0.028)	0.058* (0.031)
l_1rd_{it}			0.534***(0.098)			0.492***(0.063)
lns_{it}			0.114 (0.119)			0.102 (0.123)
ep_{it}			0.023** (0.009)			0.017** (0.007)
l_1im_{it}			0.019 (0.013)			0.011 (0.009)
$lnag_{it}$			0.041* (0.019)			0.036* (0.017)
dpp			-0.092 (0.078)			-0.081 (0.073)
instruments	*SB,HI,TC*	*SB,HI,TC*	*SB,HI,TC*	*SB,HI,TC*	*SB,HI,TC*	*SB,HI,TC*
log pseudo-likelihood	-2151.68	-2104.62	-2068.73	-1022.34	-1012.92	-1009.83
wald chi^2	389.82	370.09	353.92	298.37	277.59	249.91
prob>chi^2	0.00	0.00	0.00	0.00	0.00	0.00
obs.	1638	1638	1638	1638	1638	1638

*Standard errors are in parentheses. ***, **,*denote significance levels at 1, 5and 10 percent levels respectively. The log- likelihood values for the ZIP and ZINB models include the log -likelihood of the probit model. Firm fixed effects and time effects included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

5.4.3. Empirical Results on *tfp*

Next in Table 5.30, we describe the effect of FDI entry on incumbent *tfp* growth. Columns 1, 2 and 3 report estimates of the variables of interest obtained from standard FE model.[20] Columns 4, 5 and 6 display empirical estimates obtained from the IV-technique. The empirical results across all specifications reflect a positive and significant correlation of FDI with the subsequent *tfp* growth in incumbents. The estimated coefficients for both the l_1hfd and l_1bfd appear significant across all specifications. The IV estimates on l_1hfd shows a marginal decrease in magnitude (Columns 4, 5 and 6 in Table 5.30) but the significance level remains same from FE specification to IV specification. The significance level for l_1bfd remains constant at 1% throughout although with a slight drop in the magnitude of estimates. This suggests that FDI entry not only spurs the productivity growth in the firms operating in upstream sectors, but it also improves the productivity of the firms active in the same three-digit sector as MNC. The statistical significance of l_1hfd and l_1bfd suggests the existence of intra as well as inter-industry productivity spillovers in Indian manufacturing sector. In contrast to l_1hfd and l_1bfd, coefficients on l_1ffd appear significant at 10% level in FE specification, but the significance level altogether disappears in IV specification, suggesting a lack of productivity spillovers on firms operating in downstream sectors.

To show that whether firms residing close to the frontier receive significant FDI generated productivity spillovers than the firms residing further down the frontier, we allow for the

[20] We have tested for random effect and fixed effect specifications. The value of the Hausman test static is 169.891 (p=0.000) reflecting that FE model is preferable.

interaction of FDI variables with that of proximity to frontier variable. The estimates across all specifications show a significant positive correlation between two of the spillover variables l_1hfd and l_1bfd with productivity growth of incumbents located near to the frontier. Incumbents located close to it show a productivity improvement of 26% as the foreign presence in the sector increases by one standard deviation. The productivity improvement arising from backward linkages is around 31% for suppliers producing near the frontier. The results are interesting in the sense that efficient firms whether acting as suppliers to MNCs or rivals to them are better able to benefit from the FDI spillovers as compared to inefficient firms. In case of forward linkages no such improvements in productivity is observed for firms producing near or away from the frontier. The findings support the view that FDI effects on productivity of incumbents are heterogeneous, with firms near the frontier benefiting more relative to ones away from the frontier. The evidence is not different from the findings of Aghion et al., (2009) based on the UK data. Our results also align with the views of Glass & Saggi (1998) that for local firms to benefit from FDI, they need to have achieved a certain threshold level of absorptive capacity.

We summarize the main results from *tfp* estimations as under:

1. As compare to innovation the spillovers on the productivity are strong suggesting that firm level productivity records more changes due to change in foreign activity than is recorded by the R&D intensity and patent counts.

2. Irrespective of the ownership, the improvement in *tfp* of firms along the supply chain is significantly determined by the presence of MNC affiliates in the downstream sectors, provided the firms are located close to the best practice frontier.

3. MNC activities within an industry lead to significant improvements in *tfp* of the rival firms regardless of the ownership, which implies that both the groups of firms, i.e. foreign owned as well domestic firms competing with MNC affiliates in the same field of activity receive significant productivity spillovers from subsidiaries of MNC.

Table 5.30: Change in *tfp*: FE and FE-IV estimates for the full sample

Dep. Var. Δtfp_{it}	(1) FE		(2) FE		(3) FE		(4) FE-IV		(5) FE-IV		(6) FE-IV	
l_1hfd_{jt}	2.970***	(1.254)	3.015***	(1.581)	3.678***	(1.621)	2.325***	(0.433)	2.550***	(0.666)	2.488***	(0.700)
l_1bfd_{jt}	1.373***	(0.542)	1.526***	(0.554)	1.602***	(0.713)	1.117***	(0.128)	1.173***	(0.173)	1.224***	(0.208)
l_1ffd_{jt}	0.398	(0.434)	0.705	(0.746)	0.767	(0.783)	0.279	(0.520)	0.272	(0.527)	0.294	(0.554)
l_1prxm_{it}	-0.081**	(0.044)	-0.125*	(0.068)	-0.129*	(0.070)	-0.064*	(0.040)	-0.052	(0.046)	-0.094*	(0.051)
$l_1hfd_{jt}*l_1prxm_{it}$			0.771***	(0.275)	0.748***	(0.277)			0.264***	(0.104)	0.266***	(0.109)
$l_1bfd_{jt}*l_1prxm_{it}$			0.334***	(0.116)	0.355***	(0.119)			0.592***	(0.252)	0.602***	(0.257)
$l_1ffd_{jt}*l_1prxm_{it}$			0.045	(0.063)	0.053	(0.050)			0.068	(0.059)	0.071	(0.058)
l_1pg_{it}					0.204***	(0.097)					0.109***	(0.049)
lns_{it}					0.121	(0.129)					0.174	(0.153)
ep_{it}					0.007**	(0.001)					0.009**	(0.003)
l_1im_{it}					0.021	(0.014)					0.025	(0.017)
$lnag_{it}$					0.091	(0.079)					0.086**	(0.049)
dpp					-0.011	(0.013)					-0.012	(0.037)
Instruments							*SB,HI,TC*		*SB,HI,TC*		*SB,HI,TC*	
R^2	0.085		0.079		0.091		0.020		0.049		0.011	
F-statistic/ wald-chi^2	9.78		8.86		6.24		127.39		163.62		167.93	
prob>F/ prob>chi^2	0.00		0.00		0.00		0.00		0.00		0.00	
obs.	7280		7280		7280		7280		7280		7280	

*Standard errors are in parentheses. ***, **,* denote significance at 1, 5and 10 per cent levels respectively. Firm fixed effects and time effects included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

Table 5.31: Change in *tfp*: FE and FE-IV estimates for the subsample of domestic firms

Dep. Var. Δtfp_{it}	(1) FE		(2) FE		(3) FE		(4) FE-IV		(5) FE-IV		(6) FE-IV	
l_1hfd_{jt}	2.371^{**}	(0.979)	2.415^{**}	(0.982)	2.489^{**}	(0.989)	1.987^{**}	(0.783)	2.108^{**}	(0.791)	2.119^{**}	(0.833)
l_1bfd_{jt}	1.174^{***}	(0.361)	1.309^{***}	(0.374)	1.321^{***}	(0.389)	0.927^{***}	(0.319)	1.103^{***}	(0.327)	1.116^{***}	(0.338)
l_1ffd_{jt}	0.286	(0.320)	0.308	(0.349)	0.317	(0.351)	0.202	(0.311)	0.212	(0.337)	0.223	(0.343)
l_1prxm_{it}	-0.072^{*}	(0.041)	-0.095^{*}	(0.049)	-0.107^{*}	(0.058)	-0.036	(0.028)	-0.045	(0.031)	-0.059^{*}	(0.036)
$l_1hfd_{jt}*l_1prxm_{it}$			0.674^{***}	(0.215)	0.682^{***}	(0.235)			0.218^{**}	(0.094)	0.239^{**}	(0.103)
$l_1bfd_{jt}*l_1prxm_{it}$			0.282^{***}	(0.076)	0.295^{***}	(0.078)			0.302^{***}	(0.092)	0.318^{***}	(0.095)
$l_1ffd_{jt}*l_1prxm_{it}$			0.032	(0.060)	0.045	(0.052)			0.048	(0.055)	0.057	(0.059)
l_1pg_{it}					0.176^{***}	(0.039)					0.099^{***}	(0.021)
lns_{it}					0.113	(0.109)					0.139	(0.133)
ep_{it}					0.011^{**}	(0.005)					0.017^{**}	(0.008)
l_1im_{it}					0.023	(0.018)					0.020	(0.015)
$lnag_{it}$					0.068^{*}	(0.039)					0.074^{*}	(0.041)
dpp					-0.019	(0.011)					-0.027	(0.017)
Instruments							*SB,HI,TC*		*SB,HI,TC*		*SB,HI,TC*	
R^2	0.081		0.076		0.089		0.021		0.046		0.015	
F-statistic/waldchi^2	9.71		8.78		6.12		124.73		151.13		169.63	
prob>F/prob>chi^2	0.00		0.00		0.00		0.00		0.00		0.00	
obs.	5642		5642		5642		5642		5642		5642	

*Standard errors are in parentheses. ***, **,* denote significance at 1, 5and 10 per cent levels respectively. Firm fixed effects and time effects included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

Table 5.32: Change in *tfp*: FE and FE-IV estimates for the subsample of foreign firms

Dep. Var. Δtfp_{it}	(1) FE	(2) FE	(3) FE	(4) FE-IV	(5) FE-IV	(6) FE-IV
l_1hfd_{jt}	1.981***(0.739)	2.115*** (0.801)	2.128*** (0.812)	1.902***(0.733)	2.119*** (0.748)	2.157*** (0.769)
l_1bfd_{jt}	0.972** (0.414)	1.103** (0.459)	1.126** (0.482)	0.897** (0.396)	0.910** (0.423)	1.109** (0.438)
l_1ffd_{jt}	0.256 (0.204)	0.275 (0.216)	0.317 (0.221)	0.229 (0.220)	0.234 (0.223)	0.239 (0.231)
l_1prxm_{it}	-0.101* (0.061)	-0.112 (0.073)	-0.120 (0.079)	-0.109* (0.063)	-0.121 (0.085)	-0.148* (0.087)
$l_1hfd_{jt}*l_1prxm_{it}$		0.235*** (0.083)	0.249*** (0.087)		0.211*** (0.064)	0.216*** (0.071)
$l_1bfd_{jt}*l_1prxm_{it}$		0.138*** (0.041)	0.146*** (0.052)		0.102*** (0.039)	0.112*** (0.047)
$l_1ffd_{jt}*l_1prxm_{it}$		0.019 (0.023)	0.028 (0.031)		0.016 (0.015)	0.017 (0.015)
l_1pg_{it}			0.298*** (0.017)			0.279*** (0.015)
lns_{it}			0.381 (0.362)			0.357 (0.349)
ep_{it}			0.018** (0.001)			0.011** (0.003)
l_1im_{it}			0.032 (0.024)			0.028 (0.023)
$lnag_{it}$			0.069 (0.053)			0.056* (0.041)
dpp			-0.063 (0.053)			-0.051 (0.046)
Instruments				*SB,HI,TC*	*SB,HI,TC*	*SB,HI,TC*
R^2	0.089	0.081	0.093	0.022	0.051	0.019
F-statistic/wald-chi^2	8.58	7.22	6.13	121.29	138.73	147.86
prob>F/prob>chi^2	0.00	0.00	0.00	0.00	0.00	0.00
obs.	1638	1638	1638	1638	1638	1638

*Standard errors are in parentheses. ***, **,*denote significance at 1, 5and 10 per cent levels respectively. Firm fixed effects and time effects included. The prefix l_1 associated with some of the variables symbolizes their one period lag.*

Chapter 6

Conclusion

6.1. Summary

This chapter summarizes the major findings, provides some policy recommendations and gives a short outlook for the further research. The world economy experienced a dramatic increase in FDI and MNC activities over the last decade. The mounting prominence of FDI has led several researchers to study the question whether local firms actually derive any benefit from such inflows. In other words, do spillovers from FDI spur the innovative and productivity performance of local firms and do such impacts vary with the domestic and foreign firms, proximity to the best practice frontier. These questions are relevant for exploration as over the years FDI flows have increased across the globe.

The basis for opening up the borders for foreign investors and giving them several concessions probably rests on the belief that such investment apart from augmenting the capital accumulation has certain indirect effects in the form of technological development, knowledge dissipation and many other externalities for host country firms. However, empirical evidence on the effects of FDI on host country firms is not unanimous. It has been argued that the dissimilar methodological approaches and different country contexts used in previous research could explain the difference in the findings. Nonetheless, even studies using firm-level panel datasets (seen as the most appropriate type of data to use in order to investigate the causal effect of inward FDI on local firms' productivity) diverge. This justifies the need for this thesis. The thesis contributes to the existing spillover literature on following: (1) providing empirical evidence not only on productivity spillovers but innovation spillovers as well, (2) investigating the existence of innovation spillovers in context of India, which has never been the focus of any empirical work at the time of the present study. Further, the study differentiates between two major types of

FDI: horizontal and vertical FDI. Horizontal FDI takes place, when the same production process is duplicated in a foreign country while vertical FDI occurs when a MNE separates its production chain geographically. Based on this differentiation, the study investigates the existence of spillovers from horizontal and vertical FDI flows on R&D, patenting and *tfp* of incumbents in Indian manufacturing. Spillover effects are further analysed in light of the incumbents' proximity to or distance from the best practice frontier. In particular, it provides the first empirical evidence on innovation spillovers arising from horizontal and vertical FDI in Indian manufacturing sector. Interestingly, India appears to possess favourable characteristics that are considered to increase the likelihood of spillovers from MNCs. India's vast market, rising income levels, growing pool of well-educated labour force, and improving investor climate are the characteristics that increase the chances for the local firms to benefit from superior knowledge brought in by MNCs.

We employ a large firm-level dataset comprising 520 firms belonging to 17-three digit manufacturing industries for the period 2000-2013. By using DEA technique, we were able to obtain *tfp* estimates and relate them to several spillover measures. For the vertical spillovers, we have used time-varying input-output tables, which allowed us to account for changes that possibly occur in linkages between different sectors of the economy. This is a significant improvement compared to previous studies. We distinguished between three measures of spillovers: horizontal, backward and forward measures. Further, conditioning the spillover effects by incumbent's proximity to the industry's best practice frontier revealed more insights into the FDI effects on incumbent innovation and productivity.

While analysing spillover effects on innovation and productivity, we raised many econometric concerns that have the tendency to render the parameter estimates biased. These problems emanate from various sources ranging from the nature of the dataset used to measurement errors committed while computing certain variables, omission of some important variables from the econometric model and simultaneity. Since, these issues pose serious doubts on the precision and consistency of coefficient estimates, and therefore we adopted specific remedial measures to address them. For instance, endogeneity concerns were taken care of by utilizing lagged values of endogenous variables. We further employ instrumental variable technique to address endogeneity issue. For appropriate instruments, we use data on business ratings, labour hiring costs and import costs obtained from various doing business reports (DBRs) of World Bank. Similarly, the problems of selectivity and heteroscedasticity have been addressed by using Heckman two-step model and White's test. The preponderance of zeros in the patent count sample was yet another concern. The zero observations possibly result from two different data generating processes: firms that do not innovate at all and that attempt to innovate but fail to generate patents. The economic significance of the two types of zeros is quite different. Since dataset on patent grants have excessive zeros, unusually more than would have naturally been predicted by the standard count models, therefore we employed zero-inflated Poisson (ZIP) and zero-inflated negbin (ZINB) models as they are better able to handle a large number of zero observations, thereby increasing the precision of estimates.

6.2. Overview of the Findings and their Implications

Our results are in conformity with previous studies on spillovers, in the sense that horizontal and backward spillovers are strongly confirmed, while forward ones are insignificant. Additionally, these spillovers are sensitive to the incumbents' proximity to or distance from the frontier. Horizontal spillovers seem to be much stronger for the firms with foreign ownership while as backward spillovers appear relatively robust for firms which are domestic. Therefore, being in the supplier position brings in significant innovation and productivity gains, foreign companies being directly interested by the quality of supplied inputs, so they provide necessary assistance in the form of technology transfer, know-how and training to the workforce. As a result, firms operating in upstream sectors are able to improve the quality of intermediate inputs they produce and eventually increase the overall productivity. Moreover, the benefits associated with backward spillovers are more important for domestic suppliers than other foreign suppliers. For clients in downstream sectors instead, the situation appears less favourable.

A final conclusion confirms that the proximity to the best practice frontier plays a vital role in the assimilation of spillover effects by incumbent firms. It suggests that firms with higher technical efficiency are better able to benefit from the spillovers than ones with lower technical efficiencies.

From a policymaker's point of view, the objective would be to maximize the positive spillovers. Since the existence of intra-industry and inter-industry spillovers (particularly backward spillovers) calls for the policy framework that, on the one hand, will encourage the entry of new firms into the sectors with foreign presence and on the other will strengthen the linkages between foreign a affiliates and local suppliers. Moreover, there is a need to devise specific policies for laggard firms located at the lower end of the frontier so that they can enjoy the benefits of spillovers.

Our results support the policy framework of opening the domestic economy for more FDI. The 'Make in India' programme designed to transform the national economy into a global manufacturing hub seems to an appropriate step in this direction. The programme apart from being an aggressive push to revive an ailing manufacturing sector will attract more foreign investment into the domestic manufacturing via streamlining investment procedures and cutting out of any red-tapism.

Based on the empirical findings an important policy implication the study offers is that FDI policies instead of aiming at attracting huge aggregate inflows should rather be tailored to promote and facilitate FDI projects with more vertical linkages (particularly backward linkages). This will lubricate the interactive process between MNCs and domestic firms, thereby generating more inter-industry spillovers to domestic firms.

The results and conclusions in this study are statistically robust, but need to be qualified. In particular, the study only covers firms listed on the stock exchange. There is, thus scope to extend the analysis to take non-listed market firms into account. Further, the study does not take into account the country of origin of the investor, which can have a profound impact on the spillovers generated by foreign firms active in the host country.

Finally, as our results suggest that introduction of product patents marginally depress the patenting activity of local firms, but not that of foreign firms. This finding should be taken with caution as patent figures show a sudden jump after 2005 due the introduction of product patents in India. However the spurt in grants did not sustain for too long. The number of grants reverted back to their normal level post 2007.

This thesis differentiates from the rest of the empirical literature in that it is the first to investigate FDI related innovation spillovers in context of India and find that positive intra-industry and inter-industry spillovers arising from foreign presence. An added advantage of the study is that unlike the previous empirical studies conducted in India, it employs a series of input output tables to work out inter-industry linkages to take into account the time variant changes that may have occurred over the period .

It is recommended for further research to test the robustness of these finding using a database that comprises more firms. Furthermore, it would be interesting to test the hypothesis related to the "country of origin effect" and to explore the possibility of technology-sourcing FDI in India. These two suggestions would provide further insights to the authorities, as those could focus on attracting foreign investors from countries or in sectors benefiting the most to Indian firms.

6.3. Limitations of the study

The thesis has some limitations that are mainly driven by data constraints. Indeed, while the dataset is representative of the total population, it does not contain information on all firms operating in Indian manufacturing sector. As a second limitation, the present analysis does not consider the country of origin of the foreign investors. While we are aware that such characteristic do influence the spillovers, the dataset did not allow us to control for the country of origin of the foreign investors. Moreover, no distinction could be made between the entry mode chosen by the foreign investors (either merger and acquisition or Greenfield investment). Once again, this is so due to data constraints. This thesis also does not consider the impact of organizational innovation on productivity as the focus was on innovations that can be patented. Since organizational innovation has the potential to improve the productivity of firms, therefore, exploration of the same could be interesting area for future empirical investigation. Yet, another limitation of the thesis relates to the use of patent grants as a proxy for innovation. However, such measure has some weaknesses. Employing patents as a proxy in order to measure innovation in this research carries the potential risk of misrepresenting innovation activity. Griliches (1990 p. 1669) pointed out, “not all inventions are patentable, not all inventions are patented, and the inventions that are patented differ greatly in ‘quality’, in the magnitude of inventive output associated with them”. However, even though all these limitations may have the consequence of misrepresenting innovation activity, a large body of research has used patents as a proxy for firm innovation (see for example, Hagedoorn and Cloodt, 2003; Cheung and Lin, 2004). Nevertheless, we believe that the present work provides a comprehensive first study on innovation spillovers from FDI in the Indian context.

The study though has come up with an important policy implication, opens up some avenues for future research. The present study needs to be extended to explore the impact of different FDI entry modes (Greenfield FDI, M&As' and JVs') on R&D behavior of manufacturing incumbents.

References

Acemoglu, D., Aghion, P., and Zilibotti, F., (2006). Distance to the frontier, selection and economic growth. *Journal of European Economic Association*, 4(1), 37-74.

Agarwal, J.P. (1980). Determinants of foreign direct investment: A survey. *Weltwirtschaftliches Archiv*. 106(4), 739–773.

Aghion, P. and Howitt, P. (1992). A model of growth through creative destruction. *Econometrica*, 60(2), 323-51.

Aghion, P., and Griffith, R. (2005). *Competition and growth: Reconciling theory and evidence,* Cambridge, MA: MIT Press.

Aghion, P., Bloom, N., Blundell, R., Griffith, R., and Howitt, P. (2005). Competition and innovation: An inverted-U relationship," *Quarterly Journal of Economics*, 120(2), 701−728.

Aghion, P., Blundell, R., Griffith, R., and Prantl, S. (2009). The effects of entry on incumbent innovation and productivity. *The Review of Economics and Statistics*, 91(1), 20-23.

Aghion, P., Harris, C., Howitt, P., and Vickers J. (2001). Competition, imitation and growth with step-by-step innovation. *Review of Economic Studies*, 68(3), 467-492.

Ahluwalia, I. (1985). *Industrial growth in India - stagnation since the mid-sixties,* Oxford University Press, Delhi.

Aitken, B.J., and Harrison, E. (1999). Do domestic firms benefit from foreign direct investment: evidence from Venezuela? *American Economic Review* 89(3), 605-618.

Al-Azzawi, S. (2011). Innovation, productivity and foreign direct investment-induced R&D spillovers. *Journal of International Trade and Development*, 21(5), 615-653.

Alfaro, L. and Rodriguez-Clare, A. (2004). Multinationals and linkages: An empirical investigation. *Economica*, 4(2), 113-169.

Alfaro, L., Chanda, A., Sebnem, K.O., and Sayek, S. (2004). FDI and economic growth: the role of local financial markets. *Journal of International Economics*, 64(1), 89-112.

Alfaro, L., and Charlton, A. (2007) Growth and the quality of foreign direct investment: Is all FDI equal. HBS Finance Working Paper, 07-072. http://dx.doi.org/10.2139/ssrn.

Amit, R., and Schoemaker, P. J. H. (1993). Strategic assets and organizational rent and performance. *Journal of Managerial Strategic Issues*, 23(2), 164-189.

Anwar, S., and Sizhong, S. (2014). Entry of foreign firms and the R&D behaviour: a panel data study of domestic and foreign firms in china's manufacturing sector. *Economics of Innovation and New Technology*, 23 (8), 739-757.

Argote, L., McEvily, B., and Reagans, R. (2003). Managing knowledge in organizations: An integrative framework and review of emerging themes. *Management Science*, 49(4), 571-582.

Arrow, K. J. (1962). Economic welfare and the allocation of resources for innovation. In N. Richard (ed.), *the rate and direction of inventive activity: Economic and social factors*, 609-626. Princeton: Princeton University Press.

Azman-Saini, W.N.W., Law, S.H., and Ahmad, A.H. (2010). FDI and economic growth: new evidence on the role of financial markets. *Economics Letters*, 107(2), 211-213.

Balsvik, R. (2009). Is labor mobility a channel for spillovers from multinationals? Evidence from Norwegian manufacturing. Working Paper No 25/09, Institute for Research In Economics and Business Administration Bergen.

Barga, H., and Willmore, L. (1991). Technological imports and technological effort: an analysis of their determinants in Brazilian firms. *Journal of Industrial Economics*, 39(4), 421-432.

Barrios, S., and Strobl, E. (2002). Foreign direct investment and productivity spillovers: evidence from Spanish experience. *Weltwirstschaftliches Archiv*, 138,459-81.

Basant, R., and Fikkert, B. (1996). The effects of R&D, foreign technology purchase, and domestic and international spillovers on productivity in Indian firms. *Review of Economics and Statistics*, 78(2): 187-99.

Basant, R., and Mani, S. (2016). Foreign R&D centers in India: an analysis of their size, structure and applications. Working Paper No WP2012-01-06, Indian Institute Of Management Ahmedabad India.

Basant, R., and Mishra, P. (2013). Concentration and other determinants of innovative efforts in Indian manufacturing sector: a dynamic panel data analysis. IIM Ahmadabad *W.P. No.2013-02-01*.

Basant, R., and Mishra, P. (2014). Determinants of inter-industry variations in research and development efforts in Indian manufacturing sector: a dynamic panel data analysis. *Innovation and Development*, 4 (1), 91–109.

Battelle & FICCI (2013). India’s emerging competitiveness as destination of global R&D, New Delhi.

Beers, V. (2004). Multinationals and the knowledge economy in small countries. *Economic Bulletin*, 41(6), 205-208.

Behera, S. R. (2015). Do domestic firms really benefit from foreign direct investment? The role horizontal and vertical spillovers and absorptive capacity. *Journal of Economic Development*, 40 (2), 57-86.

Belderbos, R. (2001). Overseas innovations by Japanese firms: an analysis of patent and subsidiary data. *Research Policy 30(2)*, 313–332.

Ben Hamida, L. (2007). *Inward foreign direct investment and intra-Industry spillovers: The Swiss Case*. A thesis submitted in partial fulfillment of the requirements of Fribourg University for the degree of doctor of philosophy. Fribourg: Fribourg University.

Bernstein, J., and Yan, X. (1997). International R&D spillovers between Canadian and Japanese industries. *Canadian Journal of Economics*, 30(2), 276-94.

Bhati, U. (2006). *Foreign direct investment: contemporary issues*. New Delhi: Deep & Deep Publications.

Birkinshaw, J., and Hood, N. (1998). Multinational subsidiary development capability, evolution and character change in foreign-owned subsidiary companies. *Academy of management review,* 23(4), 773-95.

Blalock, G., and Gertler, P. J. (2005). Foreign direct investment and externalities. In: Moran, T., Graham, E., and Blomstrom, M., (eds). *Does foreign direct investment affect economic growth*? Washington, DC: Institute of Economic Growth and Centre for Global Development: 77-106.

Blalock, G., and Gertler, P. J. (2008). Welfare gains from foreign direct investment through technology transfer to local suppliers. *Journal of International Economics*, 74(2), 402-421.

Blalock, G., and Gertler, P. J. (2009). How firm capabilities affect who benefits from foreign technology. *Journal of Development Economics*, 90(2), 192-199.

Blalock, G., and Simon, D. H. (2009). Do all firms benefit equally from downstream FDI? The moderating effect of local suppliers' capabilities on productivity gains. *Journal of International Business Studies*, 40(7), 1095-1112.

Blalock, G., and Simon, D.H. (2009). Do all firms benefit equally from downstream FDI? The moderating effect of local suppliers' capabilities on productivity gains. *Journal of International Business Studies*. 40(7), 1095-1112.

Blomstrom, M. (1986). Foreign investment and productive efficiency: The case of Mexico. *Journal of Industrial Economics*, 35(1), 97-110.

Blomstrom, M., and Kokko, A. (1998). Multinational corporations and spillovers. *Journal of Economic Surveys*, 12(3), 247-277.

Blomstrom, M., and Wolff, E. (1994). Multinational Corporations and Productivity Convergence in Mexico. In W. Baumol, R. Nelson and E. Wolff (eds), *Convergence of productivity: Cross-national studies and historical evidence,* Oxford: Oxford University Press.

Blonigen, B. and Wang, M. (2005). Inappropriate pooling of wealthy and poor countries in empirical FDI studies. In *does foreign direct investment promote development?* (Eds.). T. Moran, E. Graham and M. Blomstrom, Institute for International Economics Publication; Washington, DC.

Borensztein, E. D., and Lee, W. (1998). How does foreign direct investment affect economic growth? *Journal of International Economics*, 45(1), 115-135.

Braga, H., and Willmore, L. (1991). Technological imports and technological effort: an analysis of their determinants in Brazilian firms. *Journal of Industrial Economics*, 39(4), 421-432.

Breschi, S. and Lissoni, F., and Montobobio (2005). The geography of knowledge spillovers; conceptual issues and measurement problems. In S. Breschi and F. Malerba (eds) *Clusters Networks and Innovation,* Oxford*:* Oxford University Press.

Brettel, M., Grève, G. I., and Flatten, T. C. (2011). Giving up linearity: Absorptive capacity and performance. Journal of Managerial Issues, 23(2), 164-189.

Buckley, P. J., Clegg, J., and Wang, C. (2002). The impact of inward FDI on the performance of Chinese manufacturing firms. *Journal of International Business Studies*, 33(4), 637–655.

Canto, D., and Gonzalez, I.S. (1999). A resourced based analysis of the factors determining a firm's R&D activity, *Research policy,* 28(8), 193-208.

Cantwell, J., (1989). *Technological innovation and multinational corporations*. Oxford: Black- well.

Carr, D. L., Markusen, J.R. and Maskus, K.E. (2001). Estimating the knowledge capital model of the multinational enterprise. *American Economic Review*, 91(3), 693-708.

Castellani, D. (2012). In praise of pecuniary externalities. *European Journal of Development Research,* 24(1), 15-19.

Castellani, D., and Zanfei, A. (2003). Technology gaps, absorptive capacity and the impact of inward investments on the productivity of European firms. *Economics of Innovation and Technology,* 12(3), 555-576.

Castellani, D., and Zanfei, A. (2006). *Multinational firm, innovation and productivity.* Edward Elgar, Cheltenham, UK.

Castellani, D., and Zanfei, A. (2007). Multinational companies and productivity spillovers: Is there a specification error? *Applied Economic Letters*, 14(14), 1047-1051.

Caves, R. E. (1971). International Corporation: The industrial economics of foreign investment. *Economica*, 38(149), 1-27.

Caves, R. E. (1974). Multinational firms, competition, and productivity in host country markets. *Economica*, 41(162), 176-193.

Cheung, K., and Lin, P. (2004). Spillover effects of FDI on innovation in China: evidence from provincial data. *China Economic Review*, 15(1), 25-44.

Cheung, K.Y., and Lin, P. (2004). Spillover effects of FDI on innovation in China: evidence from the provincial data. *China Economic Review*, 15(1), 25–44.

Choong, C.K. (2012). Does domestic financial development enhance the linkages between foreign direct investment and economic growth? *Empirical Economics*, 42(3), 819- 834.

Choudhury, P., and Khanna, T. (2014). Charting dynamic trajectories: multinational firms in India. Special issue on business, networks, and the state in India. *Business History Review, 88(1),* 133–169.

Coe, D., and Helpman, E. (1995). International R&D spillovers. *European Economic Review*, 39(5), 859-887.

Cohen, W. M., and Levinthal, D. A. (1989). Innovation and learning: The two faces of R & D. *Economic Journal*, 99(3), 569-96.

Cohen, W. M., and Levinthal, D. A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1), 128-152.

Cohen, W., and Levinthal, D. (2007). Innovation and market structure. In handbook of industrial organization (vol. 2, pp. 1075). Elsevier North Holland.

Cohen, W.M., and Levinthal, D.A. (1990). Absorptive Capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1), 128-152.

Crepon, B., Duguet, E., & Mairesse, J. (1998). Research, innovation and productivity: An econometric analysis at the firm level. *Economics of Innovation and New Technology, 7*(2), 115-158.

Crescenzi, R., Gagliardi, L. and Iammarino, S. (2015). Foreign multinationals and domestic innovation: Intra-industry effects and firm heterogeneity, *Research Policy*, 44(3), 596–609.

Crescenzi, R., Lammarino, S., and Gagliardi, L. (2015). Foreign multinationals and domestic innovation: Intra-industry effects and firm heterogeneity. *Research Policy*, 44,596-609.

Crespi, G., Criscuolo, C., Haskel, J. E., and Slaughter, M. (2007). Productivity growth, knowledge flows and spillovers, *CEP Discussion Paper No 785*: Centre for Economic Performance, London School of Economics and Political Science.

Crespo, N., and Fontoura, M.P. (2007). Determinant factors of FDI spillovers: what do we really know? *World Development*, 35(3), 410-425.

Crone, M. and Roper, S. (2001). Local learning from multinational plants: knowledge transfers in the supply chain, *Regional Studies*, 35(6), 535-48.

Damijan, J.P., Knell, M., Majcen, B., and Rojec, M. (2003). Technology transfer through FDI. In top-10 transition countries: How important are direct effects, horizontal and vertical spillovers, William Davidson Working Paper no. 549, February University Of Michigan.

Djankov, S., and Hoekman, B. M., (2000).Foreign investment and productivity growth in Czech enterprises. *World Bank Economic Review*, 14(1), 49-64.

Driffield, N., and Jindra, B. (2012). Challenging the production function approach to assess the developmental effects of FDI. *European Journal of Development Research*, 24(1), 31-37.

Driffield, N., and Love, J. (2003). Foreign direct investment, technology sourcing and reverse spillovers, *The Manchester School*, 71(6).

Driffield, N., and Munday, M., and Roberts, A. (2002). Foreign direct investment, transactions linkages, and the performance of the domestic sector, *International Journal of Economic Studies*, 9(3), 335-51.

DST (2013). R&D Statistics at a Glance 2011-12: DST, GOI. Department of Science and Technology Ministry of Science and Technology Government of India: New Delhi

Duguet, E. (2006). Innovation height, spillovers and TFP growth at the firm level: Evidence from French manufacturing. *Economics of Innovation and New Technology*, 15 (5), 415-442.

Dunning, J. H. (1977). Trade, location of economic activity and the multinational enterprise: A search for an eclectic approach. In B. Ohlin, P. O. Hesselborn, and P. M. Wiskman (Eds.). *The International Allocation of Economic Activity*. London, UK: Macmillan.

Dunning, J. H. (1988b). The eclectic paradigm of international production: A restatement and possible extensions. *Journal of International Business Studies*, 19(1), 1-32.

Dunning, J.H. (1980). Towards an eclectic theory of international production: some empirical tests. *Journal of International Business Studies*, 11(1), 9-31.

Dunning, J.H., and Lundan, S. (2008). *Multinational enterprises and the global economy, (2nd ed)*. Cheltenham: Edward Elgar.

Dyer, J. H., and Singh, H. 1998. The relational review: Cooperative strategy and sources of inter-organizational competitive advantage. Academy of Management Review, 23(4), 660-679.

Easterby-Smith, M., and Prieto, I. M. (2008). Dynamic capabilities and knowledge *Economic Journal*, 99(3), 569-596.

Edquist, C., (2000). Systems of innovation approaches, their emergence and characteristics. In Edquist C and McKelvey (eds.), Systems of innovation: Growth, competitiveness and employment. Cheltenham, UK: Edward Elgar.

Ernst, H., Lichtenthaler, U., and Vogt, C. (2011). The impact of accumulating and reactivating technological experience on R&D alliance performance. *Journal of Management Studies,* 48(6), 1194-1216.

Faeth, I. (2009). Determinants of foreign direct investment: A tale of nine theoretical models. *Journal of Economic Surveys*. 23(1), 165-196.

Fan, C. S. and Hu, Y. (2007). Foreign Direct Investment and indigenous technological efforts: Evidence from China. *Economics Letters*, 96(2): 253-258.

Fan, C.S., and Hu, Y., (2007). Foreign direct investment and indigenous technological effort: evidence from China. *Economic Letters*, 96(2), 253-258.

Färe, R., Grosskopf, S., Norris, M. and Zhongyang, Z (1994). Productivity growth, technical progress and efficiency change in industrialized countries. *American Economic Review*, 84 (1), 66-83.

Feinberg, S. and Keane, M.P. (2006). Accounting for the growth of MNC-based trade using a structural model of US MNCs. *American Economic Review*, 96(5), 1515-58.

Feinberg, S. E., & Majumdar, S. K. (2001). Technological spillovers from foreign direct investment in the Indian pharmaceutical industry. *Journal of International Business Studies,* 32(3), 421-437.

FICCI (2013). India's emerging competitiveness as destination of global R&D, New Delhi.

Figueiredo, P. N., Cohen, M., and Gomes, S. (2013). Firms' innovation capability-building paths and the nature of changes in learning mechanisms: multiple case-study evidence from an emerging economy. *UNU-MERIT Working Papers*, ISSN 1871-9872.

Filatotchev, I., Liu, X., Lu, J., and Wright, M. (2011). Knowledge spillovers through human mobility across national borders: evidence from Zhongguancun Science Park in China. *Research Policy*, 40(3), 453-462.

Findlay, R. (1978). Relative Backwardness, Direct Foreign Investment, and the transfer of technology: A Simple Dynamic Model. *Quarterly Journal of Economics,* 92(1), 1-16.

Fosfuri, Massima, M., and Thomas, R. (2001). Foreign direct investment and spillovers through workers mobility. *Journal of International Economics*, 53(1), 205-222.

Franco., C. and Subash, S. (2010). MNEs, technological efforts and channels of export spillovers: An analysis of Indian manufacturing industries. *Economic Systems,* 32(3), 270-288.

Freel, M. (2003). Sectoral patterns of small firm innovation, networking, and proximity. *Research Policy*, 32(5), 751-770.

Ghosh, S. (2009). R&D in Indian manufacturing enterprises: what shapes it? *Economics of Innovation and New Technology*, 18(4), 337-352.

Ghosh, S. (2012). Does R&D intensity influence leverage? Evidence from Indian panel data. *Journal of International Entrepreneurship*, 10(2), 158-75.

Giarratana, S., Pagano, A., and Torrisi, S. (2004). The role of multinational firms in the evolution of the software industry in India, Ireland, and Israel. In A. Arora and A. Gambardella (Eds.). *From underdogs to tigers: The rise and growth of the software industry in Brazil, China, India, Ireland and Israel,* New York: Oxford University Press, 207-35.

Girma, S. (2005). Absorptive capacity and productivity spillovers from FDI: a threshold regression analysis. *Oxford Bulletin of Economics and Statistics*, 67(3), 281-306.

Girma, S., and Gorg, H. (2007). The role of the efficiency gap for spillovers from FDI: Evidence from the UK electronics and engineering sectors. *Open Economies Review*, 18(2), 215-232.

Glass, A. J., and Saggi, K. (1998). International technology transfer and the technology gap. *Journal of Development Economics*, 55(2), 369-398.

Globerman, S. (1979). Foreign direct investment and spillover efficiency benefits in Canadian manufacturing industries. *Canadian Journal of Economics*, 12(1), 42-56.

Globerman, S., and Meredith, L. (1984).The foreign ownership and innovation nexus in Canada. *Columbia Journal of World Business*, 19(4), 53-62.

Gorg, H. and Greenaway, D. (2004). Much ado about nothing? Do domestic firms really benefit from foreign direct investment? *World Bank Research Observer*, 19(2), 171- 197.

Gorg, H. and Strobl, E. (2005). Spillovers from foreign firms through worker mobility: an empirical investigation. *Scandinavian Journal of Economics*, 107(4): 693–709.

Gorg, H., and Strobl, E. (2001). Multinational companies and productivity spillovers: A meta-analysis. *The Economic Journal*, 111, F723±F739 DOI: 10.1111/1468-0297.00669.

Gorg, H., and Strobl, E. (2005). Spillovers from foreign firms through worker mobility: an empirical investigation. *Scandinavian Journal of Economics*, 107(4), 693–739.

Gorodnichenko, Y., Svejnar, J., and Terrell, K. (2008). Globalization and innovation in emerging markets, *Working Papers 583*, Research Seminar in International Economics, University of Michigan.

Gourieroux, C., Monfort, A., and Trognon, A. (1984). Pseudo maximum likelihood methods: Application to Poisson models. *Econometrica*, 52(3), 701–720.

Gow, H. R., and Swinnen, J. F. M. (1998). Up-and downstream restructuring, foreign direct investment, and hold-up problems in agricultural transition. *European Review of Agricultural Economics*, 25(3), 331-350.

Grant, R. M. (1996). Toward the knowledge-based theory of the firm. *Strategic Management Journal*, 17, 109-122.

Greunz, L. (2005). Intra- and inter-regional knowledge spillovers: Evidence from European regions. *European Planning Studies*, 13(3), 449-473.

Griffith, R., Redding, S. and Simpson, H. (2002). Productivity convergence and foreign ownership at the establishment level. *Institute for Fiscal Studies Working Paper No. 22.*

Griliches, Z. (1979). Issues in assessing the contribution of research and development to productivity growth. *The Bell Journal of Economics*, 10(1), 92-116.

Griliches, Z. (1990). Patent statistics as economic indicators: A survey. *Journal of Economic Literature*, 28(4), 1661-1707.

Griliches, Z. (1990). Patent statistics as economic indicators: A survey. *Journal of Economic Literature*, 28(4): 1661-1707.

Griliches, Z. (1998) Patent statistics as economic indicators: A survey. In Z. Griliches (Eds.) *R&D and productivity: The econometric evidence.* Chicago: The University of Chicago Press: 278-343.

Grossman G.M. and Helpman, H. (eds.) (1991). *Innovation and growth in the global Economy*. MIT Press.

Grossman, G., and Helpman, E. (2002). Much ado about nothing? Do domestic firms really benefit from foreign direct investment Endogenous Product Cycles, in: *CEPR Discussion Paper Number 3485?*

Haddad, Mona, and Harrison, E. (1993). Are there positive spillovers from direct foreign investment: evidence from panel data for Morocco? *Journal of Development Economics*, 42(1), 51-74.

Hagedoorn, J. and Cloodt, M. (2003). Measuring innovative performance: is there an advantage in using multiple indicators? *Research Policy*, 32(8), 1365-1379.

Hall, L. A. and Bagchi-Sen, S. (2002). A study of R&D, innovation, and business performance in the Canadian biotechnology industry. *Technovation*, 22(4), 231-244.

Hanson, G. H., Mataloni, R. J., and Slaughter, M. J. (2001). Expansion strategies of U.S. multinational firms. *NBER Working Paper No. 8433*.

Harris and Tzavalis (1999). Inference for unit roots in dynamic panels where the time dimensions fixed. *Journal of Econometrics*, 91, 201-226.

Haskel, J., Pereira, S. and Slaughter, M. (2002). Does inward foreign direct investment boost the productivity? *NBER working paper 8724*.

Haskel, J.E., Pereira, S.C., and Slaughter, M.J. (2007). Does inward foreign direct investment boost the productivity of domestic firms? *Review of Economic Statistics*, 89(3), 482-496.

Hausman, J., Hall, B., and Griliches, Z. (1984). Econometric models for count data with an application to the patents–R&D relationship. *Econometrica*, 52(4), 909–938.

Havranek, T., and Irsova, Z. (2011). Estimating vertical spillovers from FDI: Why results vary and what the true effect is. *Journal of International Economics*, 85(2), 234-244.

Heckman, J. J. (1974). Shadow prices market wages and labor supply. *Econometrica*, 42(4), 679-694.

Heckman, J. J. (1976). The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator for such models. *Annals of Economic and Social Measurement*, 5,475-492.

Heckman, J. J. (1979). Sample selection bias as a specification error. *Econometrica*, 4(7), 153-162.

Heckscher, E. F. (1919). The effect of foreign trade on the distribution of income. (English translation of the original 1919 article in 1919, Ekonomisk Tidskrift).

Helpman, E. (1984). A simple theory of trade with multinational corporations. *Journal of Political Economy*, 92(3), 451-471.

Helpman, E. and Krugman, P.R. (1985). *Market Structure and Foreign Trade*. Cambridge, MA: MIT Press.

Hennart, J.F. and Larimo, J. (1998). The Impact of culture on the strategy of multinational enterprises: Does national origin affect ownership decisions? *Journal of International Business Studies*, 29(3), 515-538.

Hirschman, A. O. (1958). *The strategy of economic development*. New Haven: Yale University Press.

Howitt, P., and Foulkes, D.M. (2005). R&D, implementation and stagnation: Schumpeterian theory of convergence clubs. *Journal of Money, Credit and Banking*, 37(1), 147-177.

Hymer S. (1976). *The International 0perations of national firms: A study of foreign direct investment.* Ph.D. Dissertation, MIT Press, Cambridge.

IP India (n.d.). Office of the Controller General of Patents, Designs and Trademarks. Department of Industrial Policy and Promotion, Ministry of Commerce and Industry, Govt. of India. Retrieved from: www.ipindia.nic.in/annual-reports-ipo.htm.

Iversen, C. (1935). *Aspects of international capital movements*. London: Levin & Munksgaard.

James A. Wolff, J.A., and Pett, T. L. (2006). Small-firm performance: Modeling the role of product and process improvements, *Journal of Small Business Management,* 44(2), 268-284.

Javorcik, B., Keller, W., and Tybout, J. (2008). Openness and industrial response in a Wal-Mart world: a case study of Mexican soaps, detergents and surfactant producers. *The World Economy*, 31(12), 1558-1580.

Javorcik, S.B. (2004). Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. *American Economic Review*, 94(3), 605-627.

Jenkins, R. (2005). Comparing foreign subsidiaries and local firms in LDCs: theoretical issues and empirical evidence. *Journal of Development Studies*, 26(2), 205-28.

Jensen, M., and Meckling, W. (1976). Theory of the Firm: Managerial behavior, agency costs and capital structure. *Journal of Financial Economics*, 3(4), 305-360.

Kaplan, S., and Henderson, R. (2005). Bridging organizational economics and organizational theory. *Organization Science*, 165(5), 509-521.

Kartak, H. (1989). Imported technology and R&D in a newly industrializing economy: The experience of Indian enterprises. *Journal of Development Economics,* 31(1), 123–139.

Kartak, H. (1985). Imported technology, enterprise Size and R&D in a newly industrializing economy: The Indian experience. *Oxford Bulletin of Economics and Statistics,* 47(3), 213–229.

Kartrak, H. (1990). Imports of technology and technological effort of Indian enterprise. *World Development*, 18(3), 371-381.

Kathuria, V. (2000). Productivity Spillovers from technology transfer to Indian manufacturing firms. *Journal of International Development*, 12(2), 343-69.

Kathuria, V. (2001). Foreign firms, technology transfer and knowledge spillovers to Indian manufacturing firms – A stochastic frontier analysis. *Applied Economics*, 33(5), 625-42.

Kathuria, V. (2002) Liberalization, FDI, and productivity spillovers: an analysis of Indian manufacturing firms. *Oxford Economic Paper,* 57(4), 688-718.

Kathuria, V. (2008). The impact of FDI inflows on R&D investment by medium –and high- tech firms in India in the post-reform period. *Transnational Corporations*, 17(2), 45-66.

Kathuria, V. (2010). Does the technology gap influence spillovers? – A post-liberalization analysis of Indian manufacturing industries. *Oxford Development Studies*, 38(2), 145-70.

Kathuria, V., and Das, S. (2005). Impact of FDI on R&D strategies of firms in the post -1991 era. *IIMB Management Review*, 17(2): 17-28.

Katila, L. (2002). New product search over the past ideas in their prime? *Academy of Management*, 45(5), 995-1010.

Katrak, H. (1989). Imported technologies and R&D in newly industrializing countries: The experience of Indian enterprises. *Journal of Development Economics*, 31(1): 123-139.

Katrak, H. (1990) Imports of technology and the technological efforts of Indian enterprises. *World Development*, 18(3): 371-81.

Keller, W., Stephen R., and Yeaple, S.R. (2009). Multinational enterprises, international trade, and productivity growth: firm-level evidence from the United States. *Review of Economics and Statistics*, 91(4), 821-831.

Kemp, M.C. (1964). *The pure theory of international trade*. Englewood Cliffs, NJ: Prentice Hall.

Kindleberger, C.P. (1969). *American business abroad: Six lectures on foreign direct investment*. New Haven, CT: Yale University Press.

Kinoshita, Y., (2001). R&D and technology spillovers through FDI: Innovation and absorptive capacity. *CEPR Discussion Paper DP2775*.

Klein, B., Crawford, R. Alchian, A. (1978). Vertical integration, appropriable rents, and the competitive contracting process. *Journal of Law and Economics*, 21(2), 297-326.

Klepper, S. (1996). Entry, exit, growth, and innovation over the product life cycle. *American Economic Review,* American economic association: 562-583.

Kogut, B., and Zander, U. (1993). Knowledge of the firm and the evolutionary theory of the multinational operation. *Journal of International Business Studies*, 24(4), 625-645.

Kohpaiboon, A. (2006). Foreign direct investment and technology spillover: A cross-industry analysis of Thai manufacturing. *World Development*, 34(3), 541–56.

Kojima, K. (1978). *Direct foreign Investment: A Japanese model of multinational business operations.* London: Croom Helm.

Kojima, K. (1982). Macroeconomic versus international business approach to Foreign Direct Investment. *Hitosubashi Journal of Economics*, 23(1), 630-640.

Kokko, A. (1994). Technology, market characteristics and spillovers. *Journal of Development Economics*, 43(2), 279-93.

Kokko, A., (1996). Productivity spillovers from competition between local firms and foreign affiliates. *Journal of International Development*, 8(4), 517-530.

Konings, J. (2001). The effect of foreign direct investment on domestic firms: Evidence from firm-level panel data in emerging economies. *Economics of Transition*, 9(3), 619-633.

Kubny, J., and Voss, H. (2014). Benefitting from Chinese FDI? An assessment of vertical linkages with Vietnamese manufacturing firms. *International Business Review*, 23(4), 731-740.

Kudaisya, M. M. (2011). *The oxford India anthology of business history*. Oxford, United Kingdom: Oxford University Pres.

Kugler, M. (2006). Spillovers from foreign direct investment: within or between industries? *Journal of Development Economics*, 80(2), 444- 477.

Kumar, N. (1987). Technology imports and local research and development in Indian manufacturing. *Developing Economies*, 25(3), 220-233.

Kumar, N. (2001). Determinants of location of overseas R&D activity of multinational enterprises: the case of US and Japanese corporations. *Research Policy*, 30(1), 159-174.

Kumar, N. and Saqib, M. (1996). Firm size, opportunities for adaptation and in-house R & D activity in developing countries: the case of Indian manufacturing. Research Policy, 25(2), 713-722.

Kumar, N., (1987). Technological imports and local research and development in Indian manufacturing. *The Developing Economies*, 25, 220-233.

Kumar, N., and Aggarwal, A. (2005). Liberalization, outward orientation and in-house R&D activity of multinational and local firms: A quantitative exploration of Indian manufacturing. *Research Policy*, 38(9), 441-460.

Kumar, N., and Saqib, M. (1996). Firm size, opportunities for adaptation and in-house R&D activity in developing countries: the case of Indian manufacturing. *Research Policy*, 25(5), 712-722.

Kust, M. J. (1965). Foreign enterprise in India. The Int. Exec., 7: 18–19. doi:10.1002/tie.5060070109

Lall (1983). Determinants of R&D in a LDC: The Indian emerging industry. *Economic Letters*, 13(4), 379-383.

Lall, S. (1980). Vertical inter-firm linkages in LDCs: An empirical study. *Oxford Bulletin of Economics and Statistics*, 42(3), 203-226.

Lall, S. and Streeten, P. (1977). *Foreign investment, transnationals and developing countries*. London, UK: Macmillan Press.

Lall, S., and Mohammad, S. (1983). Multinationals in Indian big business: Industrial characteristic of foreign investment in a heavily regulated economy. *Journal of Development Economics,* 13(1-2), 143-157

Lambert, D. (1992). Zero-inflated poisson regression, with an application to defects in manufacturing. *Technometrics*, 34(1), 1-14.

Lane, P. J., and Lubatkin, M. 1998. Relative absorptive capacity and inter-organizational learning. *Strategic Management Journal*, 19(5), 461-477.

Lee, J. (1996). Technology imports and R&D efforts of Korean manufacturing firms. *Journal of Development Economics*, 50(1), 197-210.

Leonard-Barton, D. (1992). Core capabilities and core rigidities: A paradox in managing new product development. *Strategic Management Journal*, 13(SI), 111-25.

Levin, R. C., and Reiss, P. C. (1988), Cost–reducing and demand–creating R&D with Spillover, *RAND Journal of Economics*, 19(4): 538–556.

Lewin, A. Y., Massini, S., and Peeters, C. (2011). Micro foundations of internal and external absorptive capacity routines. *Organizational Science*, 22(1), 81-98.

Li, J., Chen, D., and Shapiro, D. M. (2010). Product innovations in emerging economies: the role of foreign knowledge access channels and internal efforts in Chinese firms. *Management and Organization Review,* 6(2), 243-266.

Lileeve, A., and Trefler, D. (2010). Improved access to foreign markets raises plant-level productivity for some plants. *The Quarterly Journal of Economics*, 125(3): 1051-1099.

Lipsey, R. E. (2003). Foreign direct investment, growth, and competitiveness in developing countries. In Peter K. Cornelius, (Eds.), *The global competitiveness report, 2002-2003,* New York, Oxford University Press, pp. 295-305.

Lipsey, R.E., and Sjoholm, F. (2004). Foreign firms and Indonesian manufacturing wages: an analysis in panel data, *EIJS working paper no. 166,* Stockholm School of Economics.

Little, R. J., and Rubin, D. B. (1987). *Statistical analysis with missing data*. New York: John Wiley & Sons.

Liu, X., and Haun, Z. (2008). The impact of Greenfield FDI and mergers and acquisitions on innovation in Chinese high-tech industries, *Journal of World Business*, 43(3), 352-364.

Liu, X., Lu, J., Filatotchev, I., Buck, T., and Wright, M. (2010). Returnee entrepreneurs, knowledge spillovers and innovation in high-tech firms in emerging economies. *Journal of International Business Studies*, 41(7), 1183-1197.

Lulia, S., and Zhang, X. (2014). Internationalization of firms and their innovation and productivity. *Economics of Innovation and New Technology*, 24(3), 183-203.

MacDougall, G. D. A. (1960). The benefits and costs of private investment from abroad: A theoretical approach. *Economic Record*, 36(73), 13-35.

MacGarvie, M. (2006). Do firms learn from international trade? *The Review of Economics and Statistics*, 88(1), 46-60.

Majumdar, S. K. (2011). Scalability versus flexibility: firm size and R&D in Indian industry. *Journal of Technology Transfer*, 36(1):101–116 DOI 10.1007/s10961-009-9147-x

Mani, S. (2009). Is India Becoming More Innovative since 1991? Some disquieting features. *Economic and Political Weekly*, 44(46), 41-51.

Mani, S. (2014) Innovation: the world's most generous tax regime. In: B. Jalan and P. Balakrishnan (eds) *Politics Trumps Economics: the Interface of economics and politics in contemporary India*. Rupa: New Delhi, pp. 155–169.

Mansfield, E. (1994). *Intellectual Property Protection, Foreign Direct Investment and Technology Transfer*. International Finance Corporation Discussion Papers 27.

Mansfield, E. and Romeo, A. (1980). Technology transfer to overseas subsidiaries by US based firms. *Quarterly Journal of Economics*, 95(4), 737-750.

Mansfield, E., Schwartz, M., and Wagner, S. (1981). Imitation costs and patents: An empirical study. *The Economic Journal*, 91(364), 907-918.

Mansfield, E., Teece, D and Romeo, A. (1979). Overseas research and development by US- based firms. *Economica*, 46(182), 187-96.

Marin., A. and Subash, S. (2010). The heterogeneity of MNC subsidiaries and technology spillovers: Explaining positive and negative effects in emerging economies. *Research Policy*, 39(10), 1227–1241.

Markowitz, H. M. (1959). *Portfolio selection: Efficient diversification of investments*. New York: John Wiley.

Markusen, J. R. (1984). Multinationals, multi-plant economies, and the gains from trade. *Journal of International Economics*, 16 (3), 205-26.

Markusen, J. R. (1995). The boundaries of multinational enterprises and the theory of international trade. *Journal of Economic Perspectives*, 9(2), 169-89.

Markusen, J. R. (2002). *Multinational firms and the theory of international trade*. Cambridge, MA: MIT Press.

Markusen, J. R., and Maskus, K.E. (2002). Discriminating among alternative theories of the multinational enterprise. *Review of International Economics*. 10(4), 694-707.

Markusen, J. R., and Venables, T. (1998). Multinational firms and the new trade theory. *Journal of International Economics*, 46(2), 183-203.

Markusen, J.R. (1997). Trade versus investment liberalization. *NBER Working Paper No. 6231*.

McCann, P., and Acs, Z.J. (2011). Globalization: countries, cities and multinationals. *Regional Studies*, 45(1), 17-32.

Meyer, K. E. (2004). Perspectives on multinational enterprises in emerging economies. *Journal of International Business Studies*, 35(4), 259-276.

Mohnen, P., and Hall, B. (2013). Innovation and productivity: An update. *Eurasian Business Review*, 3(1), 47-65.

Moosa, I. A. (2002). *Foreign Direct Investment: Theory, evidence and practice.* Palgrave Macmillan ISBN 978-1-4039-0749-3.

Morrissey, O. (2012). FDI in Sub-Saharan Africa: Fewer linkages, fewer spillovers, *European Journal of Development Research*, 24, 26-31.

Mowery, D. C., Oxley, J. E., and Silverman, B. S. (1996). Strategic alliances and inter-firm knowledge transfer. Strategic Management Journal, 17 (Special Issue), 77-91.

Narula, R. and Dunning, J.H. (2000). Industrial development, globalization and multinational enterprises: New realities for developing countries. *Oxford Development Studies*, 28(2), 141–67.

Narula, R., & Driffield, N. (2012). Does FDI cause development? The ambiguity of the evidence and why it matters. *European Journal of Development Research*, 24(1), 1-7.

Nayyar, D. (1983). International relocation of production and industrialization in LDCs. *Economic and Political Weekly*, 18(13), 13–26.

Nelson, R.R. (2004). The challenge of building an effective innovation system for catch-up new product development. *Strategic Management Journal*, 13(S1), 111-125.

Nurkse, R. (1933). Causes and effects of capital movements reprinted in J. H. Dunning *international investment* (Penguin Readings, 1972).

OECD (2003), OECD Science, Technology and Industry Scoreboard 2003, OECD Publishing doi: 10.1787/sti_scoreboard-2003-en

Ogueze V.C. and Odim, O. U. (2015). Foreign direct investment as a panacea for economic development in Nigeria, *Middle-East Journal of Scientific Research,* 23 (2): 175-185.

Ohlin, B. (1933). *Interregional an international trade*. Cambridge, MA: Harvard University Press 5-374.

Pearce, R.D. (1999). Decentralized R&D and strategic competitiveness: Globalized approaches to generation and use of technology in multinational enterprises. *Research Policy,* 28(2-3), 157-178.

Ping, L., and Saggi, K. (2005). Multinational firms, exclusivity, and the degree of backward linkages. *Kiel Working Papers 1250*, Kiel Institute for the world economy.

Pires, A., (2010). FDI, R&D and Endogenous productivity asymmetries. Retrieved from http://www.estg.org/ETSG2010/papers/Gracials.

Potter, B., Moore, B., and Spires, R. (2003). Foreign manufacturing investment in the United Kingdom and the upgrading of supplier practices, *Regional studies*, 37(1), 41-60.

Pradhan, J.P. (2003). Liberalization, firm size and R&D performance: a firm level study of Indian pharmaceutical industry. RIS Discussion paper, No. 40/2003, January.

Prasad, S. (1999). *Some dimensions of research and development in India: An analysis with special reference to post liberalization scenario*. (Unpublished M Phil thesis) Centre for Development Studies, Trivandrum (India).

Protsenko, V. A. (2003). *Vertical and horizontal foreign direct investments in transition countries* (Unpublished doctoral dissertation). Ludwig-Maximilians-Universität münchen.

Puhani, P.A. (2000). The Heckmans' correction for selection bias and its critique. *Journal of economic surveys*, 14(1), 53-58.

Rammer, C. (2016, September). Measuring output of process innovation at the firm level: results from German panel data paper presented at the Blue Sky Conference Ghent, Belgium.

Ramondo, N., Rappoport, V., Ruhl, K. (2011). Horizontal vs. vertical FDI: Revisiting evidence from U.S. multinationals. Mimeo, Arizona State University. https://www.princeton.edu/fall11.

Rao, K.S., Murthy, M.R., and Ranganathan, K.V.K. (1999). Foreign direct investment in the post-liberalization period: an overview. *Journal of Indian School of Political Economy*, July-September.

Rastogi, R. and Sawhney, A. (2013). What attracts FDI in Indian manufacturing industries? Discussion Paper 13-02, Centre for International Trade and Development School of International Studies Jawaharlal Nehru University India.

Robock, S.H. and Simmonds, K. (1983). *International business and multinational enterprises*. Homeward, IL: Irwin.

Rodriguez-Clare, A. (1996). Multinationals, linkages and economic development. *The American Economic Review*, 86(4), 852-873.

Romer, P. M. (1990b). Endogenous technological change. *Journal of Political Economy,* 98(5), 71-102.

Romer, P.M. (1990a). Human capital and growth: theory and evidence. *NBER Working Paper No. 3173*.

Roper, S., Du, J., and Love, J. H. (2008). Modeling the innovation value chain. *Research Policy*, 37(6), 961-977.

Rosenberg, N. (1990). Why do firms do basic research (with their own money)? *Research Policy*, 19(2), 165-74.

Rosenbusch, N., Brinckmann, J, and Bausch, A. (2011). Is Innovation always beneficial? A meta-analysis of the relationship between innovation and performance in SMEs. *Journal of Business Venturing,* 26(4), 441-457·

Rugman, A.M., Verbeke, A. and Nguyen, Q.T.K. (2011). Fifty years of international business theory and beyond. *Management International Review*, 51(6), 755-786.

Salomon, R. M., and Shaver, J. M. (2005). Learning by exporting: new insights from examining firm innovation. *Journal of Economics and Management Strategy*, 14(2), 431-460.

Sands, A. (2004). The Irish software industry. In A. Arora and A. Gambardella (Eds.). *From Underdogs to Tigers: The rise and growth of the software industry in Brazil, China, India, Ireland and Israel,* New York: Oxford University Press.

Sanna-Randaccio, F. (2002). The impact of foreign direct investment on home and host countries with endogenous R&D. *Review of International Economics*, 10(2): 278-298.

Sasidharan, S. (2006). Foreign direct investment and technology spillovers: Evidence from the Indian manufacturing sector. *MERIT Working Papers010*, United Nations University-Maastricht Economic and Social Research Institute on Innovation and Technology.

Sasidharan, S., and Kathuria, V. (2011). Foreign direct investment and R&D: substitutes or complements-a case of Indian manufacturing after 1991 reforms, *World Development*, 39(7), 1226-1239.

Saxenian, A. L. (1994). Regional advantage*: Culture and competition in Silicon Valley and Route 128*, Cambridge, MA: Harvard University Press.

Schoors, K., and Tol, B. v. d. (2002). Foreign direct investment spillovers within and between sectors: Evidence from Hungarian data, *Working Paper 157*: Ghent University.

Schumpeter, J.A. (1950). *Capitalism, socialism, and democracy.* (3rd ed.). New York, NY: Harper and Row.

Siddharthan, N. S. (1988). In-house R&D, imported technology, and firm size: Lessons from Indian experience. *The Developing Economies,* 26(3), 212-221.

Siddharthan, N.S. (1992). Transaction costs, technology transfer, and In-house R&D: A study of Indian private corporate sector. *Journal of Economic Behaviour and Organisation,* 18(2), 265-271.

Siedsclag, I., and Zhang, X. (2015). Internationalization of firms and their innovation and productivity. *Economics of Innovation and New Technology*, 24(3), 183-201.

Smith, J. (2015). Imperialism in the Twenty-First Century. *Monthly Review*, 67(3).

Smith, P. J. (2001). How do foreign patent right affect US exports, affiliate sales, and licenses. *Journal of International Economics*, 55(2), 411-39.

Sophie, N., and Pascal, N. (2012). Characteristics of R&D expenditures in Japan's pharmaceutical industry. *Asia Pacific Business Review*, 18(2), 225-240.

Sorensen, J., and Stuart, T., (2000). Aging and organizational innovation. *Administrative Science Quarterly* 45(3), 81–112.

Spencer, W. J. (2008). The impact of multinational enterprise strategy on indigenous enterprises: horizontal spillovers and crowding out in developing countries. *Academy of Management Review*, 33(2), 341-61.

Statement on Industrial Policy (1948), Ministry of Industry, Government of India, New Delhi, April 6.

Stiebale, J., and Reize, F. (2011).The impact of FDI through mergers and acquisitions on innovation in target firms. *International Journal of Industrial Organization*, 29(2), 155-167.

Sasidharan, S., and Ramanathan, A. (2007). FDI and spillovers: Evidence from Indian manufacturing industries. *International Journal of Trade and Global Markets*, 1(1), 5- 22.

Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal*, 17(S2), 27-44.

TIFAC (2005). *FDI in the R&D sector, study for the pattern in 1998-2003,* TIFAC, Department of Science and Technology: Delhi.

Tobin, J. (1958). Liquidity preference as behaviour towards Risk. *Review of Economic Studies*, 25(2), 65-86.

UNCTAD (2001). *World Investment Report: Promoting Linkages,* Geneva And New York; United Nations.

UNCTAD (2006). *Trade and development report*, 2006 UNCTAD/ TDR/2006.

UNCTAD (2006). *World Investment Report: FDI from developing and transition economies: Implications for development.* Geneva: United Nations.

UNCTAD, (2013a). *World Investment Report -global value chains: investment and trade for development*. New York and Geneva: United Nations.

UNCTAD, (2013b). Economic Development in Africa Report 2013: intra-African trade – unlocking private sector dynamism. New York and Geneva: United Nations.

Vahter, P. (2010). Does FDI spur innovation, productivity and knowledge sourcing by incumbent firms: Evidence from manufacturing industry in Estonia? *William Davidson Working Paper No.986.*

Vernon, R. (1966). International investment and international trade in the product cycle. *Quarterly Journal of Economics*, 80(2), 190–207.

Veugelers, R. and Cassiman, B. (2004). Importance of international linkages for local know-how flows: some econometric evidence from Belgium. *European Economic Review,* 48(2), 455-76.

Veugelers, R. and Houte, P.V. (1990). Domestic R&D in the Presence of Multinational Enterprises. *International Journal of Industrial Organization,* 8(1): 1-15.

Veugelers, R., and Venden Houte, P. (1990). Domestic R&D in presence of multinational enterprises. *International Journal of Industrial Organization*, 8(1), 1-15.

Wang, J., and Blomstrom, M. (1992). Foreign investment and technology transfer: a simple model. *European Economic Review*, 36(1), 137-155.

Wang, H., Liang, P., Huiyu, L., and Ruili, Yang, R. (2016). Financing sources, R&D investment and enterprise risk. *Procedia Computer Science*, 91, 122 – 130.

Williamson, O. (1985). *The Economic Institutions of Capitalism*. New York: Free Press.

Xiaohui, L., and Haun, Z. (2008). The impact of greenfield FDI and mergers and acquisitions on innovation in Chinese high-tech industries. *Journal of World Business,* 43(3), 352- 364.

Yamin, M. (2000). A critical re-evaluation of Hymer's contribution to the 'theory of international operations'. In C. Pitelis, and R. Sugden (Eds.). *The Nature of the Transnational Firm*. New York: Rutledge.

Yeaple, S. (2003). The complex integration strategies of multinational firms and cross-country dependencies in the structure of foreign direct investment. *Journal of International Economics*, 60(2), 293-314.

Zhang, K.H. and Markusen, J.R. (1999). Vertical multinational and host country characteristics. *Journal of Development Economics*, 59(2), 233–262.

Zimmerman, K.F. (1987). Trade and dynamic efficiency. *Kyklos*, 40(1), 37-87.

Zukowska-Gangelmann, K. (2002). Productivity spillovers from foreign direct investment in Poland. *Economic Systems*, 24 (3), 223-56.

Appendix

Table 1A: Descriptive statistics of the variables for subsample of domestic and foreign firms

Variable	Domestic Firms				Foreign Firms			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Total Factor Productivity (tfp_{it})	1.01	2.18	0.03	1.15	1.19	5.16	0.09	1.73
Patent Grants (pg_{it})	1.02	3.52	0.00	168.00	2.12	6.34	0.00	49.00
Proximity to Frontier (l_1prxm_{it})	0.03	0.08	0.01	0.87	0.09	0.03	0.63	0.97
R&D Intensity (l_1rd_{it})	0.015	0.051	0.001	0.07	0.013	0.027	0.001	0.08
Export intensity (ep_{it})	0.21	0.26	0.00	0.81	0.39	0.33	0.16	0.92
Import intensity (l_1im_{it})	0.17	0.24	0.00	0.73	0.14	0.39	0.11	0.94
Firm size (lns_{it})	3.39	9.32	1.09	6.33	3.59	7.56	1.33	5.39
Firm age ($lnag_{it}$)	1.47	0.26	1.14	2.02	1.82	0.92	1.00	2.04

Table 2A: Correlation matrix

	pg_{it}	rd_{it}	ep_{it}	lns_{it}	im_{it}	lk_{it}	$lnag_{it}$	$prxm_{it}$	tfp_{it}	$ffdi_{jt}$	$hfdi_{jt}$	$bfdi_{jt}$	dlc_{it}	dpp	$prft_{it}$	lvg_{it}
pg_{it}	1															
rd_{it}	0.25	1.00														
ep_{it}	0.05	0.02	1.00													
lns_{it}	0.11	0.02	0.07	1.00												
im_{it}	0.01	0.03	0.11	0.03	1.00											
lk_{it}	0.08	0.06	0.01	0.90	0.06	1.00										
$lnag_{it}$	0.10	0.01	0.23	0.29	-0.07	0.18	1.00									
$prxm_{it}$	0.00	0.05	0.06	0.10	0.01	0.02	0.09	1.00								
tfp_{it}	0.13	0.08	-0.04	0.11	0.00	0.04	0.06	0.85	1.00							
$ffdi_{jt}$	0.01	0.00	-0.08	0.07	-0.01	0.04	0.00	0.01	0.02	1.00						
$hfdi_{jt}$	0.03	0.72	0.04	0.03	-0.06	-0.07	0.01	0.01	0.26	0.21	1.00					
$bfdi_{jt}$	0.10	0.69	0.04	-0.07	-0.03	-0.11	0.00	0.05	0.35	0.13	0.77	1.00				
dlc_{it}	0.06	0.14	0.05	0.35	0.02	0.30	0.06	0.01	0.01	0.06	0.06	0.04	1.00			
dpp	0.00	-0.03	0.01	0.00	0.00	0.01	-0.05	-0.05	-0.04	-0.01	-0.12	-0.06	0.01	1.00		
$prft_{it}$	0.02	0.00	0.02	0.33	0.03	0.30	0.06	-0.01	-0.01	0.05	-0.07	-0.05	0.50	0.00	1.00	
lvg_{it}	0.01	0.01	0.02	0.05	0.01	0.05	0.02	-0.02	-0.02	-0.01	-0.04	-0.03	-0.01	0.01	-0.02	1.00

Table 3A: R&D intensity of exporting and non-exporting firms

R&D Intensity	Exporting Firms			Non-exporting Firms		
	2003	2008	2013	2003	2008	2013
Entire Sample	0.009	0.012	0.015	0.002	0.005	0.007
Domestic Firms	0.008	0.011	0.016	0.001	0.003	0.005
Foreign Firms	0.005	0.009	0.019	0.003	0.005	0.008