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DO DOMESTIC FIRMS REALLY BENEFIT FROM FOREIGN DIRECT INVESTMENT? THE ROLE OF HORIZONTAL AND VERTICAL SPILLOVERS AND ABSORPTIVE CAPACITY

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This paper examines whether the existence of externalities associated with foreign direct investment (FDI) benefits the domestic firms of Indian manufacturing industries. Empirical findings reveal that local firms benefit from vertical foreign presence, whereas the horizontal foreign presence at the industry level could not substantially raise the value addition of labor across Indian industries. The absorptive capacity of domestic firms is highly relevant to reap the benefit from foreign presence, and could act as a precondition for incorporating the benefit of FDI externalities. Higher concentration and a greater size of the domestic market facilitate to raise the productivity spillovers from foreign presence. Furthermore, the FDI-technology spillovers seem to be higher for R&D-and technology-intensive firms.

Keywords: Foreign Direct Investment, Technology Spillover, Manufacturing, Panel Cointegration, Unit Root Test
JEL classification: O41, F43, E23, C22, C23

1. INTRODUCTION

Foreign direct investment (FDI) is supposed to bring positive spillovers to domestic firms in the recipient country. The idea is that the presence of multinational corporations (MNCs), which are the most technological advanced firms, can facilitate the transfer of technological and business know-how to domestic firms. This transfer of technology may then spread to the entire economy leading to productivity gains in domestic firms (Romer, 1993). This kind of consideration has motivated authorities in many countries to ease restrictions on FDI and even to offer foreign investors more favorable conditions

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than those granted to domestic firms (Marcin, 2008). In India, after the economic reforms, the government has not only alleviated most of the restrictions on foreign presence, but taking initiative to attract foreign investors as one of the key elements of economic policy. In order to win the race and to attract the prestigious project in different regions of the country, and in an attempt to overbid the rival countries, India often offer the most generous tax incentives, subsidies, and land acquisition policies, etc.

FDI spillovers can occur through five main channels: demonstration/imitation, labor mobility, exports, competition, and backward and forward linkages with domestic firms (Crespo and Fontoura, 2007, p. 411).[1] Demonstration (by MNEs)/imitation (by domestic firms) is probably the most important spillover channels (Das, 1987; Wang and Blomstrom, 1992). The introduction of a new technology into a given market may be too expensive and risky for a domestic firm to follow, because of the cost inherent in acquiring its knowledge and uncertainty of the results that may be obtained (Crespo and Fontoura, 2007). If a technology is successfully used by a MNE, then domestic firms will be encouraged to adopt such technology. Barrios and Strobl (2002) suggest that the relevance of this effect increases with the similarity of the goods produced by the two types of firms in case of spillover related to product and process technology.

FDI spillovers could be occurred, when the possibility of domestic firms hiring of MNEs workers, who have knowledge and experience of the technology and are able to apply this technology in domestic firms (Fosfuri *et al*., 2001; Glass and Saggi, 2002). However, the possibility of negative impact arising through this channel could not be avoided, as MNEs may attract best workers from domestic firms by offering higher wages and salaries (Sinani and Meyer, 2004). In addition, the influence of labor mobility on the efficiency of local firms is difficult to evaluate, as it involves tracking the workers in order to investigate their impact on the productivity of other workers (Saggi, 2002).[2] The remaining important channels of FDI spillovers are exports, competition, and forward-backward linkages with domestic firms, etc.[3]

FDI and technology imports could be recognized as alternative channels for technology spillover (Kanturia, 2001, 2002; Behera *et al*., 2012). Importing the technologically advanced intermediate inputs can also activate the learning process of the domestic producers, and enable to improve the product quality and reduce the cost of the production. The learning ability of the domestic firms could be assessed by the potential to gain the advanced technology from its foreign counterparts and it also depends on the ability of the recipient firms to make use of the technology spillover. Nevertheless, technology transfer to the developing countries via FDI is newer than that of transfer via licensing (Findlay, 1978; Mansfield and Romeo, 1980). However, there

[1] For detailed discussion of five FDI spillover channels, see Crespo and Fontoura (2007).

[2] There is no large numbers of studies and do not have detailed analysis on the aspect of the labor mobility and its impact on domestic firms (Saggi, 2002).

[3] See Crespo and Fontoura (2007).

are several well-known mechanisms through which spillover may occur (Gorg and Greenaway, 2004; Blomstrom and Kokko, 2003).

FDI can improve the managerial knowledge and marketing skills, increases efficiency and productivity, and provides a wide array of goods and services to the host economy. It has been widely recognized that MNCs are among the most technologically advanced firms investing a significant part of their resources in R&D and technology up-gradation unlike purely domestic firms (Griffith, 1999). Furthermore, FDI presents a greater potential for knowledge transfer through spillover effects if MNEs display higher productivity levels than the domestic firms. If MNEs possess knowledge-based intangible assets which are not generally available in the host country firms, then it is reasonable to assume that at least some of their technological superiority may spillover to domestic firms via different channels other than market transactions such as purchase of patents, licenses, etc. In spite of this well-known problem related to the higher productivity levels of MNEs than the domestic firms and its measurement issues (Arnold and Javorcick, 2004, p. 6) there is a relative consensus in the empirical literature on the superiority of MNEs productivity, as shown, for example, in Dimelis and Louri (2002), Torlak (2004), and Proenca *et al*. (2006). It has been demonstrated that MNCs tend to invest more in personnel training in host countries than local firms (Arnold and Javorcick, 2004).

The empirical evidence, as surveyed by Gorg and Greenaway (2004) and Crespo and Fontoura (2006), has provided mixed results. Most of the studies focus on the spillover effects of FDI on domestic firms in the same industry. The former survey found evidence of positive productivity spillovers in only seven cases. The latter authors, surveying a wider sample, reported a negative impact in 12 studies, while the existence of productivity spillovers was not confirmed in 31 cases and only 17 studies pointed to the existence of a positive impact.[4] The most important lesson to be learned from the existing literature is that it is necessary to evaluate, whether aggregate FDI spillovers exist or not by conducting a detailed analysis of the different circumstances and policies of countries, industries, and firms that promote or obstruct spillovers (Lipsey, 2002, p. 32).

While the main focus of the previous studies was based on the global evaluation of FDI productivity spillovers, this paper aims to examine whether FDI in a developing country like India precipitates positive externalities to local producers. Over the last three decades, India has taken massive reforms of its industry and financial sectors by removing the quantitative barriers in a phased manner, the lowering of tariff on imports, and the application of suitable tax policy, and land acquisition policy, etc. Since 1990s, the continuous efforts in the reduction of tariffs have opened up the Indian economy to international market forces which has led to the rapid emergence of a highly competitive environment in the industrial sector. Keeping these factors into consideration, it would

[4] Some studies focus on FDI, wages and export spillovers, as reported by Gorg and Greenaway (2004).

be an ideal testing ground to examine whether the externalities associated with FDI presence facilitate productivity spillover in Indian manufacturing industries. To examine the FDI-technology spillover in Indian manufacturing industries, the study has selected twelve 2-digit level Indian manufacturing industries.[5] We look for possible spillovers to domestic firms not only from foreign presence in the same industry (horizontal spillovers) but also try to find out the evidence of spillovers from the vertical inter-linkages between domestic and foreign firms of the different industries (vertical spillovers). Moreover, we also attempt to examine, whether absorptive capacity of domestic firms, higher concentration, and market size facilitate spillovers from FDI.

The rest of this paper has been organized as follows. Section 2 summarizes the theoretical and empirical literature on spillovers from FDI in developing and transition economies. Section 3 describes the empirical framework of the study, while Section 4 discusses the econometric procedures and its estimation strategy. Section 5 interprets the empirical results of the study. Section 6 concludes the analysis with a set of policy implications.

2. BRIEF LITERATURE REVIEW

In most of the countries, FDI is considered to be an important component of development strategy and policies are designed accordingly in order to stimulate inward flows (Crespo and Fontoura, 2007). Governments the world over try to attract FDI by offering such as trade policy concessions, financial assistance, and tax breaks. One prominent motivation for doing so is the presumption that FDI is an important channel of international technology transfer.[6]

Theoretical work has generally found a positive effect of FDI presence on domestic firms' productivity through the labor mobility channel (Kaufmann, 1997; Haaker, 1999; Fosfuri, Motta, and Rønde, 2001) or through competition and demonstration effects (Wang and Blomstrom, 1992). These models predict intra-industry or horizontal spillovers. In addition, Rodriguez-Clare (1996) outlines forward and backward linkages between foreign firms and local firms as a possible mechanism for positive spillovers. The empirical evidence on whether FDI facilitates technology spillovers is ambiguous. Caves (1974) find positive and significant spillovers in the Australian manufacturing industries. Rhee and Belot (1989) find that the entry of foreign firms is largely responsible for the creation and subsequent growth of domestically owned textiles firms in Mauritius and Bangladesh. Nevertheless, Germidis (1977) examines a sample of 65 multinational subsidiaries in 12 developing countries and find almost no evidence of technology transfer from foreign firms to local firms. Haddad and Harrison (1993) find

[5] See Appendix B, Table B. 1, for details of the selection.

[6] For an extensive review, see Gorg and Greenaway (2004).

negative spillover associated with FDI in Morocco.

Sjoholm (1999) indicates that FDI in Indonesia benefits domestic establishments in neighbouring industries within the region, while Aitken and Harrison (1999) find that FDI affects adversely in the productivity of domestic firms in Venezuela. Using panel of manufacturing industries from China, Liu (2002) finds that FDI has significant impact on the productivity of manufacturing industries in the domestic sector. Similarly, using large panel of Chinese manufacturing firms, Liu (2008) finds that an increase in FDI at the four-digit industry level lowers the short-term productivity level but raises the long-term rate of productivity growth of domestic firms in the same industry. In addition, he finds that spillovers through backward and forward linkages between industries at the two-digit level have similar effects on the productivity domestic firms, and backward linkages seem to be statistically the most important channels of FDI-technology spillover in Chinese manufacturing firms. Javorcik (2004) finds the evidence of positive productivity spillovers from foreign firms to their local suppliers in upstream sectors in Lithuania. In addition, he finds that spillovers are associated with projects with shared domestic and foreign ownership but not with fully owned foreign investments.

Kohpaiboon (2006) examines the technology spillover from FDI based on a cross-industry analysis of Thai manufacturing. She finds that liberalizing the foreign investment regime while retaining a restrictive trade policy is likely to induce the type of FDI inflows that are unlikely to introduce the technology spillover. Javorcik and Spatareanu (2008) study was based on the Romanian firm-level data sets, and their findings suggest that vertical spillovers are associated with projects with shared domestic and foreign ownership but not with fully owned foreign subsidiaries. Marcin (2008) study examines the existence of externalities associated with FDI in a host country by exploiting firm-level panel data of Polish corporate sector. He finds that the absorptive capacity of domestic firms is highly relevant to the size of spillovers, and vertical spillovers are larger for R&D investing firms, while firms investing in other (external) types of intangibles benefit more from horizontal spillovers.

Kathuria (2002) find that domestic firms in Indian manufacturing industries could be benefited from the knowledge spillovers from the presence of foreign-owned firms, provided they have significant technological capabilities to decode the spilled knowledge. Furthermore, his study finds that only scientific non-FDI firms have benefited from the trade liberalization, and in case of non-scientific firms, the impact of productivity spillover from FDI is quite negligible. Similarly, Kathuria (2001) study finds the evidence of positive spillovers in Indian manufacturing firms, but the nature and type of spillovers vary depending upon the industries to which the firms' belong. Franco and Sasidharan (2010) examine the empirical evidence for the export spillover effect in case of an emerging market economy, namely India, using firm-level data for the period 1994-2006. Their findings 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. Banga (2006) paper highlights the export-diversifying impact of FDI in a developing country like India.

FDI may lead to export diversification in the host country, and indirectly, it may encourage export diversification through spillover effects: that is, the presence of FDI in an industry may increase the export intensity of domestic firms. Her findings suggest that FDI from the US has led to diversification of India's exports, both directly and indirectly, but Japanese FDI has no significant impact on India's exports.

Previous studies examined the Intra-industry spillover, plant level productivity and FDI productivity spillover in the context of developed, developing and low developed countries, and in particular, in this paper only a few selected studies have been cited. Furthermore, few papers have discussed the different channels of FDI spillover effect across Indian manufacturing industries. Furthermore, none of the previous studies have clearly examined the intra-and inter-industry technology spillover across Indian manufacturing industries. However, there are some previous studies related to the possible channels of FDI spillovers, like forward and backward linkages with domestic firms (intra-and inter-industry spillover) in the context of developing countries,[7] but none of these papers have discussed in the context of Indian manufacturing industries. Thus, this paper empirically attempts to examine the possible FDI spillovers channels to domestic firms of Indian manufacturing industries. In other words, this paper empirically attempts to examine, whether FDI presence in Indian manufacturing industries really benefit the domestic firms productivity. Furthermore, it is imperative to discuss the significance impact of R&D activities and to examine the significance impacts of the local firms' productivity spillover from FDI in Indian manufacturing industries.

3. EMPIRICAL FRAMEWORK

In the present analysis, we develop an empirical model to assess the technology spillover effect of FDI at the industry level. Followed by Hall and Mairesse (1995), the industry-level output Y_{jt}, can be represented with a conventional Cobb-Douglas production technology:

$$Y_{jt} = A_{jt}\bar{\gamma}_{jt}^{\sigma}K_{jt}^{\alpha}L_{jt}^{\beta}e^{\varepsilon jt} , \tag{1}$$

in which K_{jt} is capital, L_{jt} is labor, α and β are their respective output elasticity's. *A* represent the industry-specific factor, and γ could be interpreted as the varieties of intermediate inputs as state of technology that summarizes all knowledge relevant to industry *j*'s production possibilities at time *t*. Assuming R&D and technology

[7] For further detailed discussion of intra-and inter-industry spillover in Thailand and Poland manufacturing industries, see, Kohpaiboon (2005) and Marcin (2008), respectively.

intensity is the determinable component of knowledge relevant to the production process, then γ includes both own and external (other) R&D and technology stocks.[8] The σ represents the elasticity share of intermediate factors upon output and we assume that $0<\sigma<1$.[9] In the present analysis, we presume that that the element of intermediate factors, which could benefit the labor productivity of domestic firms are R&D intensity and technology import intensity at the firm/industry level. Furthermore, following Coe and Helpman (1995) insights, and based on the degree of effectiveness, the R&D intensity can be separated into R&D spending of own industry (*RDI*) and other industries (*RDIO*); and similarly, technology import intensity can be separated into technology import intensity of own industry (*TMI*), and other industries (*TMIO*), respectively.[10]

Dividing Eq. (1) by labor (*L*),

$$Y_{jt} / L_{jt} = A_{jt} \bar{\gamma}_{jt}^{\sigma} \left(K_{jt} / L_{jt} \right)^{1-\beta} K^{\alpha+\beta-1} e^{\varepsilon jt} . \tag{2}$$

Taking natural logarithm in Eq. (2).

$$\ln\left(Y_{jt} / L_{jt} \right) = \ln(A_{jt} \bar{\gamma}_{jt}^{\sigma}) + \beta_1 \ln K_{jt} / L_{jt} + \beta_2 \ln K_{jt} + \varepsilon_{jt} . \tag{3}$$

In the above equation the *K* has been divided between $\ln K/L$ and $\ln K$, because the empirical estimation attempts to analyze the separate effects of size and scale factors to the productivity of the labor (Kohpaiboon, 2006). In Eq. (3), let *LP* represents the log of labor productivity (gross output divided by the unit of labor) or value added per worker of *j*th industry over different time *t* and small letter symbols like $\left(k_{jt} / l_{jt} \right)$ and

[8] The motivation in this paper is to find out the role of intermediate inputs in determining the industry-level labor productivity and FDI-technology spillover. However, apart from R&D intensity and technology import intensity, there could be the possibility of other intermediate inputs, which can affect the labor productivity of firms/industries. But due to unavailability of adequate information for some specific factors in the data base, the study primarily focuses to analyze the role of intermediate factors like R&D intensity and technology import intensity to the FDI-productivity spillover.

[9] Coe and Helpman (1995) and Lichtenberg and Van Pottelsberghe de la Potterie B. (1998) pointed out how and what extent R&D spillovers embodied in intermediate factors benefit the total factor productivity (*TFP*), so that the productivity spillovers becomes higher in the long-run.

[10] See Appendix A, for construction of the variables.

k_{jt} represents the $\ln\left(K_{jt}/L_{jt}\right)$ and $\ln K_{jt}$, respectively, then Eq. (3) can be specified as follows:

$$LP_{jt} = \ln TFP_{jt} + \beta_1\left(k_{jt}/l_{jt}\right) + \beta_2 k_{jt} + \varepsilon_{jt}\,. \tag{4}$$

In Eq. (4), the logarithm of total factor productivity (*TFP*) can be defined as follows:

$$\ln TFP_{jt} = \ln A_{jt} + \sigma \ln \overline{\gamma}_{jt}\,. \tag{5}$$

To empirically examine the FDI-technology spillover in Indian manufacturing industries, we consider the labor productivity of domestic firms (*LPd*) of an industry as the endogenous variable. Nevertheless, there could be the possibility of constant returns to scale with labor and intermediate factors, while there can be increasing returns to scale with respect to labor, capital, and industry-specific factors, etc. Furthermore, to relaxing the assumptions of constant returns to scale, the capital stock has been exogenously added into the empirical specification of model. More specifically, the total factor productivity (*TFP*) can be defined by taking the proxies of horizontal foreign presence (*HFP*), and vertical foreign presence (*VFP*) in place of *A*; R&D intensity of own industry (*RDI*), and other industries (*RDIO*); technology import intensity of own industry (*TMI*), and other industries (*TMIO*) in place of γ, respectively.[11]

Additionally, we expand our model to examine whether market size and concentration of industry facilitate spillovers from FDI. The size of the domestic market would be one of the determinant factors for MNEs when deciding modes of entry, i.e., either producing and exporting from the home country, or locating and producing within the host country. MNEs are more likely to establish their affiliates in large domestic market (Kohpaiboon, 2006). The Indian large growing market could be an attractive destination for foreign investors, and some of their knowledge based intangible-asset like technological superiority may spillover to domestic firms via channels other than market transactions, such as purchases of patents, licenses, etc.

As discussed in the previous empirical studies on the determinants of labor productivity and FDI-technology spillovers in industries, the study takes into account of

[11] The labor productivity of the domestic firms can be affected by the firm or industry-level R&D intensity and technology import intensity. However, in "Prowess" data base, there is no enough information on R&D spending and technology imports at each firm-level, and even after the financial liberalization (1991) in India, usually firms are using very negligible share of expenditure on R&D. Thus, in order to find a feasible estimation, the analysis is restricted to the industry-level study, although the variables are highly aggregated and compiled from firm-level to industry-specific effects.

the role of market concentration (*CON*) of an industry. The market concentration of an industry is needed to be incorporated into the model because two industries having the same technical efficiency may show a different value-added per worker because of different domestic market concentration. In addition, as argued by Hall (1988), the impact of any possible exogenous factors on industrial labor productivity would be conditioned by the degree of market concentration. Therefore, after substituting the different variables in place of *TFP* and after including the market size (*MSIZE*) and concentration index (*CON*) in the set of exogenous variables, the estimating equation is specified as follows:

$$\begin{aligned} LPd_{jt} &= \beta_{0i} + \beta_1 {k_{jt}}/{l_{jt}} + \beta_2 k_{jt} + \beta_3 HFP_{jt} + \beta_4 VFP_{jt} + \beta_5 RDI_{jt} + \beta_6 RDIO_{jt} \\ &\quad + \beta_7 TMI_{jt} + \beta_8 TMIO_{jt} + \beta_9 MSIZE_{jt} + \beta_{10} CON_{jt} + \varepsilon_{jt}, \end{aligned} \tag{6}$$

where j stands for the cross-section (industry) unit of data, and it varies across 12 Indian manufacturing industries, t stands for time periods, and it varies from 1990 to 2012. The detail discussions of the sources of the data and compilation of variables are given in the Appendix A.

4. ECONOMETRIC TECHNIQUES

From an econometric point of view, the present analysis follows three familiar steps. The first step is to investigate the stochastic process of the variables, which is examined by inspecting the unit root in the panel. To test the presence of stochastic trends, the present analysis uses a battery of panel unit root tests, designed explicitly to address the assumption of cross-sectional dependence. The reason for applying several panel unit root tests is to check for the robustness of our results, as the testing strategies are varied from each other. Furthermore, to examine the issue of stationarity in the underlying data, three different approaches of first generation panel unit root tests are used in the study, namely Levin Lin and Chu (LLC); Breitung; and Im, Pesaran and Shin (IPS).

Indian manufacturing industries are inter-connected in terms of their inter-industry export-import trade share, and more specifically, one industry finished products can be used as primary products in other industries. In addition, the possibility of cross-sectional dependence across cross-section units (industries) could also be raised due to variety of factors, such as omitted observed common factors, spatial spillover effects, for example via unobserved common factors, and general residual interdependence. To handle the problem of cross-sectional dependence, it is instructive to apply the panel unit root test proposed by Pesaran (2007).[12]

[12] See Maddala and Wu (1999) and Pesaran (2007, p. 266) for detailed discussion of cross-sectional

Next issue of interest in empirical research is to search for the cointegrating relationship between variables. Furthermore, researchers have started the panel cointegration framework to get econometrically robust findings (Baltagi and Kao, 2000; Pedroni, 1999, 2000; Kao and Chiang, 2000; Philips and Moon, 1999; and Westerlund, 2007). The major advantage of applying the panel cointegration technique is that it allows one to pool the long-run information and concurrently permitting the short-run dynamics of the different cross-sectional unit. The pooling can be done by either within or between dimensions. Pedroni (2001) concluded that the between dimension has relatively smaller sample distortions. Furthermore, to estimate the cointegrating relationship between variables in Eq. (6), we apply residual based cointegration tests, namely the Pedroni (2001, 2004),[13] and Kao (1999) test, and recently introduced error-correction based Westerlund (2007) test. Westerlund (2007) error-correction based test not only allow for various form of heterogeneity, but it also provides *p*-values which are robust against cross-sectional dependence via bootstrapping. In this cointegration test, four test statistics are proposed; two are designed to test the alternative that the panel is cointegrated as whole, while the other two are designed to test the alternative that variables in at least one cross-section unit are cointegrated. The former two test statistics are referred as group statistics (G_τ and G_α); while the later two are referred to as panel statistics (P_τ and P_α). In case of the group-mean statistics, the error-correction coefficients are estimated for each cross-section unit individually, and then average statistics are calculated, usually denoted as G_τ and G_α statistics (Breitung and Das, 2005). The null hypothesis of this test is no error-correction. If the null is rejected, then there is an evidence of cointegrating relationship between variables in question.

Having found the convincing evidence of cointegrating relationship between variables in Eq. (6), it is practical interest to estimate the consistent parameter estimates of the discussed variables. However, using standard ordinary least squares (*OLS*) technique on non-stationary panel data may lead to false inferences in the estimating equation. Thus to avoid the kind of inconsistency with respect to the OLS method, it is instructive to apply the fully modified *OLS* (*FMOLS*) proposed by Pedroni (2001) and dynamic *OLS* (*DOLS*) estimator proposed by Stock and Watson (1993). *FMOLS* is believed to eliminate the problem of endogeneity in the regressors, and serial correlation in the errors, which may lead to consistent estimate of parameters in relatively small samples.[14] Similarly, the *DOLS* estimator solve the problem of endogeneity, multicollinearity, and serial correlation by including leads and lags of the differenced *I(1)*

dependence in panel data.

[13] Pedroni (2001, 2004) proposes seven statistics to check the presence of cointegration. Furthermore, out of seven statistics, if four statistics are in favour of the cointegration, then we infer the presence of cointegration between variables.

[14] See Ramirez (2007) for detailed discussion of the panel cointegration, and consistent parameters estimates in relatively small samples.

regressors in the regression. Moreover, before going to interpret the regression results, the statistical summary and correlating matrix of the variables are given in the following Tables 1 and 2.

Table 1. A Statistical Summary of the Key Variables

Variables	*Mean*	*SD*	*Min*	*Max*
LPd	9.966	2.083	7.58	15.963
k/l	12.777	3.914	0.754	17.927
k	13.184	4.405	0.512	20.742
CON	0.137	0.167	0.009	0.845
HFP	0.178	0.155	0.034	0.594
VFP	0.070	0.013	0.039	0.105
RDI	0.002	0.002	0	0.047
RDIO	0.002	0.0006	0.002	0.05
TMI	0.017	0.014	0.001	0.089
TMIO	0.026	0.049	0.005	0.367
MSIZE	9.104	2.099	2.549	13.892

Source: Author's estimations are based on data series discussed in the Appendix A. No. of observations, NT=276.

Notes: Mean= simple average; SD= standard deviation; Min= minimum; and Max= maximum. Estimates of *LPd*, *k/l*, *k*, are logarithmic transformation of their value. The other variables are converted into logarithmic form as ln(1+*x*) where *x* is the variable.

Table 2. Correlation Matrix of the Variables

	LPd	*k*	*k/l*	*RDI*	*TMI*	*HFP*	*VFP*	*RDIO*	*TMIO*	*MCON*	*MSIZE*
LPd	1										
K	0.270	1									
k/l	0.274	0.808	1								
RDI	-0.037	0.131	0.099	1							
TMI	0.073	0.154	0.207	0.048	1						
HFP	-0.169	-0.470	-0.303	0.004	-0.164	1					
VFP	0.039	-0.036	-0.316	0.117	0.148	-0.150	1				
RDIO	0.224	0.077	0.128	0.002	0.360	-0.009	0.137	1			
TMIO	0.208	0.041	-0.080	0.116	0.052	-0.058	0.627	0.042	1		
MCON	-0.086	-0.371	-0.205	-0.128	-0.129	0.176	0.044	-0.018	-0.117	1	
MSIZE	0.485	0.258	0.049	0.161	-0.216	-0.010	0.103	-0.055	0.248	-0.267	1

Source: Author's estimations are based on data series discussed in the Appendix A. No. of observations, NT=276.

5. ESTIMATION RESULTS

This section reports and analyzes the panel unit root and cointegration tests results. In addition, this section interprets and analyzes the panel estimation results. There are several panel unit root tests in the literature. However, there is no uniformly powerful test for the unit root hypothesis. This paper uses three popular panel unit root tests, namely LLC, Breitung, and IPS, for testing unit root in dependent, and in the set of independent variables. These test results are reported in Table 3. In the case of unit root testing, the automatic selection of lag length is chosen on the basis of Schwartz Information Criteria (SIC), and Newey-West bandwidth selection using Bartlett and Kernel. Test results show that all variables under consideration contain unit root at their level.[15] However, as discussed before, there is an evidence of cross-sectional dependence in panel data; so, it is instructive to consider the issue of cross-sectional dependence, while examining the stationarity and cointegrating relationship between variables under consideration. In addition, the literature illustrates that the first generation panel unit root tests could not solve the problem of cross-sectional dependence.[16] So, to handle this problem, we also apply the Pesaran (2007) test along with the other first generation panel unit root test.

The Pesaran (2007) panel unit root test results are reported in Tables 4 and 5. The results show that the presence of unit root for variable under consideration at level cannot be rejected by Pesaran (2007) test. So, in both first and second generation panel unit root tests, the null of unit root cannot be rejected at level in panel data. Next, these tests are also applied on the variables in first differences, and the results find evidence in favor of the rejection of the non-stationary hypothesis for all variables (see Tables 3 and 5), which justifies the possibility of cointegration. Furthermore, when the variables are integrated to order one, then the next issue of interest in empirical research is to search for the long-run relationship between them. Therefore, cointegration analysis proposed by Pedroni (1999, 2004) is used next, and all Pedroni proposed seven tests based on the null hypothesis of no cointegration are considered. The results are reported in Table 6. Cointegration results are encouraging and show that the variables are cointegrated under both within and between dimension statistics. Out of 7 statistics, 4 are highly significant; indicate cointegrating relationship between labor productivity of domestic firms and the set of independent variables under consideration.[17]

[15] Except in few exceptional cases, that is, out of three familiar unit root tests, most of these test results are in favour of the presence unit root at level.

[16] For further discussion, see, Bai and Ng (2004), Breitung and Das (2005), Moon and Perron (2004), Pesaran (2007), and Smith *et al*. (2004).

[17] In order to find out the cointegration between labor productivity of domestic firms (*LPd*) and the set of explanatory variables, we do the Pedroni cointegration between *LPd* and the different set of independent variables, only altering the independent variables. In addition, we find that in most of the cases, there is the presence of cointegration between *LPd* and the different set of explanatory variables.

Table 3. Test Results for Unit Roots

	Constant			Constant and Trend		
Variables	*LLC*	*Breitung*	*IPS*	*LLC*	*Breitung*	*IPS*
LPd	1.136	0.871	-1.290	0.055	-1.436	-1.075
	(0.872)	(0.803)	(0.0985)	(0.522)	(0.075)	(0.141)
Δ*LPd*	-7.124	-4.333	-9.595	-4.841	-7.999	-6.588
	(0.000)	(0.000)	(0.000)*	(0.000)	(0.000)	(0.000)
k	-2.472	-2.219	-5.074	-1.771	-3.605	-1.718
	(0.006)	(0.132)	(0.000)	(0.038)	(0.000)	(0.042)
Δ*k*	-8.858	-8.970	-10.835	-7.073	-11.492	-7.326
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
k/l	-0.342	-4.260	0.849	-0.091	-4.034	-0.445
	(0.366)	(0.500)	(0.803)	(0.463)	(0.000)	(0.328)
Δ*k/l*	-9.816	-8.709	-9.136	-7.136	-8.826	-5.498
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CON	1.833	3.789	2.932	-0.434	2.947	1.154
	(0.966)	(0.999)	(0.998)	(0.331)	(0.998)	(0.875)
Δ*CON*	-5.306	-4.049	-7.007	-4.723	-5.132	-6.163
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
HFP	-0.161	-2.756	-0.833	-0.163	-3.023	-0.774
	(0.435)	(0.290)	(0.202)	(0.435)	(0.001)	(0.219)
Δ*HFP*	-9.451	-7.504	-8.572	-5.349	-7.815	-4.677
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
VFP	2.399	-0.670	1.194	2.118	-2.601	1.718
	(0.991)	(0.251)	(0.883)	(0.983)	(0.004)	(0.957)
Δ*VFP*	-10.789	-8.982	-8.717	-7.359	-7.953	-4.261
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RDI	-0.835	-1.754	-3.360	-1.932	-1.235	-1.375
	(0.207)	(0.397)	(0.004)	(0.026)	(0.108)	(0.084)
Δ*RDI*	-8.609	-1.754	-9.071	-6.704	-10.086	-6.876
	(0.000)	(0.039)	(0.000)	(0.000)	(0.000)	(0.000)
RDIO	1.154	-4.105	-1.888	3.202	-4.348	0.652
	(0.875)	(0.000)	(0.295)	(0.999)	(0.000)	(0.742)
Δ*RDIO*	-2.872	-8.963	-7.738	5.202	-7.287	-2.671
	(0.002)	(0.000)	(0.000)	(1.000)	(0.000)	(0.003)
TMI	-1.803	-2.882	-3.135	-0.628	-2.571	-0.666
	(0.035)	(0.210)	(0.900)	(0.264)	(0.005)	(0.252)
Δ*TMI*	-10.249	-7.566	-9.581	-6.865	-8.910	-5.849
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
TMIO	19.369	5.959	3.704	3.324	3.340	4.423
	(1.000)	(1.000)	(0.999)	(0.999)	(0.999)	(1.000)

ΔTMIO	-3.265	-2.733	-5.3116	-4.420	-5.530	-3.965
	(0.003)	(0.093)	(0.002)	(0.000)	(0.000)	(0.000)
MSIZE	-7.274	2.696	-3.033	-2.878	2.696	-0.095
	(0.000	(0.996)	(0.001)	(0.002)	(0.996)	(0.462)
ΔMSIZE	-5.686	-4.975	-5.668	-3.897	-4.975	-4.563
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: 1. Automatic selection of maximum lags. Automatic selection of maximum lags is based on SIC: 0 to 2. Newey-West bandwidth selection using Bartlett and Kernel. No. of observation, NT=276.

Table 4. Pesaran (2007) Panel Unit Root Test (CADF Test)

Lags	*Variables*	*Constant*			*Constant and Trend*		
		[t-bar]	Z [t-bar]	P-value	[t-bar]	Z [t-bar]	P-value
0	*LPd*	-2.006	-0.843	0.200	-3.136	-3.039	0.001
1	*LPd*	-1.526	0.871	0.808	-2.643	-1.203	0.114
0	*k*	-3.579	-6.460	0.000	-3.626	-4.863	0.000
1	*k*	-3.264	-5.334	0.000	-3.176	-3.187	0.001
0	*k/l*	-2.966	-4.273	0.000	-3.600	-4.766	0.000
1	*k/l*	-2.330	-2.001	0.023	-3.203	-3.288	0.001
0	*RDI*	-2.098	-1.172	0.121	-2.507	-0.696	0.243
1	*RDI*	-2.099	-1.175	0.120	-2.413	-0.347	0.364
0	*TMI*	-2.633	-3.080	0.001	-2.837	-1.927	0.027
1	*TMI*	-2.413	-2.298	0.011	-2.669	-1.301	0.097
0	*HFP*	-2.302	-1.898	0.029	-2.453	-0.495	0.310
1	*HFP*	-2.198	-1.530	0.063	-2.351	-0.114	0.454
0	*VFP*	-0.927	3.011	0.999	-1.237	4.035	1.000
1	*VFP*	-0.732	3.708	1.000	-1.043	4.756	1.000
0	*RDIO*	-2.608	-2.991	0.001	-3.171	-3.171	0.001
1	*RDIO*	-1.837	-0.240	0.405	-2.271	0.182	0.572
0	*TMIO*	-1.782	-0.042	0.483	-2.099	0.823	0.795
1	*TMIO*	-1.776	-0.020	0.492	-1.996	1.206	0.886
0	*CON*	-1.446	1.157	0.876	-2.784	-1.728	0.042
1	*CON*	-1.186	2.085	0.981	-2.546	-0.841	0.200
0	*MSIZE*	-2.664	-3.192	0.001	-2.735	-1.546	0.061
1	*MSIZE*	-2.600	2.963	0.002	-2.471	0.562	0.287

Notes: We report the [t-bar] and Z [t-bar] statistics in the Table. Under the null of all cross-sectional (industry) series containing a non-stationary process this statistic has a non-standard distribution. The critical values including constant are -2.140 for 10%, -2.250 for 5%, and -2.450 for 1% significance level, respectively. The critical values including constant and trend are -2.660 for 10%, -2.760 for 5%, and-2.960 for 1% significance level, respectively.

Table 5. Pesaran (2007) Panel Unit Root Test (CADF Test)

Lags	*Variables*	*Constant*			*Constant and Trend*		
		[t-bar]	Z [t-bar]	P-value	[t-bar]	Z [t-bar]	P-value
0	Δ*LPd*	-5.276	-12.520	0.000	-5.463	-11.705	0.000
1	Δ*LPd*	-4.034	-8.084	0.000	-4.156	-6.838	0.000
0	Δ*k*	-5.602	-13.686	0.000	-5.629	-12.326	0.000
1	Δ*k*	-4.100	-8.319	0.000	-4.052	-6.451	0.000
0	Δ*k/l*	-5.639	-13.816	0.000	-5.624	-12.308	0.000
1	Δ*k/l*	-4.614	-10.157	0.000	-4.533	-8.244	0.000
0	Δ*RDI*	-5.055	-11.730	0.000	-5.098	-10.347	0.000
1	Δ*RDI*	-3.817	-7.312	0.000	-3.811	-5.552	0.000
0	Δ*TMI*	-5.007	-11.561	0.000	-5.097	-10.344	0.000
1	Δ*TMI*	-4.165	-8.553	0.000	-4.259	-7.221	0.000
0	Δ*HFP*	-4.681	-10.397	0.000	-4.590	-8.456	0.000
1	Δ*HFP*	-3.248	-5.277	0.000	-3.194	-3.254	0.001
0	Δ*VFP*	-4.141	-8.466	0.000	-4.699	-8.862	0.000
1	Δ*VFP*	-2.113	-1.226	0.110	-2.687	-1.368	0.086
0	Δ*RDIO*	-5.622	-13.757	0.000	-5.773	-12.862	0.000
1	Δ*RDIO*	-3.356	-5.665	0.000	-3.344	-3.814	0.000
0	Δ*TMIO*	-4.687	-10.418	0.000	-4.797	-9.226	0.000
1	Δ*TMIO*	-3.092	-4.722	0.000	-3.188	-3.234	0.001
0	Δ*CON*	-5.360	-12.822	0.000	-5.597	-12.205	0.000
1	Δ*CON*	-3.559	-6.390	0.000	-3.831	-5.628	0.000
0	Δ*MSIZE*	-4.656	10.307	0.000	-5.067	10.232	0.000
1	Δ*MSIZE*	-3.447	5.991	0.000	-3.290	3.613	0.000

Notes: We report the [t-bar] and Z [t-bar] statistics in the Table. Under the null of all cross-sectional (industry) series containing a non-stationary process this statistic has a non-standard distribution. The critical values including constant are -2.140 for 10%, -2.250 for 5%, and -2.450 for 1% significance level, respectively. The critical values including constant and trend are -2.660 for 10%, -2.760 for 5%, and-2.960 for 1% significance level, respectively.

However, as there is evidence of cross-sectional dependence, and to handle the problem of cross-sectional dependence, we use the panel cointegration test proposed by Westerlund (2007). The error-correction based test proposed by Westerlund (2007) not only provides the efficient estimation to find out the cointegrating relationship between variables in case of cross-sectional dependence but it also takes into account of the various forms of heterogeneity in the panel.[18] Table 7 reports the results of this

[18] The Westerlund (2007) test which accounts for cross-sectional dependence is sensible to apply to the specifications while the Pedroni test points towards the presence of cointegration (Banerjee and Carrion-i-Silvestre, 2006).

cointegration test. The test results suggest that 4 of reported 3 statistics points towards the presence of cointegration between labor productivity of domestics firms and foreign presence (see Columns 2 and 3). Furthermore, when we consider to altering the covariates, then 3 out of 4 reported statistics points towards the rejection of null hypothesis of no-cointegration (see Columns 4 and 5). In addition, while altering the covariates and considering in taking more covariates in the set of independent variables, then the null of no error correction is rejected at the 1% significance level for one of the panel statistic (see Columns 6 and 7). It indicates that *LPd* and the set of explanatory variables are cointegrated in at least one cross-section unit. In addition, these results indicate that the existence of cross-sectional dependence between industries does not invalidate the results obtained in Pedroni's residual-based cointegration test.

Table 6. Test Results for Panel Cointegration, Pedroni (2004)

1	2	3 Without trend	4 With Trend	5 Without Trend	6 With Trend	7 Without Trend	8 With Trend
Within-dimension	Panel V-Statistics	0.374 (0.354)	-0.981 (0.836)	-0.484 (0.685)	-1.800 (0.964)	0.607 (0.271)	-0.976 (0.835)
	Panel Rho-Statistic	0.791 (0.785)	1.834 (0.966)	1.588 (0.943)	1.795 (0.963)	-0.250 (0.401)	0.507 (0.694)
	Panel PP-Statistic	-6.267 (0.000)	-6.485 (0.000)	-4.042 (0.0000)	-5.639 (0.000)	-5.775 (0.000)	-6.456 (0.000)
	Panel ADF-Statistic	-3.562 (0.0002)	-2.917 (0.001)	-1.444 (0.0743)	-1.528 (0.063)	-1.067 (0.143)	-1.428 (0.076)
Between-dimension	Group Rho-Statistic	1.982 (0.976)	3.227 (0.999)	2.761 (0.997)	2.460 (0.993)	2.225 (0.987)	3.493 (0.999)
	Group PP-Statistic	-8.399 (0.0000)	-7.578 (0.000)	-4.042 (0.0000)	-6.933 (0.000)	-9.851 (0.000)	-7.915 (0.000)
	Group ADF-Statistic	-2.803 (0.002)	-3.236 (0.0006)	-1.444 (0.074)	-2.427 (0.007)	-1.691 (0.045)	-1.545 (0.061)
Kao Residual Cointegration Test	t-statistic	-3.347 (0.000)		-3.475 (0.000)		-1.211 (0.112)	

Notes: 1. Newey-West automatic bandwidth selection using Bartlett and Kernel. User specified lag length: 1. 2. Columns 3 and 4 regressors are *k, k/l, CON, HFP, VFP, RDI*. 3. Columns 5 and 6 regressors are *k, k/l, HFP, VFP, TMI, TMIO*. 4. Columns 7 and 8 regressors are *TMI, TMIO, RDI, RDIO, CON, MSIZE*

Table 7. Test Results for Panel Cointegration, Westerlund (2007)

Test	2 Without Trend	3 With Trend	4 Without Trend	5 With Trend	6 Without Trend	7 With Trend	8 Without Trend	9 With Trend
G_t	-2.950	-3.321	-2.717	-3.458	-3.475	-3.602	-3.526	-3.373
	(0.006)	(0.000)	(0.038)	(0.001)	(0.011)	(0.054)	(0.006)	(0.226)
G_α	-13.066	-12.712	-9.958	-12.256	-7.585	-6.831	-7.412	-6.926
	(0.296)	(0.361)	(0.690)	(0.921)	(1.000)	(1.000)	(1.000)	(1.000)
P_t	-10.238	-11.245	-10.319	-14.028	-9.881	-12.727	-9.413	-9.197
	(0.000)	(0.000)	(0.000)	(0.000)	(0.187)	(0.006)	(0.325)	(0.851)
P_α	-13.310	-12.714	-11.020	-15.482	-7.267	-7.183	-6.262	-5.882
	(0.007)	(0.016)	(0.030)	(0.066)	(0.990)	(1.000)	(0.997)	(1.000)

Notes: 1. The Westerlund (2007) tests take no cointegration as the null. The test regression is fitted with a constant, constant and trend, and one lag and one lead. The width of the Bartlett kernel window is used in the semi-parametric estimation of long run variances. The *P*-values are for a one-sided test based on the normal distribution and reported in the parenthesis. 2. Columns 2 and 3 represent 12 series and 1 covariate (*HFP*). 3. Columns 4 and 5 represent 12 series and 3 covariates (*k*, *k/l*, and *HFP*). 4. Columns' 6 and 7 represent 12 series and 6 covariates (*k, k/l, HFP, VFP , RDI,, TMI*). 5. Column 8 and 9 represent 12 series and 6 covariates (*HFP, VFP, RDI, TMI, CON, MSIZE*)

As discussed before, and after getting the convincing evidence on the cointegrating relationship between variables, it is of practical interest to estimate the consistent parameters of the discussed variables. The FMOLS procedure proposed by Pedroni (2000, 2001) and DOLS procedure proposed by Stock and Watson (1993) are used to estimate the parameters in Eq. (6). FMOLS and DOLS are estimated by incorporating with and without time dummies. Pedroni (2000) notes that common time dummies are intended to capture certain types of cross-sectional dependency in the panel. Table 8 reports the FMOLS and DOLS results for the whole panel.

The results show that, in both estimates, the regression coefficients of foreign presence are found to be un-expectably negative. One possible explanation could be that the correlation between productivity of domestic firms and the foreign presence in the same industry does not necessarily result from leakages of superior technology possessed by foreign firms, but rather reflects imitation of their organizational practices by local firms or just elimination of inefficiencies forced by increased competition. Nevertheless, the technological gap between the local and foreign firms in the upstream market is too large for the latter to upgrade their existing technology based on their own research effort. In addition, the technological gap between local and their competitors from abroad is too large for the former to exploit additional spillovers relying only on their own R&D based absorptive capacity (Marcin, 2008). Nevertheless, it could also be happened that the technological externalities associated with MNCs are not good enough or raise the issue of appropriateness of these technology to the local firms.

The coefficients of vertical foreign presence are found to be positive and statistically significant. This suggests that benefits reaped by the local firms from the foreign presence in downstream market increase the overall productivity of domestic companies. In other words, they can increase their benefit they reap from inter-industry foreign presence reaching out for upgrading the stock of knowledge, adopting the advanced technology, and the fruits of other firms' innovation efforts, which embodied in available patents, licenses, software, etc.

We next examine whether firms with greater absorptive capacity (measured by R&D stock) benefit more from foreign presence than others.[19] We start the analysis by taking the first measure of firm's innovation effort, *RDI*, which can be interpreted as R&D intensity at the industry-level. The *RDI* could be interpreted as the predominant factor for spillover to take place in the local firms. Our results suggest that domestic firms those are involved in R&D, benefit more from the foreign presence, and facilitate to increase their labor productivity. Furthermore, our results also suggest that foreign firms build their local supply chains by transferring technology to local firms with sufficient absorptive capacity. A positive coefficient of *RDI* indicate that domestic firms with higher absorptive capacity can exploit technology and knowledge embodied in intermediate goods produced by multinational firms better than others.[20] On the other hand, the statistical significance of inter-industry R&D intensity suggests that higher involvement of R&D intensity at the inter-industry level persuade competition between the firms of different industries, and demonstrate to invest in R&D. Furthermore, the empirical results suggest that higher competition is associated with larger spillovers from FDI-presence. The plausible interpretation is that domestic firms operating in highly competitive environment have high learning ability are certainly more effective and therefore better prepared to cooperate with foreign clients, which are in certain circumstances usually more demanding and high-quality oriented.

[19] For further detailed discussion of FDI presence, R&D, and absorptive capacity of the domestic firms, see Girma (2005).

[20] Since 1991, after the trade liberalization in India, many of the domestic firms are not doing much investment in R&D, and many of the Indian firms are not reporting their R&D expenditure on regular basis. So, due to this limitation, we do not find a very high significant impact of R&D intensity to the value addition of labor. However, the coefficient at DOLS estimate (without time dummy) is found to be positive and significant, but in rest of the estimates, these coefficients are found to be statistically insignificant.

Table 8. Panel Cointegration Estimation, Dependent variable: *LPd*

	Panel without time dummy		*Panel with time dummy*	
Variables	*FMOLS*	*DOLS*	*FMOLS*	*DOLS*
k	0.227***	-0.141	0.196**	0.120
	(1.669)	(-0.715)	(1.684)	(0.655)
k/l	0.279*	0.235*	0.069***	0.064
	(5.779)	(3.999)	(1.687)	(1.094)
CON	0.658	0.983	3.209*	2.959**
	(0.746)	(1.075)	(2.568)	(2.108)
HFP	-1.604	-2.114	-6.246**	-4.940*
	(-1.102)	(-1.247)	(-4.367)	(-2.715)
VFP	3.576*	2.512*	2.060**	3.052
	(2.338)	(2.933)	(1.919)	(1.037)
RDI	-0.161	3.648*	1.744	3.472
	(-2.807)	(2.461)	(0.852)	(0.195)
RDIO	2.102*	4.312**	5.523*	4.011*
	(2.676)	(1.955)	(4.011)	(3.101)
TMI	1.507*	7.080	5.436	5.137
	(0.542)	(1.011)	(0.982)	(0.761)
TMIO	1.302***	0.902	1.693*	1.220
	(1.065)	(1.140)	(0.803)	(1.393)
MSIZE	1.237***	1.199***	0.161	1.167***
	(0.617)	(0.195)	(0.630)	(0.569)
R^2	0.819	0.934	0.890	0.959
Adjusted R^2	0.804	0.858	0.875	0.904
Durbin-Watson stat	1.083	1.565	1.278	1.8102
Long-run variance	1.198	0.380	0.659	0.192
No. of Obs.	264	264	264	264

Notes: *t*-statistics are reported in parenthesis. ***, ** and * indicate 10%, 5% and 1% level of significance, respectively. *DOLS* regressions include one lead and one lag for the differenced regressors. AR lags in computing is S (0) 1.

We repeat our analysis by examining the second measure of innovation effort, *TMI*, which indicates the technology import intensity at the industry level. We find that the coefficients of technology import intensity and inter-industry technology import intensity are found to be significant. This could suggests that investing in technology up-gradation and in intangible assets, and importing the capital goods from foreign clients helps to increase the benefits reaped by domestic firms from FDI presence in industries. Moreover, it also suggests that domestic firms involved in using technologically superior inputs from the foreign supplier in a highly competitive environment are more effective and enable to exploit the additional spillover from FDI presence in industry. Conversely, this means that domestic firms those who are willing to invest in R&D, and importing intermediate capital goods can reap the benefit from foreign presence and grow faster than their rivals, which are not investing in R&D and technology up-gradation. Furthermore, it can be seen from the Table 8 that the coefficients of capital and capital intensity are found to be positive and statistically significant. This suggests that both capital and capital intensity substantially adding the value addition of labor in Indian manufacturing industries.

We next try to examine how higher concentration and market size affects the productivity of domestic firms and what role it plays in accounting for the extent of spillovers from foreign presence. Our results suggest that higher concentration seems to be consistent with larger spillovers from foreign presence in the industry. Similarly, size of the domestic market plays a leading role to attract the foreign investors, and persuade to gravitating their plant in the highly competitive and large growing domestic sector. This result seems to be consistent with the insight of Marcin (2008), according to him, using the foreign technological superior inputs could lead to productivity gains, but it may require additional costs (for instance, investment, training for the employees, marketing of new products), which can only be covered if firm has market power and enough skill, or is able to expand its market share exploiting increasing returns to scale.

6. CONCLUDING REMARKS

This paper has examined whether productivity externalities from FDI really benefit the labor productivity of domestic firms. We find stronger vertical spillovers and no significant horizontal spillovers. Nevertheless, although this paper confirms the existence of positive productivity externalities associated with FDI presence, but the policy implications are not straight forward. On the other hand, there is also evidence that the measure of innovation effort (R&D intensity as well as technology intensity) play an important role in determining to reap the benefits from FDI presence in industries. Finally, we find that the highly concentrated market structure and large growing market size significantly impacts on the value added per worker.

From this paper, we find that FDI presence in one sense seems to be raised the productivity spillover in Indian industries, but at the same time the risk of FDI presence cannot be avoided. It is generally recognized that FDI brings multiple benefits to the recipient country. With this presumption, many countries competing for FDI, so there is the risk of overbidding, i.e. granting subsidies surpassing the level of spillover benefits (see Oman, 2000). In addition, the granting subsidies create market distortions, which may lead to welfare losses in the host country. From this paper, we find domestic firms that exhibit laggard technological capability relative to a foreign firm could not reap the benefit from the FDI presence in the same industry, and would be lower labor productivity. Our significant findings of vertical spillover should not necessarily be viewed as a call for policies enforcing links between foreign investors and local recipient firms/supplier, such as local content requirements. The local content requirements like input tariff may discourage the foreign investors (see Gorg and Greenaway, 2004).

In our view, the policy implications in this paper are consistent with the suggestions of Blomstrom and Kokko (2003) and Marcin (2008). The policies are designed to strengthening the absorptive capacity of domestic firms. This can be achieved through the direct subsidies to domestic firms investing in knowledge and human capital formation. The direct subsidies and creating research infrastructure can close the gap between foreign and local firms, and later on it could raise the absorptive capacity of the domestic firms. In addition, subsequent step in reforms can increase the competition, particularly in sectors supplying advanced technological firms, and could benefit the country growth rate. Furthermore, increasing the quality of institutions, modern infrastructure, and improving the other fundamentals like creating better investment climate with transparent labor laws can create a healthy completion, and able to attract such FDI those are likely to introduce technology spillover and also become beneficial to the domestic firms.

APPENDIX A

Data

The data in this paper mainly comes from the Centre for Monitoring Indian Economy (CMIE) based corporate data base ‘Prowess’, Annual Survey of Industries (ASI) and National Accounts of Statistics (NAS), and Central Statistical Organization.

Variables

Labor productivity

LPd: The labor productivity at the firm-level is constructed by dividing the gross value added to the number of man-days (labor) of firm of an industry. The analytical estimation is restricted to the industry-level, so the labor productivity has been constructed to the industry-specific variable. Furthermore, in order to construct the labor productivity of domestic firms as an industry-specific variable, we simply doing the average of the labor productivity over domestic firms in an industry for a specific period of time.

Capital (*k*): For the present study, to construct the capital variable from the Prowess data set we simply follow the methodology derived by Srivastava (1996) and Balakrishnan *et al.* (2000). They used the perpetual inventory method, which involves capital at its historic cost. However, the direct interpretation of the perpetual inventory method is not an easy task. Therefore, the capital stock has to be converted into an asset value at replacement cost. The capital stock is measured at its replacement cost for the base year 1993-94. Nest, we follow the methodology of Balakrishnan *et al.* (2000) to arrive at a revaluation factor. The derivations of revaluation factors, R^G and R^N for initial years gross (*G*) and net (*N*) capital stocks are discussed below.

The balance sheet values of the assets in an initial year have been scaled by the revaluation factors to obtain an estimate of the value of capital assets at replacement cost.[21] Nevertheless, the replacement cost of capital $= R^{i*}$ (value of capital stock at historic cost), where i stands for either gross (*G*) or net (*N*) value. The formula to obtain the value of the capital stock at historic cost (GFA_t^h) is given below:

$$GFA_t^h = P_t I_t^* ((1+g)(1+\pi)/(1+g)(1+\pi)-1),$$

where $P_t =$ Price of the capital stock; $I_t =$ Investment at the time period *t* (*t* =1993) = the difference between the gross fixed assets across two years, i.e., $I_t = GFA_t - GFA_{t-1}$, *g* stands for the growth rate of investment, i.e., $g = (I_t / I_{t-1}) - 1$ and $\pi = (P_t / P_{t-1}) - 1$. The revaluation factor for the gross fixed asset is, $R^G = (l+g)(l+\pi) - 1/g(1+\pi)$. Here, *l* stands for the life of the machinery and equipment. However, the revaluation factor has been constructed by assuming that the life of machinery and equipment is 20 years and the growth of the investment is constant throughout the period. We again presume that the price of the capital stock has been changed at a constant rate from the date of incorporation of the firm to the later period, i.e., from 1990 to 2012.

The revaluation factor has been used to convert the capital in the base year to the capital at replacement cost, at current prices. We then deflate these values to arrive at the values of the capital stock at constant prices for the base year. The deflator used for this purposes could be obtained by constructing the capital formation price indices from the series of gross capital formation of NAS. Then, subsequent year's capital stocks are arrived by taking the sum of investments to the capital stock at constant prices.

Labor (*l*): For the present study, the principal source of the data base is Prowess. Our key analysis is based on the Prowess data set. However, the Prowess data base does not provide any exact information of labor per unit of the firms. Thus, we need to use this information as man-days per firm. Man-days at the firm level are obtained by dividing the salaries and wages of the firm to the average wage rate of an industry to which the firm belongs. The formula to obtain the man-days at the firm-level is as follows:

Number of man-days per firm = salaries and wages/average wage rate.

Furthermore, to get the average wage rate of an industry, we collect the information from ASI. The ASI has the information on total emoluments and total man-days for the

[21] See Srivastava (1996, 2000) for detailed discussion of the perpetual inventory method to compile the real gross capital stock from the CMIE based data set Prowess.

relevant industry groups. The average wage rate can be obtained by dividing the total emoluments to the total man-days for the relevant industry groups (average wage rate = total emoluments/ total man-days).

Capital Intensity (*k/l*): Capital intensity at the firm level can be obtained by dividing the real gross capital stock to the labor of that firm. To get capital intensity as an industry-specific variable, we simply divide the summation over all firms' capital stock to the summation over all firms' labor (man-days) within an industry.

Market Concentration (*CON*): The market concentration is proxied by the widely used proxies of Herfindahl-Hirschman index (*HHI*) of concentration. The formula of *HHI* of market concentration is given below:

$$HHI = \sum_i \left(s_{ij} \Big/ \sum s_{ij} \right)^2 ,$$

where s_{ij} is a total sale of the *i*th firm in the *j*th industry.

Horizontal Foreign Presence (*HFP*): Horizontal foreign presence is defined as the share of an industry output produced by foreign-owned firms. However, in some previous empirical studies, employment or capital shares have been used to measure the foreign presence. Taking foreign presence as an employment share tends to underestimate the actual role of foreign affiliates because MNEs affiliates tend to be more capital intensive than the locally non-affiliated firms. Conversely, the capital share can be easily distorted by the presence of foreign ownership restrictions. Hence, the output share is considered as the preferred proxy (Kohpaiboon, 2006). So, the horizontal foreign presence for industry *j* at time *t* could be specified as follows.

$$HFP_{jt} = \frac{\sum_{i \in j} Y_{it} \cdot F_{it}}{\sum_{i \in j} Y_{it}} ,$$

where Y_{it} is the value of gross output for firm *i* at time *t*, and F_{it} is a dummy variable equal to one if the firm is foreign-owned firms and zero otherwise.[22]

Vertical Foreign Presence (*VFP*): Vertical foreign presences are designed to capture the vertical spillovers to domestic firms in an industry. Nevertheless, vertical spillover variable is used as a measure to capture the productivity spillovers to those domestic firms, which supply inputs to multinational firms. We proxy the share of a firm output

[22] Firm with foreign equity of 10% or more than that are considered as foreign firms. According to the International Monetary Fund (IMF) criterion, this is a very standard threshold level to classify between domestic and foreign firms.

sold to foreign firms by the share of an industry output sold to foreign firms in different downstream industries. Then how to measure the share of an industry output sold to foreign firms in other industries. We assume that a firm share of an industry use of a particular input is equal to its output share, and then a measure of the share of an industry output sold to foreign firms is the sum of the output shares purchased by other industries multiplied by the share of foreign output in each industry (Blalock and Gertler, 2008). So, the vertical foreign presence for industry *j* at time *t* could be specified as follows.

$$VFP_{jt} = \sum_{j \neq l} \alpha_{jl} HFP_{jt} ,$$

where α_{jl} is the proportion of industry *j*'s output supplied to industry *l*, which is taken from the 2003-04 input-output transaction table at the two-digit level (NIC-1998) provided by the Central Statistical Organization. The formula shows that inputs supplied within the sector are not included, since the horizontal foreign presence captures this effect.

R&D Intensity

RDI: The R&D intensity at the firm level is measured by the share of R&D expenditure to total sales. To construct R&D expenditure as an industry-specific variable, we simply divide the summation of R&D expenditure of all firms within an industry to the summation of total sales of all firms of that industry for a specific year. Then subsequent years R&D intensity as an industry-specific variable are constructed by this procedure.

*RDIO***:** R&D intensity of other industry (other than *j* but summing over *j**) (inter-industry R&D intensity) has been compiled by taking the sum of all *j** industries R&D expenditure to the total sales of the other *j** industries rather than *j*. For instance, we want to measure the R&D intensity of other industries (*RDIO*) for the food products industry, then, we take the sum of R&D expenditure of all eleven industries (excluding the R&D spending of food products industry) out of twelve selected industries divided by the sum of total sales of the eleven industries (excluding the sales of food products industry).

Technology Import Intensity (*TMI*)

*TMI***:** The technology imports can be broadly classified into two categories as embodied technology, consisting of imported capital goods and disembodied technology consisting of blue prints and license fees, and it is considered as remittances on royalty and license fees. Hence, the technology import intensity at the firm level can be obtained by dividing the summation of embodied and disembodied technology to total sales of the firm. Nevertheless, to calculate the technology import intensity (*TMI*) as an industry-specific variable, we simply divide the summation of total disembodied and embodied technology of all firms within an industry to the summation of total sales of all firms of that industry for a specific year. Then for the entire sample period, the *TMI* can be easily constructed by following this procedure.

TMIO: Technology import intensity of other industry (other than j but summing over $j*$) (inter-industry technology import intensity). To construct this variable, for instance, we consider to compile for textiles industry, then taking the summation of both disembodied and embodied technology across the firms of all eleven industries (excluding the firms of textiles industry) out of twelve selected industries for a specified time period divided by the total sales of all eleven industries (excluding the total sales of textiles industry).

Market Size (*MSIZE*): The size of the domestic market is measured by the sum of gross output and import of all firms within an industry for a specific period of time. Then subsequent years *MSIZE* variable is constructed by following this procedure.

APPENDIX B

Table B.1. Classification of Firms across Indian Manufacturing Industries

NIC 1987 code	Industry Classification	Domestic Firms	Foreign Firms	Total Firms	*% of Foreign Firms*
20-21	Food Products	146	12	158	7.59
22	Beverages and Tobacco	85	4	89	4.49
23	Cotton Textiles	307	4	311	1.28
26	Textiles	245	13	258	5.03
27	Woods Products	20	1	21	4.76
28	Paper and Paper Products	40	5	45	11.11
29	Leather Products	14	1	15	6.66
30	Chemicals	410	77	487	15.81
32	Non-Metallic Mineral Products	96	14	110	12.72
34	Metal Products	176	24	200	12
35	Non-Electrical Machinery	229	26	255	10.19
36	Electrical Machinery	226	21	247	8.50

Source: Based on own calculations from the CMIE data set 'Prowess'.

Note: FDI firms (foreign firms) are those firms with foreign equity of 10 percentages or more than of 10 percentages.

REFERENCES

Aitken, B., and A. Harrison (1999), "Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela," *American Economic Review*, 89(3), 605-618.

Arnold, J., and B. Javorcick (2004), "Gifted Kids or Pushy Parents? Foreign Acquisitions and Plant Performance in Indonesia," World Bank Policy Research Working Paper, 3597, Washington, DC: The World Bank.

Bai, J., and S. Ng (2004), "A Panic Attack on Unit Roots and Cointegration," *Econometrica*, 72, 1127-1177.

Balakrishnan, P., K. Pushpangandan, and M.S. Babu (2000), "Trade Liberalization and Productivity Growth in Indian Manufacturing: Evidence from Firm Level Panel Data," *Economic and Political Weekly*, 35, 3679-3682.

Baltagi, B.H., and C. Kao (2000), "Nonstationary Panels, Cointegration in Panels and Dynamic Panels: A Survey," *Advances in Econometrics*, 15, 7-51.

Banerjee, A., and J.L. Carrion-i-Silvestre (2006), "Cointegration in Panel Data with Breaks and Cross Section Dependence," ECB Working Paper, 591.

Banga, R. (2006), "The Export-Diversifying Impact of Japanese and US Foreign Direct Investment in the Indian Manufacturing Sector," *Journal of International Business Studies*, 37(4), 558-568.

Barrios, S., and E. Strobl (2002), "Foreign Direct Investment and Productivity Spillovers: Evidence from the Spanish Experience," *Weltwirtschaftliches Archiv*, 138(3), 459-481.

Behera, S.R., P. Dua, and B. Goldar (2012), "Foreign Direct Investment and Technology Spillover: Evidence Across Indian Manufacturing Industries," *The Singapore Economic Review*, 57(2).

Blalock, G., and P.J. Gertler (2008), "Welfare Gains from Foreign Direct Investment through Technology Transfer to Local Suppliers," *Journal of International Economics*, 74, 402-421.

Blomstrom, M., and A. Kokko (2003), "The Economics of Foreign Direct Investment Incentives," NBER Working Papers, 9489.

Breitung, J., and S. Das (2005), "Panel Unit Root Tests Under Cross-Sectional Dependence," *Statistica Neerlandica*, 59, 414-433.

Caves, R. (1974), "Multinational Frms, Competition and Productivity in Host-Country Markets," *Economica*, 41, 176-193.

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

Crespo, N., and M. Fontoura (2006), "30 Anos de Investigacao Sobre Externalidades do IDE Para as Empresas Dome´sticas - Que Concluso˜es?" Working Paper 2/2006/ DE/CISEP, ISEG-Technical University of Lisbon, Department of Economics.

_____ (2007), "Determinant Factors of FDI Spillovers - What Do We Really Know?" *World Development*, 35(3), 410-425.

Das, S. (1987), "Externalities and Technology Transfer through Multinationals Corporations: A Theoretical Analysis," *Journal of International Economics*, 22, 171-182.

Dimelis, S., and H. Louri (2002), "Foreign Ownership and Production Efficiency: A Quantile Regression Analysis," *Oxford Economic Papers*, 54(3), 449-469.

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, A., M. Motta, and T. Ronde (2001), "Foreign Direct Investment and Spillovers Through Workers' Mobility," *Journal of International Economics*, 53(1), 205-222.

Franco, C., and S. Sasidharan (2010), "MNEs, Technological Efforts and Channels of Export Spillover: An Analysis of Indian Manufacturing Industries," *Economic Systems*, 34(3), 270-288.

Germidis, D. (1977), *Transfer of Technology by Multinational Corporations*, Development Centre of the OECD, Paris.

Girma, S. (2005), "Absorptive Capacity and Productivity Spillover from FDI: A Threshold Regression Analysis," *Oxford Bulletin of Economics and Statistics*, 67(3), 281-306.

Glass, A., and K. Saggi (2002), "Multinational Firms and Technology Transfer," *Scandinavian Journal of Economics*, 104(4), 495-513.

Gorg, H., and D. Greenaway (2004), "Much Ado About Nothing? Do Domestic Firms Really Benefit From Foreign Direct Investment?" *The World Bank Research Observer*, 19(2), 171-197.

Griffith, R. (1999), "Productivity and Foreign Ownership in the UK Car Industry," IFS Working Papers, W99/11, Institute for Fiscal Studies.

Haaker, M. (1999), "Spillovers from Foreign Direct Investment through Labor Turnover: The Supply of Management Skills," Discussion Paper, London School of Economics.

Haddad, M., and A.E. Harrison (1993), "Are There Positive Spillovers from Direct Foreign Investment: Evidence from Panel Data for Morocco," *Journal of Development Economics*, 42(1), 51-74.

Hall, B.H., and J. Mairesse (1995), "Exploring the Relationship between R&D and Productivity in French Manufacturing Firms," *Journal of Econometrics*, 65, 263-293.

Hall, R.E. (1988), "The Relation between Price and Marginal Cost in US Industry," *Journal of Political Economy*, 96, 921-947.

Javorcik, B. (2004), "Does Foreign Direct Investment Increases the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages," *American Economic Review*, 94(3), 605-627.

Javorcik, B.S., and M. Spatareanu (2008), "To Share or Not to Share: Does Local Participation Matter for Spillovers from Foreign Direct Investment?" *Journal of Development Economics*, 85, 194-217.

Kanturia, V. (2001), "Foreign Firms, Technology Transfer and Knowledge Spillovers to Indian Manufacturing Firms: A Stochastic Frontier Analysis," *Applied Economics*, 33, 625-642.

Kanturia, V. (2002), "Liberalisation, FDI, and Productivity Spillovers: An Analysis of Indian Manufacturing Firms," *Oxford Economic Papers*, 54, 688-718.

Kao, C. (1999), "Spurious Regression and Residual-Based Tests for Cointegration in Panel Data," *Journal of Econometrics*, 90(1), 1-44.

Kao, C., and M.H. Chiang (2000), "On the Estimation and Inference of a Cointegrated Regression in Panel Data," *Advances in Econometrics*, 15, 179-222.

Kaufmann, L. (1997), "A Model of Spillovers trough Labor Recruitment," *International Economic Journal*, 11(3), 13-34.

Kohpaiboon, A. (2005), *Industrialization in Thailand: MNEs and Global Integration*, Unpublished Doctoral Dissertation, The Australian National University, Canberra.

_____ (2006), "Foreign Direct Investment and Technology Spillover: Across-Industry Analysis of Thai Manufacturing," *World Development*, 34(3), 541-556.

Lichtenberg, F., and B. van Pottelsberghe de la Potterie (1998), "International R&D Spillovers: A Comment," *European Economic Review*, 42(8), 1483-1491.

Lipsey, R. (2002), "Home and Host Country Effects of FDI," NBER Working Paper, 9293, Cambridge, MA: National Bureau of Economic Research.

Liu, Z. (2002), "Foreign Direct Investment and Technology Spillover: Evidence from China," *Journal of Comparative Economics*, 30(3), 579-602.

_____ (2008), "Foreign Direct Investment and Technology Spillover: Theory and Evidence," *Journal of Development Economics*, 85, 176-193.

Maddala, G.S., and S. Wu (1999), "A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test," *Oxford Bulletin of Economics and Statistics*, 61, 631-652.

Mansfield, E., and A. Romeo (1980), "Technology Transfer to Overseas Subsidiaries by US-Based Firms," *Quarterly Journal of Economics*, 95(4), 737-750.

Marcin, K. (2008), "How Does FDI Inflow Affect Productivity of Domestic Firms? The Role of Horizontal and Vertical Spillovers, Absorptive Capacity, and Competition," *The journal of International Trade and Economic Development*, 17(1), 155-173.

Moon, H., and B. Perron (2004), "Testing for a Unit Root in Panels with Dynamic Factors," *Journal of Econometrics*, 122(1), 8-126.

Oman, C. (2000), *Policy Competition for Foreign Direct Investment: A Study of Competition Among Governments to Attract FDI*, Paris: OECD.

Pedroni, P. (1999), "Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors," *Oxford Bulletin of Economics and Statistics*, Special Issue, 653-670.

_____ (2000), "Fully Modified OLS for Heterogeneous Cointegrated Panels," *Advances in Econometrics*, 15, 93-130.

_____ (2001), "Purchasing Power Parity Tests in Cointegrated Panels," *Review of Economics and Statistics*, 83, 727-731.

_____ (2004), "Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis," *Econometric Theory*, 20, 597-625.

Pesaran, M. (2007), "A Simple Panel Unit Root Test in the Presence of Cross Section Dependence," *Journal of Applied Econometrics*, 22(2), 265-312.

Phillips, P.C.B., and H. Moon (1999), "Linear Regression Limits Theory for Nonstationary Panel Data," *Econometrica*, 67, 1057-1111.

Proenca, I., M. Fontoura, and N. Crespo (2006), "Productivity Spillovers from Multinational Corporations: Vulnerability to Deficient Estimation," *Applied Econometrics and International Development*, 6(1), 87-96.

Ramirez, M. (2007), "Is Foreign Direct Investment Productive in the Latin America Case? A Panel Unit Root and Panel Cointegration Analysis, 1980-2001," Yale University Working Papers on Economic Applications and Policy, 23.

Rhee, J.W., and T. Belot (1989), "Export Catalysts in Low-Income Countries," Working Paper, World Bank.

Rodriguez-Clare, A. (1996), "Multinationals, Linkages, and Economic Development," *American Economic Review*, 86(4), 852-873.

Romer, P. (1993), "Idea Gaps and Object Gaps in Economic Development," *Journal of Monetary Economics*, 32(3), 543-573.

Saggi, K. (2002) "Trade, Foreign Direct Investment, and International Technology Transfer: A Survey," *The World Bank Research Observer*, 17(2), 191-235.

Sinani, E., and K. Meyer (2004), "Spillovers of Technology Transfer from FDI: The Case of Estonia," *Journal of Comparative Economics*, 32, 445-466.

Sjoholm, F. (1999), "Productivity Growth in Indonesia: The Role of Regional Characteristics and Direct Foreign Investment," *Economic Development and Cultural Change*, 47(3), 559-584.

Smith L.V., S. Leybourne, T-H. Kim, and P. Newbold (2004), "More Powerful Panel Data Unit Root Tests with an Application to Mean Reversion in Real Exchange Rates," *Journal of Applied Econometrics*, 19, 147-170.

Srivastava, V. (1996), *Liberalization, Productivity and Competition: A Panel Study of Indian Manufacturing*, Oxford University Press, Delhi.

_____ (2000), "The Impact of India's Economic Reforms on Industrial Productivity, Efficiency and Competitiveness," Report of a Project sponsored by the Industrial Development Bank of India, New Delhi, National Council of Applied Economic Research.

Stock, J.H., and M.W. Watson (1993), "A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems," *Econometrica*, 61, 783-820.

Torlak, E. (2004), "Foreign Direct Investment, Technology Transfer, and Productivity Growth in Transition Countries: Empirical Evidence from Panel Data," Cege Discussion Paper, 26.

Wang, J., and M. Blomstrom (1992), "Foreign Investment and Technology Transfer: A Simple Model," *European Economic Review*, 36, 137-155.

Westerlund, J. (2007), “Testing for Error Correction in Panel Data,” *Oxford Bulletin of Economics and Statistics*, 69, 709-748.

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