Impact of Foreign Direct Investments on Industrial Productivity: A Subnational Study of India

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Impact of Foreign Direct Investments on Industrial Productivity: A Subnational Study of India*

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Abstract

The paper uses unique aggregate industry-level dataset at subnational level from India to measure the effects of foreign investments on the productivity of domestic firms. Using pooled regression analysis with fixed effects for the period 2002 – 2005, we find that: (a) foreign investments have significant positive effect on productivity of domestic firms. However, the coefficient values of FDI are smaller, suggesting that the positive effects are marginal. (b) When FDI inflows are controlled for in the cross-section productivity regression, the relationship between the share of foreign technical collaborations and productivity of domestic firms increases significantly. This supports the argument that foreign technical collaborations increase productivity in part through its effect on the FDI inflows. (c) Another interesting finding is that there is no strong evidence to show that this positive effect is state-heterogeneous. In turn, we find partial effects of FDI are marginally higher in non-industrial states. Thus, we suggest that domestic firms can reap rich dividends if the FDI inflows are evenly distributed across the regions, particularly concentrating the efforts on attracting FDI into non-industrial states.

JEL codes: O1; O4

Keywords: FDI; Productivity; India

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1. Introduction

Developing countries witnessed a surge in FDI inflows post 1990s. In many developing countries the rate of growth of FDI inflows surpassed the growth rates of foreign trade. The efforts of the governments have shifted towards designing investor friendly policies to attract FDI inflows. Economists and experts believe that FDI generates substantial benefits to the local economy. There is also sizeable empirical evidence to show that the macroeconomic growth and development is spurred by rapid FDI inflows. Also, FDI generate considerable direct and indirect positive spillover effects in the form of transfer of technology. This in turn leads to increased productivity of domestic firms in the host country (Aschauer, 1989; Bloomstrom & Wolff, 1994; Cardoso, 1993; De Mello, Jr., 1997; Green & Villanueva, 1991; Huang, 2004; Ramirez, 2000; Ram & Zhang, 2002). In fact, India is the world's second largest recipient of FDI inflows (after China). Yet, there is very little evidence on the impact of foreign investments on productivity levels of domestic firms. More so, regional level empirical studies are absent in the case of India.

There are few prominent studies which measure the impact of FDI on productivity and output of domestic firms. These include: Globerman (1979) for Canada; Blomstrom (1986) for manufacturing sector in Mexico; Aitken & Harrison (1999) general plat level in Venezuela; and Hsieh (2006) for general plat level for China. Majority of them found that foreign investments do not make any significant impact on productivity and output levels of domestic firms. At domestic level, prominent studies like: Trivedi et al. (2000); Goldar (2000); Unel (2003); Goldar & Kumari (2003) and Goldar (2004) studied and estimated the TFP effects for Indian manufacturing sector. However, the effects of FDI on TFP and output performance of local firms remained untouched.

Following the approach taken by Goldar (2004), I apply alternative methods to compute Total Factor Productivity (TFP hereafter) at aggregate industry level for all the regions within India. This is followed by the approach taken by many international studies highlighted earlier to examine FDI effects on the productivity and output performance of industry at regional level within India. The underlying spirit of this study is similar to that of Aitken & Harrison (1999) and Hsieh (2006), but the extensions differ significantly as I combine aggregate inflows of FDI and the performance of industry as a whole at regional level. I seek answers for the following questions: First, does the presence of foreign investments in the region result in technology spillovers to domestic firms and thereby affecting growth and TFP? Second, do foreign technical collaborations affect domestic firms? Third, how different are these effects in industrial and non-industrial states within India?

Rest of the paper is organized as follows: Section 2 estimates TFP using different alternative measures. Also, growth effects of regional FDI specifications are derived. Section 3 presents stylized facts about the TFP, FDI in industry within India. Section 4 deals with empirical results and discussion. Section 5 gives plausible explanation of the results and highlight policy implications and Section 6 concludes the study.

2. TFP Estimates & Model Specifications

This section presents set of estimates of TFP growth for industry as a whole for each region in India for the period 2002 – 2005. After the description of Translog index is specified, the model specification for the FDI effects are presented. The subsection below discusses briefly the estimations of TFP using different frameworks.

2. 1 Measuring TFP

TFP is defined as the ratio of weighted sum of output to the weighted sum of inputs. The TFP can be measured using: non-parametric index number and parametric production functions. In this study I make use of the later approach which includes Growth Accounting Approach (GAA hereafter) to estimate TFP. The origins of GAA can be traced back to Solow (1956). The Translog Index (TLI henceforth) is the main index used in GAA. The TLI of TFP is the discrete approximation of technical change and was used by many studies in Indian context for measuring TFP. I make use of two frameworks namely, “value added function framework” and “gross output function framework”.

(a) Value Added Function Framework

This is a two-input case, where value added is taken as output along with two inputs namely, labour and capital. The TLI of TFP growth is given by the following equation:

$$\Delta \ln TFP_{(t)} = \Delta \ln Y_{(t)} - \left(\frac{SL_{(t)} + SL_{(t-1)}}{2} \times \Delta \ln L_{(t)} \right) - \left(\frac{SK_{(t)} + SK_{(t-1)}}{2} \times \Delta \ln K_{(t)} \right)$$

Where, Y is output; L is labour; K is capital; SL is share of income of labour; SK is share of income of capital. $\Delta \ln Y_{(t)} = \ln Y_{(t)} - \ln Y_{(t-1)}$. $\Delta \ln L_{(t)}$ and $\Delta \ln K_{(t)}$ are also defined in the same manner. $\Delta \ln TFP$ is rate of technological changes or rate of growth of TFP.

(b) Gross Output Function Framework

This is a three-input case, where along with labour and capital, value of materials (like: services, energy etc) is the third input. The TLI of TFP growth is given as follows:

$$\Delta \ln TFP_{(t)} = \Delta \ln V_{(t)} - \left(\frac{SL_{(t)} + SL_{(t-1)}}{2} \times \Delta \ln L_{(t)} \right) - \left(\frac{SK_{(t)} + SK_{(t-1)}}{2} \times \Delta \ln K_{(t)} \right)$$

$$\left(\frac{SM_{(t)} + SM_{(t-1)}}{2} \times \Delta \ln M_{(t)} \right)$$

Where, V is gross output; L is labour; K is capital; M is materials; SL is share of income of labour; SK is share of income of capital; SM is the share of income of materials; $\Delta \ln V_{(t)} = \ln V_{(t)} - \ln V_{(t-1)}$. $\Delta \ln L_{(t)}$; $\Delta \ln K_{(t)}$ and $\Delta \ln M_{(t)}$ are also defined in the same manner. $\Delta \ln$ TFP is the rate of technological changes or rate of growth of TFP.

Measurement of Inputs and Output

At the outset it must be highlighted that the sample period for the study was selected purely based on the availability of data on FDI inflows for regions within India[1]. The data is made available for regions within India for Department of Industrial Policy and Promotion[2] (DIPP henceforth) only from 2002. The figures for 2002 are aggregate values of FDI inflows into these regions from 1991. From 2003 onwards yearly data on FDI inflows into each state is provided. Though the data on FDI inflows into Indian regions was made available even for 2006, we could not consider this because of the absence of the aggregate industry level data on regions for 2006. Similarly, to compute the share of technical collaborations, the data for both technical collaborations and total collaborations for each state was collected from DIPP from Handbook of Industry Policy and Statistics 2003-2005[3], published by Government of India. It is noteworthy that the data on technical collaborations for regions within India are available only until 2004. From thereon, approval of foreign collaborations was merged with automatic FDI route, whose permissions are granted by Reserve Bank of India (RBI). The data of technical collaborations and total collaborations for the year 2001 are aggregate values from 1991 to 2001 for all the regions.

The basic source of data for the alternate TFP estimates is the Annual Survey of Industries[4] (ASI hereafter) as in the other studies on Indian manufacturing industry in literature. The ASI has created a systematic, electronic database which includes aggregate industry data at regional level within India. From this single database, the series on output and input (undeflated) have been obtained for all indicators for all regions within India. Data have been drawn on the following variables: gross output, net value added, employment, total emoluments of employees, fixed capital stock, new capital invested and value of materials. Real gross output and real gross value added, new capital invested, emoluments paid have been obtained by deflating the nominal figures by the wholesale price index for manufactured products with base year 2000. Thus, converting the indicators from INR. current to INR. 2000 constant prices. Total number of persons engaged has been taken as the measure of labour input. This includes working proprietors and emoluments paid include remunerations for the managers. Though I believe that capital stock should have been calculated using perpetual inventory method, it could not be done so due to non-availability of initial values. Real intermediate input has been taken as the sum of values of materials which also includes: power and fuel, and other intermediate inputs, all expressed at constant prices of 2000. The reported series on materials has been deflated to obtain material inputs at constant prices.

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[1] For the list of total regions covered in this study, see annexure 1.
[2] The data can be downloaded from: http://dipp.nic.in/fdi_statistics/india_fdi_index.htm
[3] The data can be downloaded from: http://eaindustry.nic.in/new_handout.htm
[4] The data can be downloaded from: http://mospi.nic.in/stat_act_t3.htm

2. 2. FDI Effects

Let the aggregate production function at time t be:

$$Y_{(t)} = A_{(t)}\ K_{(t)}^{\alpha}\ L_{(t)}^{\beta} \tag{1}$$

Where, Y, K, L, denote: output; capital stock and labour respectively. Besides the factor inputs, we also account for the "some unexplained technological efficiency gains" of the basic production function. This is reflected in equation (1) as $A_{(t)}$. This also measure of technical change in output per period. $A_{(t)}$ measures the proportionate change in output per period when input level are held constant.

The above production function can be expressed in linear form as follows:

$$Y_{(t)} = A_{(t)} + \alpha\ K_{(t)} + \beta\ L_{(t)} \tag{2}$$

The estimation of this equation yields values of ($\alpha + \beta$) and *A*. *A* is the value of technical progress which is the rate of technological change. Sum of the partial elasticities ($\alpha + \beta$) indicates the extent of economies or diseconomies to scale. The returns to scale are constant, increasing or decreasing if the value of ($\alpha + \beta$) is equal to one, more than one or less than one respectively.

Dividing the above function by L and introducing logs equation (2) would become:

$$\text{Log}\left(\frac{Y}{L}\right)_{(t)} = \text{Log}\ A_{(t)} + \alpha\ \text{Log}\left(\frac{K}{L}\right)_{(t)} \tag{3}$$

I make an attempt to relax the assumption of constant returns to scale for estimating parameters value, which is given below:

$$\text{Log}\left(\frac{Y}{L}\right)_{(t)} = \text{Log}\ A_{(t)} + (\alpha + \beta - 1)\ \text{Log}\ L_{(t)} + \alpha\ \text{Log}\left(\frac{K}{L}\right)_{(t)} \tag{4}$$

Where, ($\alpha + \beta - 1$) indicates the degree of returns to scale for all production factors. If this is not significantly different from zero, then the condition of constant returns to scale holds true. If this is greater (lesser) than zero, it depicts the condition of increasing (decreasing) returns to scale. But, in the equation (4) how and where do "FDI" fit?

As described above, $A_{(t)}$ reflects unexplained sources which the model here does not explicitly capture. This in growth theory is called as "exogenous technology progress".

$A_{(t)} = A(t_0)$ (5)

Where, $A_{(t)}$ is the level of stock of technology, which in turn is dependent on the initial level of technology, $A(t_{0})$.

At macro level, the role of FDI has become crucial because it provides new capital, allowing additional investments in human as well as physical capital, which can be beneficial for developing countries which are capital scarce. Most importantly, FDI is widely seen at both macro and mirco level as a means of transferring and incorporating new knowledge from outside the country. The theory of MNE argues that foreign firms possess the technological advantage over the local firms which result is reduction in their cost of operations abroad (Caves, 1996). If this theory holds good, then FDI could very well lead to externalities on the domestic production factors. The inflow of new knowledge like: greater production methods; new technologies; organizational and managerial techniques; management and marketing skills and activities may benefit domestic firms through imitation, increased competition, mobility of human capital from foreign firms to domestic firms, thereby leading to increase in overall productivity levels (Findlay, 1978; Blomstrom, 1986; Markusen & Venables, 1999; Glass & Saggi, 2002). On the other hand, the developing countries are keen to attract FDI not only because of the diffusion effects of ideas and innovations but would also provide access to the modern technologies for the domestic firms. This is because not only the greater part of world's R&D spending comes from MNCs but they also possess control over much advanced production techniques. Thus, higher FDI inflows coming from advanced countries would lead to increase in the rate of technological progress in host country and hence greater the technological diffusion for the local firms (Wang, 1990; Ram & Zhang 2002; Peri & Urban 2006).

The above arguments suggest that any increase in foreign capital would show up in $A_{(t)}$. Increase in foreign capital not only includes mere quantity but also the quality of the capital stock. The economic theory has modeled the development of capital stock in three different ways. One, Solow & Swan (1956) model of "capital widening" which is mere accumulation of capital through increase in quantitative production of existing capital goods. Two, Aghion & Howitt (1992) model of "technology change", focuses on improving the quality of existing type of capital goods. Three, Romer (1990) model of "technology change" where the focus on increase in variety of new type of capital goods[5]. All these three channels of capital stock improvements contribute overall economic development through production function. Thus, if $A_{(t)}$ is not growing, it is presumed that most of the output growth is coming from mere accumulation of foreign capital and not due to its quality. This is in line with the many developing countries that are in the stage of capital accumulation. It is argued that countries which open up their markets for FDI will first experience an increase in foreign capital stock. In later stages once the capital accumulation has been established, the major part of the FDI will then be associated with improving the quality of existing foreign capital stock in the country. The

[5] Both Aghion & Howitt (1992) and Romer (1990) models are called "capital deepening" models. The former is called "capital deepening via quality improvement" and the later is known as "capital deepening via increase in the variety of capital goods".

accumulation of FDI inflows stock can easily be observed in the case of India especially in post-1990 period. In future, this accumulated stock will be driven by the quality improvements. The quality improvement in the foreign capital has spillover effects on the local firms through technological capability upgradations. As highlighted above, this could occur through a variety of channels like imitation, movement of workers employed by foreign firms to local firms, or starting their own business.

According to these theoretical groundings, I assume that the level of $A_{(t)}$ depends on the initial stock of $A_{(t0)}$ and the externalities from FDI inflows.

Thus,

$$A_{(t)} = A_{(t0)}\left(\frac{FDI}{L}\right)_{(t)} \qquad (6)$$

Replacing equation (6) into (4) gives:

$$\text{Log}\left(\frac{Y}{L}\right)_{(t)} = \text{Log } A_{(t)} + (\alpha + \beta - 1)\text{ Log } L_{(t)} + \alpha \text{ Log}\left(\frac{K}{L}\right)_{(t)} + \Omega \text{ Log}\left(\frac{FDI}{L}\right)_{(t)} \qquad (7)$$

Denoting by Y; K; FDI for log (Y/L); log (K/L) and log (FDI/L) we get:

$$\text{Log } Y_{(t)} = \text{Log } A_{(t)} + (\alpha + \beta - 1)\text{ Log } L_{(t)} + \alpha K_{(t)} + \Omega\, FDI_{(t)} \qquad (8)$$

Having laid theoretical foundations for the empirical analysis by introducing FDI into the aggregate production function, several forms the equation (8) will now be estimated using the panel data method viz., Dynamic pooled OLS and Fixed effects. This method is used because of the possible unobservable effects (Baltagi, 2005). However, for some smaller states the data on FDI is time invariant. Usage of fixed effects will be collinear with time-invariant or largely time-invariant regressors (Beck, 2001). Therefore, I restrict by including just period effects (time dummies). The pooled time-series cross-sectional (TCSC) data may exhibit Heteroskedasticity and serial correlation problems. While these problems do not bias the estimated coefficients as pooled regression analysis in itself is a more robust method for large sample consisting of cross section and time series data. However, they often tend to cause biased standard errors for coefficients, producing invalid statistical inferences. To deal with these problems, I estimated for all the models the Huber-White robust standard errors clustered over countries. These estimated standard errors are robust to both Heteroskedasticity and to a general type of serial correlation within the cross-section unit (Rogers, 1993 and Williams, 2000).

The equation (8) runs over T observations, t = 1…..T periods and applies to all the sample regions i = 1…..N. Attaching region specific indices i to each variable and adding an error term leads to the following econometric formulation:

$$\text{Log } Y / L_{it} = \text{Log } Y_{i\,(t-1)} + \psi_1 K_{it} + \psi_2 L_{it} + \psi_3 \text{ FDI}_{it} + \psi_4 CV_{it} + \delta_{it}$$

$$\delta_{it} = \lambda_t + \omega_{it} \qquad (9)$$

Where, **Y / L** $_{it}$ is the dependent variable measured as output per number of workers engaged in the total industry in the region i at year t.

Log Y$_{i\,(t-1)}$ is the log of output in INR crores in previous year.

K$_{it}$ is the domestic investments of the local industry in the state i at year t. I take total log of Gross Fixed Capital Formation in INR crores.

FDI$_{it}$ is measured in terms of log of total FDI inflows stock in the state i in year t. There are several reasons behind selecting FDI inflows stock over FDI inflows. First, according to IMF benchmark definition, FDI also includes items like owning stock in a company in foreign country of more than 10%. Buying equity in another company would not result in technological diffusion at least in the immediate future. It would certainly take time for the domestic acquired firm to reap the benefits of foreign stock ownership. Secondly, for most of the smaller states, the FDI inflows in some years are nil. This might lead to estimation problems. I also do not consider "net FDI" simply because there is no data on the FDI outflows at regional level for India. Even if the data was available, the values will be too small for majority of the states and in some cases there might not be any outflows at all. The data for FDI inflows is logged and is in INR crores, obtained from various issues of Industrial Surveys of DIPP from Handbook of Industry Policy and Statistics 2003-2005, published by Government of India.

CV$_{it}$ apart from the main variables of the output equation, I also include some of the important policy variables which influence output growth performance. These control variables include: Raw material consumptions and new invested capital. Both are logged and are in INR crores. The data for all variables except FDI inflows are from Annual Industry Survey, Center for Statistics Organization, Government of India.

In addition, I also include: λ_t capturing time-specific effects which vary according to time (time dummies).

3. Estimates of TFP & FDI: Some Stylized Facts

In this section I present stylized facts of TFP growth estimates. The TFP growth for aggregate industry for every region is computed using value added and gross output framework. These estimates are based on the Translog index of TFP (see section 2 for description of the index). Table 1 captures the annual average TFP growth with two and three input cases for the period 2002 – 2005. This table also captures information related to FDI inflows stock in each region.

Table 1: FDI inflows and TFP growth of aggregate industry within Indian regions

(Period: avg. 2002 – 2005)

Indian States	TFP (2 input case)	TFP (3 input case)	Average FDI Inflows Stock	Total FDI inflows Stock	Share in Total FDI inflows stock
Southern States					
Andhra Pradesh	0.449	0.106	114095.43	125222.47	6.045
Karnataka	0.646	0.215	199029.23	248083.33	11.975
Kerala	-0.006	0.049	17061.65	18590.04	0.897
Tamil Nadu	0.223	0.061	226075.42	234904.93	11.339
Pondicherry	0.851	0.207	12738.05	12912.54	0.623
Total	**0.433**	**0.128**	**113799.96**	**639713.31**	**30.879**
Western States					
Goa	0.679	0.203	10074.57	10387.90	0.501
Gujarat	0.570	0.057	120121.66	129677.97	6.260
Maharashtra	0.608	0.171	393828.54	499965.41	24.134
Rajasthan	0.145	0.091	28988.20	29115.10	1.405
Total	**0.500**	**0.131**	**138253.24**	**669146.38**	**32.300**
Central States					
Madhya Pradesh	-0.074	0.006	92725.31	92775.05	4.478
Jharkhand	1.208	0.597	1457.15	1466.15	0.071
Chhattisgarh	0.689	0.009	10435.44	24829.33	1.199
Total	**0.608**	**0.204**	**34872.63**	**119070.53**	**5.748**
Northern States					
Delhi	0.095	0.101	307880.00	339655.60	16.395
Punjab	0.130	0.075	18334.33	22345.04	1.079
Haryana	0.591	0.147	38552.76	39673.50	1.915
Himachal Pradesh	1.361	0.425	12091.74	12356.45	0.596
Jammu & Kashmir	1.771	0.544	84.10	84.10	0.004
Uttaranchal	1.063	0.219	1331.14	1542.76	0.074
Total	**0.835**	**0.252**	**63045.68**	**415657.45**	**20.064**
Eastern States					
Manipur	1.851	1.110	31.85	31.85	0.002
Meghalaya	3.986	1.099	529.60	529.60	0.026
Nagaland	3.436	0.604	36.80	36.80	0.002
Orissa	0.705	0.028	82704.48	84284.00	4.068

Tripura	-1.103	-0.400	26.06	30.88	0.001
Uttar Pradesh	0.205	0.081	48255.29	49206.81	2.375
West Bengal	0.424	0.201	78035.52	81304.41	3.925
Assam	1.129	0.829	18.58	24.03	0.001
Bihar	-0.157	0.347	7397.05	7397.05	0.357
Total	**1.164**	**0.433**	**24115.03**	**222845.43**	**10.757**
Union Territories					
A & N. Island	6.368	2.208	137.87	137.87	0.007
Chandigarh	0.239	0.756	2717.66	3241.71	0.156
Dadra & N Haveli	0.390	0.092	1239.80	1239.80	0.060
Daman & Diu	0.716	0.721	583.22	609.95	0.029
Total	**1.928**	**0.944**	**1169.64**	**5229.33**	**0.252**

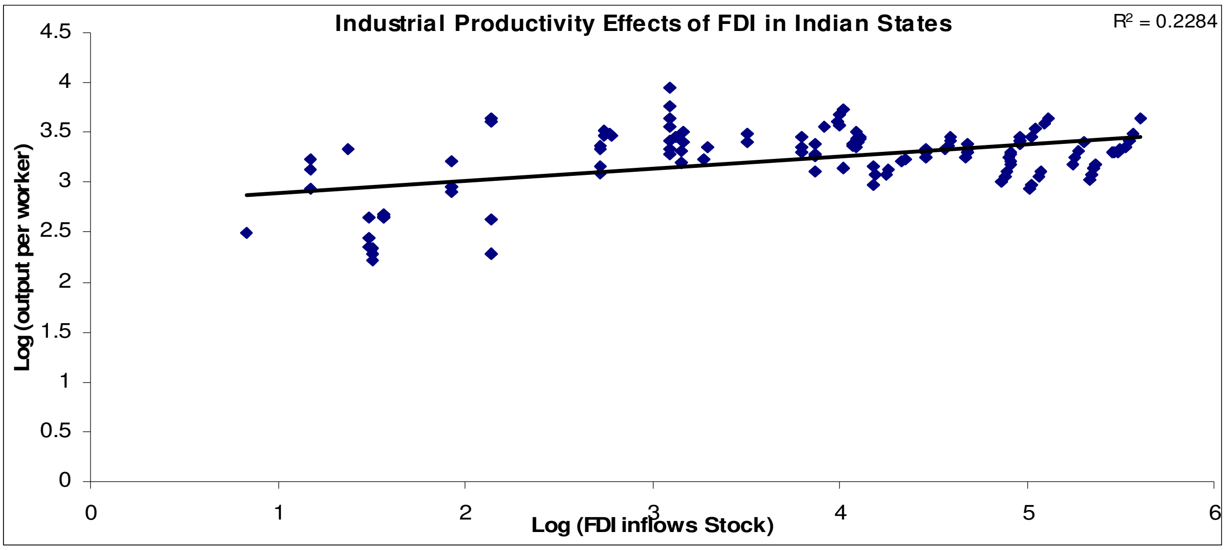
NOTES: (a) Source of the data: calculated & computed by author; **(b)** Average FDI inflows and Total FDI inflows stock are in INR crores; **(c)** share of FDI inflows to total inflows stock are in percentage

It is seen from table 1 that states like Kerala, Madhya Pradesh, Tripura, Bihar have witnessed negative growth rate of TFP (2 input case) during the study period, while Tripura is the only state to have witnessed negative growth rate of TFP (3 input case). The overall TFP growth is higher in some of the smaller states like Himachal Pradesh, Jammu & Kashmir; Uttaranchal; Assam; Andaman Islands and Jharkhand. This is largely due to significant variations in the data every year. For example number of firms operating in Andaman Islands increased drastically in the late 1990s to early 2000. This increased output and fixed capital formation significantly. With respect to Southern versus Western states, the two most industrial regions, the TFP growth is marginally higher in the case of later. The estimates of TFP produced in table 1 are based on GAA. This approach assumes constant returns to scale, which is seriously questioned in the case of developing regions. Also, discrepancies in data collection for majority of the smaller states do not give us confidence to over highlight the estimates of TFP. This apart, the computation is also not completely foolproof. The absence of initial value to compute capital stock forced us to take gross fixed capital formation in constant terms as proxy for capital stock. With these shortcomings, usage of TFP estimates would be biased. Therefore, for empirical exercise, we make use of output per worker as proxy for industrial productivity.

The data on FDI inflows into Indian region shows some interesting trends. The total FDI inflows into India are largely attracted by two regions, south and west. The FDI share of western region is around 32% while the share of southern region is close to 31%. This is followed by northern region with a share of 20%. Over 80% of the FDI inflows into India is attracted by three regions, leaving aside other three regions (central; eastern regions and union territories) with little FDI inflows. This highlights uneven distribution of FDI inflows in India. Even in these three regions, four major states, viz., Maharashtra, Delhi, Tamil Nadu and Karnataka attract more than 64% of the total FDI inflows in India, while 27 states attract only 36% of FDI inflows. In this, if we remove Andhra Pradesh and Gujarat's share then less than 23% of total FDI inflows in India is attracted by 25 states, which means less that 1% share of FDI per state !

Graph 1 provides an overview of the impact of FDI inflows on output per worker in Indian regions for 2002 – 2005 period. The graph illustrates a positive relationship between FDI inflows stock and output per worker in Indian regions.

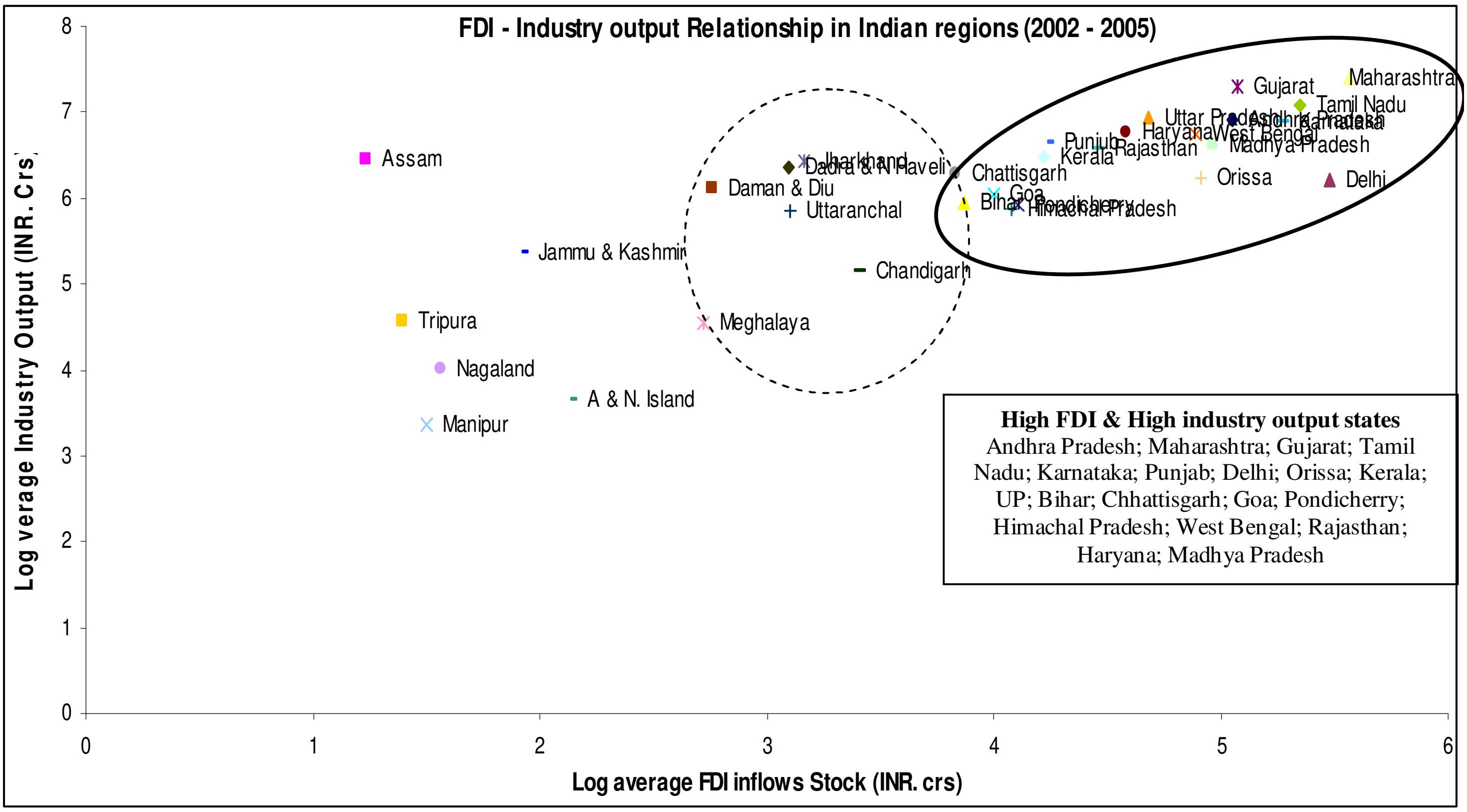
Graph 1



For an overall 124 observations, the Log FDI inflows have a mean of 8.66% with a standard deviation of 3.02 (see annexure 2). This reiterates the fact that there is a significant cross country variation in terms of FDI inflows within Indian region. A simple correlation between FDI inflows stock and output per worker spanning over 2002 to 2005 demonstrate a very low correlation, r = 0.228 in our 124 sample observations. Although the data points in this plot are affected by various other factors which I will control for in the following section in a more systematic analysis, there clearly seems to be a positive effect of FDI on output performance. But the interesting point noteworthy is that the positive effect is only marginal and not very high. Though majority of region-years depict both high productivity and high FDI inflows, some of region-years are outliers. There are also some region-years which have average FDI inflows and productivity.

In graph 2 I capture the relationship between average industrial output and FDI inflows stock for all states between 2002 and 2005. The graph shows some interesting trends. Majority of the states which fall under the category of high FDI and high industrial output are industrial states. These are the states which attract almost 95% of the FDI inflows in India. Not surprisingly these are the states where the industrial output is also high. On the other hand, there are also some states which have average FDI inflows and average industrial output. These states are circled with thin lines. Three of them are union territories and couple of them are newly formed states (Jharkhand and Uttaranchal). The only North-Eastern state whose performance is above the rest is Meghalaya. Rest of the states in the graph can be termed as outlier. For example, Assam has very high industrial output, but the FDI inflows are virtually low. Same is the case with Jammu & Kashmir, whose industrial output is far higher than Chandigarh, but relatively lower FDI inflows.

Graph 2



In table 2, I capture the technical collaborations in Indian regions. The share of total collaborations, technical and financial collaborations is presented for each region as an average during the period 2002 – 2005.

Table 2: Technical Collaborations in Indian regions (avg. 2002 to 2004)

(% share in total)

Indian States	Total Collaborations All-India Share	Technical Collaborations All-India Share	Financial Collaborations All-India Share
Southern States			
Andhra Pradesh	6.24	5.23	6.60
Karnataka	12.51	9.67	13.53
Kerala	1.65	1.36	1.75
Tamil Nadu	13.34	11.99	13.82
Pondicherry	0.67	0.84	0.61
Total	**34.40**	**29.10**	**36.31**
Western States			
Goa	1.21	1.30	1.18
Gujarat	6.24	11.05	4.51
Maharashtra	24.77	25.69	24.43
Rajasthan	1.80	2.07	1.70
Total	**34.01**	**40.11**	**31.82**

Central States			
Madhya Pradesh	1.27	1.44	1.21
Jharkhand	0.41	1.04	0.19
Chhattisgarh	0.24	0.60	0.12
Total	**1.93**	**3.09**	**1.52**
Northern States			
Delhi	13.50	6.00	16.20
Punjab	1.03	1.22	0.96
Haryana	4.47	6.12	3.88
Himachal Pradesh	0.52	1.14	0.30
Jammu & Kashmir	0.03	0.06	0.01
Uttaranchal	0.27	0.46	0.20
Total	**19.82**	**15.00**	**21.56**
Eastern States			
Manipur	0.01	0.00	0.01
Meghalaya	0.03	0.00	0.04
Nagaland	0.01	0.02	0.01
Orissa	0.74	0.98	0.65
Tripura	0.02	0.02	0.02
Uttar Pradesh	4.17	5.46	3.71
West Bengal	3.47	3.97	3.29
Assam	0.10	0.30	0.03
Bihar	0.26	0.44	0.20
Total	**8.80**	**11.19**	**7.94**
Union Territories			
A & N. Island	0.04	0.00	0.06
Chandigarh	0.38	0.24	0.43
Dadra & N Haveli	0.38	0.96	0.17
Daman & Diu	0.23	0.30	0.20
Total	**1.03**	**1.50**	**0.86**

Source: calculated & computed by author

Even in technical and other collaborations, the states like Maharashtra, Delhi, Karnataka, Tamil Nadu, Gujarat and Andhra Pradesh are the major beneficiaries. States like Maharashtra, Tamil Nadu and Karnataka enjoyed highest share amongst both types of collaborations. The region of west has the highest share in total technical collaborations, while southern region has highest share in financial collaborations. Even here, the wide range disparity between states is visible. Some of the eastern states have virtually no collaborations. Once again, central, eastern regions and union territories are lagging behind in terms of all types of collaborations.

4. Empirical Results & Discussion

The results of regression estimates using period fixed effects method in assessing the impact of FDI inflows on output growth performance of industry at regional level are presented in 11 different models in table 3. I also control for Heteroskedasticity using White Heteroskedasticity-consistent standard errors & covariance. The summary of data is provided in annexure 2. The model 1 presents basic results from the estimation equation (9) without FDI inflows. The dependent variable, log output per worker is regressed on log gross fixed capital formation and log labour. Consistent to our predictions, I find significant positive impact of gross fixed capital formation on output per labour. The significant negative sign of labour suggests that the returns to scale are diminishing for aggregate industry at regional level in India. In model 2, I include Log FDI inflows stock as the main independent variable. I use this model as a benchmark throughout the study. The long run coefficient on FDI is positive and significant. For every 1% increase in FDI inflows stock, leads to 0.027% increase in output per worker. In other words, holding at its mean value, increase in log FDI inflows by its highest value of log 12.92 would increase the output performance for industries at regions by 0.027%. Inclusion of FDI inflows stock does improve the explanatory power of the model marginally (R2 increased from 0.62 to 0.65). This result suggests that foreign presence in the region does seem to have positive spillover effects on the productivity of the domestic firms. To this benchmark model, I now add several control variables.

In model 3, I include lagged value of log output and raw materials consumed in logs. Both assert positive sign, but only raw materials are found to be statistically significant. But the interesting finding is that though explanatory power has significantly gone up (R2 from 0.65 to 0.97) the impact of FDI inflows stock on output performance of domestic industries has come down considerably. After controlling for other variables, 1% increase in FDI inflows yields only 0.006% increase in output per worker. The statistical significance has also come down from 1% to 5%. In model 4, I also include log new capital investments made in current year by the domestic firms. I find the results to be positive and significant at 10% confidence level. In this case, the positive effect of FDI inflows goes down even further to 0.004%. Also, the level of significance comes down from 5% to 10%. The explanatory power of the model improves marginally from R2 0.97 to 0.98. In model 5, we find a significant nonlinear relationship between FDI inflows and output per worker. The relationship is non-linear which means that FDI inflows have a positive impact on output per worker only if the FDI exceed a certain threshold. The quality of FDI path exists if there is a statistically significant relationship between FDI inflows and output per worker. A path displays a turning point if the coefficient value of FDI inflows is < 0 and the coefficient value of FDI inflows squared indicator is > 0. FDI inflows at turning point, denoted by FDI+, where FDI+ = Exp (- FDI / 2 * FDI squared). The result is found to be INR one crore[6]. This suggests that if FDI were to make positive impact on productivity of domestic firms, the region should attract FDI inflows of around INR one crore per year.

Next, I examine how the effects of FDI may vary over regions. Specifically I allow FDI to have different effects over different regions in India. For this purpose I create dummy variables for two sets of regions. The first set of region includes ‘industrial states’ and the second set includes ‘non-industrial states’. For both these variables I give dummy coding of 1 if the respective state is industrial / non-industrial and 0 otherwise. I then interact

[6] This is estimated as: Turning point = Exp (- [-3.08^{E-09} / 0.013284])

them with FDI separately. Models 6 and 7 in table 3 present the estimation results. The coefficients of FDI inflows in both models regain its positive signs with statistical significance. Some interesting findings emerge from these results. First, FDI inflows though positive, its interaction with industrial states dummy is negative. Second, along with FDI inflows, the interaction effect with non-industrial states dummy also yielded positive sign. This highlights that the productivity affects of FDI inflows for domestic firms in the regions is not heterogeneous. Rather, the positive effects from non-industrial states interactions shows that even a marginal increase in FDI inflows into these regions can have a significant impact on the performance of local firms.

In model 8, I replace FDI inflows stock with share of foreign technical collaborations in total foreign collaborations for each region in India. As one can see the number of cross-section observations is now only 93. This is because the number of technical collaborations approvals was transferred into automatic route controlled by Reserve Bank of India (RBI) from 2005 onwards. Therefore, the data of technical collaborations at regional level is available from 2002 to 2004 only. The results show that the share of foreign technical collaborations yield positive sign but remains statistically insignificant. But in model 9, when I control for FDI inflows stock, the impact of share of foreign technical collaborations becomes statistically significant at 1% confidence level. We also find that FDI inflows stock is also positive and 1% significant. This provides support for the argument that foreign technical collaborations influence the performance of local firms in part through its effect on the FDI inflows stock. This effectively means that mere signing or approval of foreign technical collaborations might not be useful unless these collaborations are backed up with substantial amount of investments by the foreign entities in the regions. Finally, in model 10 and 11, I examine how the effects of foreign technical collaborations may vary over regions as well. I follow similar approach highlighted above with respect to industrial and non industrial states. I interact the share of foreign technical collaborations with both industrial and non industrial states dummies. The results once again reiterate the fact that foreign technical collaborations are non-state heterogeneous. This also means that a marginal increase in foreign technical collaborations in non-industrial states can have a considerable positive impact on the performance of the local firms (see annexure 3 for industrial & non industrial states list).

Robustness check

I ran several tests of sensitivity. First, I ran the baseline model with one lagged values for all the independent variables along with FDI inflows. There is no significant change in the results. The coefficient values of FDI retain its positive sign with same significance level as in benchmark model 2. Its impact on output per worker is also similar to that of benchmark model. Moreover, with respect of other control variables I do not find any significant changes in their results. Second, I ran all 11 models using pooled OLS method (results are displayed in annexure 4). As can be seen there is not much change in the results, especially with respect to main independent variables and also the various interaction effect variables. Removal of period effects do not alter the results drastically.

Table 3: FDI & Productivity equation function

Dependent Variable**:** Log (Output per worker per region)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11
	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Constant	3.248 * (0.14)	3.308 * (0.14)	2.258 * (0.09)	2.246 * (0.08)	2.257 * (0.10)	2.224 * (0.08)	2.224 * (0.08)	2.243 * (0.08)	2.293 * (0.08)	2.267 * (0.08)	2.267 * (0.08)
Log Gross Fixed Capital	0.193 * (0.02)	0.181 * (0.03)	0.020 ** (0.01)	0.017 ** (0.01)	0.020 ** (0.01)	0.018 ** (0.01)	0.018 ** (0.01)	0.017 ** (0.00)	0.015 ** (0.00)	0.015 ** (0.00)	0.015 ** (0.00)
Log Labour Employed $(\alpha + \beta - 1)$	-0.187 * (0.03)	-0.202 * (0.03)	-0.420 * (0.01)	-0.419 * (0.01)	-0.420 * (0.01)	-0.411 * (0.01)	-0.411 * (0.01)	-0.418 * (0.00)	-0.416 * (0.00)	-0.412 * (0.01)	-0.412 * (0.01)
Log FDI inflows Stock	------	0.027 * (0.01)	0.006 ** (0.00)	0.004 *** (0.00)	-3.08E-09 (3.96E-08)	0.009 ** (0.00)	0.006 * (0.00)	------	0.015 * (0.00)	0.015 * (0.00)	0.015 * (0.00)
Log total output (t – 1)	------	------	0.130 (0.09)	0.112 (0.09)	0.130 (0.09)	0.123 (0.09)	0.123 (0.09)	0.082 (0.08)	0.086 (0.07)	0.082 (0.07)	0.082 (0.07)
Log Raw Materials consumed	------	------	0.265 * (0.08)	0.254 * (0.07)	0.264 * (0.08)	0.268 * (0.07)	0.268 * (0.07)	0.320 * (0.07)	0.298 * (0.06)	0.302 * (0.06)	0.302 * (0.06)
Log New invested capital	------	------	------	0.034 *** (0.02)	------	------	------	------	------	------	------
Log FDI inflows Stock Squared	------	------	------	------	0.007 ** (0.00)	------	------	------	------	------	------
Log FDI **X** Industrial States	------	------	------	------	------	-0.003 ** (0.00)	------	------	------	------	------
Log FDI **X** Non-industrial states	------	------	------	------	------	------	0.003 ** (0.00)	------	------	------	------
Technical collaborations / Total collaborations	------	------	------	------	------	------	------	0.018 (0.03)	0.129 * (0.04)	0.111 * (0.04)	0.048 (0.05)
Technical collaborations share **X** Industrial States	------	------	------	------	------	------	------	------	------	-0.063 *** (0.03)	------
Technical collaborations share **X** Non-industrial States	------	------	------	------	------	------	------	------	------	------	0.063 *** (0.03)
R-squared	0.622619	0.647399	0.979525	0.980783	0.979525	0.980486	0.980486	0.977106	0.980682	0.981053	0.981053
Adjusted R-squared	0.606628	0.629317	0.978100	0.979266	0.977909	0.978945	0.978945	0.975220	0.978842	0.978999	0.978999

F-statistic	38.936 *	35.803 *	687.688 *	646.484 *	605.974 *	636.440 *	636.440 *	518.241 *	533.023 *	477.525 *	477.525 *
Number of States / Regions	31	31	31	31	31	31	31	31	31	31	31
Total Number of Observations	124	124	124	124	124	124	93	93	93	93	93
Period Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: * Significant at 1% confidence level; ** Significant at 5% confidence level; *** Significant at 10% confidence level. All models are controlled for Heteroskedasticity. White Heteroskedasticity-Consistent Standard Errors are reported in parenthesis.

5. Plausible Explanations & Policy Implications

The results displayed above calls for plausible explanations and highlight the policy implications. First, the comparison of the contribution of FDI across the models highlights that the coefficient value are smaller. However, one must be cautious in interpreting these results and this cannot be taken as a conclusion that foreign capital is not playing a greater role in the technology diffusion process in regions within India. This is because there is a need to go much deeper in order to examine the actual net impact of foreign firms' presence and their penetration on productivity of local firms in each sector region-wise. This kind of micro-level study would reveal the true effects of foreign investments on local firms within India.

Second, the table 4 and 5 gives a brief summary of the temporal pattern of the effects of both FDI and foreign technical collaborations on output per worker of industry in Indian regions[7]. First, the partial effects of FDI inflows indicate that FDI has become increasingly important not only for industrial regions but also for non-industry regions. The partial effects coefficient for industrial states is relatively lower than that of non-industrial states. Though FDI inflows has been rewarding for industrial states, it was even more rewarding for non-industrial states. The partial effect gains from FDI inflows for industrial states were 0.58% compared to 0.87% for non-industrial states.

Table 4: Regional industry output gains from FDI within India

Variables	Coefficient of generic term	Gains from FDI (partial effects)
Industrial States	0.008666 %	0.005758 %
Non-industrial States	0.005757 %	0.008665 %
Differences in partial effects	-0.002907 %	

Second, the partial effects of foreign technical collaborations indicate that the effect is relatively higher for non-industrial states. The partial effect gains from foreign technical collaborations for industrial states are 4.8%, while the same for non-industrial states is 11.09% (see table 5).

Table 5: Regional industry output gains from Technical Collaborations within India

Variables	Coefficient of generic term	Gains from Collaborations (partial effects)
Industrial States	0.110942 %	0.048001 %
Non-industrial States	0.048001 %	0.110942 %
Differences in partial effects	-0.062941 %	

Source for table 4 & 5: computed & compiled by author

[7] Partial coefficients are calculated as follows: The estimated coefficients for the regions outside a region is equal to the coefficient of the generic term and the estimated coefficient for the region is equal to the sum of the coefficient of the generic term and the coefficient of the respective interaction term.

One credible recommendation which can be derived from these results are that domestic firms can reap rich dividends if the FDI inflows are evenly distributed across the states, particularly concentrating the efforts on attracting FDI into non-industrial states. As we have shown earlier that there is uneven distribution with respect to FDI inflows within Indian regions, as a consequence, policies that have been successful in one region should not be blindly replicated in other regions. This sometimes is unlikely to be successful, particularly for poor and North-Eastern regions of India. Rather, our results have shown that a marginal attempt to attract FDI inflows and foreign technical collaborations in these so called non-industrial states can affect local firms positively. Thus, minor contributions do make a difference, and ultimately lead to inflows of FDI leading to technology diffusion. Finally, the insignificant effect of foreign technical collaborations unless controlled for FDI inflows shows that mere signing of the collaborations with foreign firms will not be of any beneficiary for the domestic firms. The collaborations must be followed by significant investments in plant and production by foreign entities if they were to make an impact on local firms in terms of technology transfers.

6. Conclusion

An attempt has been made in this study to compute TFP growth for aggregate industry at regional level within India for the period 2001 to 2005. Using Translog index method of 2 case and 3 case inputs, TFP growth is estimated. This was followed by estimating the effects of FDI inflows on industrial productivity in regions within India using augmented production function framework. The results highlight that FDI inflows has significant positive effect on increasing the productivity of industry within India. However, the coefficient of FDI inflows is smaller, suggesting that this positive impact is only marginal. In the next step we also introduced share of foreign technical collaborations in each region into the augmented production function model. Surprisingly, we could not find the results of technical collaborations to be significant despite earlier results indicating positive impact of FDI inflows. However, in the next model when FDI inflows are controlled for, the relationship between the share of foreign technical collaborations and productivity of domestic firms increased significantly. This supports the argument that foreign technical collaborations increases productivity in part through its effect on the FDI inflows. Lastly, there is no strong evidence in our study to show that this positive effect is state-heterogeneous. In turn, we find partial effects of FDI are marginally higher in non-industrial states. Thus, the domestic firms can reap rich dividends if the FDI inflows are evenly distributed across the states, particularly recommending the policy makers to concentre the efforts on attracting FDI into non-industrial states.

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ANNEXURES

Annexure 1: Regions under study

Andhra Pradesh	Maharashtra	Jharkhand
Assam	Manipur	Chhattisgarh
Bihar	Meghalaya	Uttaranchal
Goa	Nagaland	A & N. Island
Gujarat	Orissa	Chandigarh
Haryana	Punjab	Dadra & N Haveli
Himachal Pradesh	Rajasthan	Daman & Diu
Jammu & Kashmir	Tamil Nadu	Delhi
Karnataka	Tripura	Pondicherry
Kerala	Uttar Pradesh	
Madhya Pradesh	West Bengal	

Annexure 2: Descriptive Statistics

Variables	Mean	Median	Maximum	Minimum	Standard Deviation	Total Observations	No. of regions
Log(Output / Labour)	3.23	3.30	3.95	2.22	0.33	124	31
Log(Output)	13.83	14.37	17.40	7.08	2.40	124	31
Log(GFCF)	10.51	11.19	14.87	0.00	2.81	124	31
Log (Labour)	10.98	11.29	13.86	5.01	2.03	124	31
Log (Raw Materials)	13.31	13.80	16.80	6.53	2.40	124	31
Log(FDI inflows stock)	8.66	9.37	12.92	1.92	3.02	124	31
Log(new capital invested)	13.14	13.76	16.48	6.66	2.41	124	31

Annexure 3: Classification of Industrial & Non-industrial states

Industrial States		**Non-industrial states**	
Andhra Pradesh	Uttar Pradesh	Assam	Nagaland
Gujarat	West Bengal	Bihar	Orissa
Haryana	Chandigarh	Goa	Rajasthan
Karnataka	Delhi	Himachal Pradesh	Tripura
Kerala	Punjab	Jammu & Kashmir	Jharkhand
Maharashtra	Tamil Nadu	Madhya Pradesh	Chhattisgarh
		Manipur	Uttaranchal
		Meghalaya	Daman & Diu
		Dadra & N Haveli	Pondicherry

Annexure 4: Robustness check **-** FDI & Productivity equation function

Dependent Variable**:** Log (Output per worker per region)

Variables	**Model 12**	**Model 13**	**Model 14**	**Model 15**	**Model 16**	**Model 17**	**Model 18**	**Model 19**	**Model 20**	**Model 21**	**Model 22**
	POLS	POLS	POLS	POLS	POLS	POLS	POLS	POLS	POLS	POLS	POLS
Constant	3.257 * (0.16)	3.318 * (0.15)	2.250 * (0.10)	2.238 * (0.09)	2.251 * (0.10)	2.217 * (0.08)	2.217 * (0.09)	2.236 * (0.08)	2.281 * (0.08)	2.250 * (0.08)	2.250 * (0.08)
Log Gross Fixed Capital	0.197 * (0.03)	0.185 * (0.03)	0.019 ** (0.01)	0.016 ** (0.00)	0.019 ** (0.01)	0.017 ** (0.00)	0.017 ** (0.00)	0.016 ** (0.00)	0.014 ** (0.00)	0.013 ** (0.00)	0.013 ** (0.00)
Log Labour Employed $(\alpha + \beta - 1)$	-0.192 * (0.03)	-0.207 * (0.03)	-0.422 * (0.00)	-0.423 * (0.00)	-0.422 * (0.00)	-0.414 * (0.00)	-0.414 * (0.01)	-0.420 * (0.00)	-0.419 * (0.00)	-0.414 * (0.01)	-0.414 * (0.01)
Log FDI inflows Stock	------	0.027 * (0.01)	0.005 *** (0.00)	0.003 *** (0.00)	-6.83E-09 (3.69E-08)	0.008 ** (0.00)	0.005 *** (0.00)	------	0.116 * (0.04)	0.014 * (0.00)	0.014 * (0.00)
Log total output $(t - 1)$	------	------	0.127 (0.10)	0.111 (0.10)	0.127 (0.10)	0.121 (0.09)	0.120 (0.09)	0.080 (0.08)	0.084 (0.07)	0.079 (0.07)	0.079 (0.07)
Log Raw Materials Consumed	------	------	0.272 * (0.08)	0.263 * (0.07)	0.272 * (0.08)	0.275 * (0.08)	0.275 * (0.08)	0.325 * (0.08)	0.306 * (0.06)	0.311 * (0.06)	0.311 * (0.06)
Log New invested capital	------	------	------	0.030 *** (0.02)	------	------	------	------	------	------	------
Log FDI inflows Stock Squared	------	------	------	------	0.006 *** (0.00)	------	------	------	------	------	------
Log FDI **X** Industrial States	------	------	------	------	------	-0.003 ** (0.00)	------	------	------	------	------
Log FDI **X** non-industrial states	------	------	------	------	------	------	0.003 ** (0.00)	------	------	------	------
Technical collaborations / Total collaborations	------	------	------	------	------	------	------	0.015 (0.03)	0.014 * (0.00)	0.094 ** (0.03)	0.017 (0.04)
Technical collaborations share **X** Industrial States	------	------	------	------	------	------	------	------	------	-0.077 ** (0.03)	------
Technical collaborations share **X**	------	------	------	------	------	------	------	------	------	------	0.077 **

Non-industrial States											(0.04)
R-squared	0.596689	0.620929	0.978370	0.979411	0.978372	0.979291	0.979291	0.976073	0.979184	0.979745	0.979745
Adjusted R-squared	0.590023	0.611452	0.977454	0.978356	0.977263	0.978229	0.978229	0.974698	0.977732	0.978077	0.978077
F-statistic	89.508 *	65.521 *	1067.501 *	927.626 *	882.119 *	922.112 *	922.112 *	709.801 *	674.234 *	587.367 *	587.367 *
Number of States / Regions	31	31	31	31	31	31	31	31	31	31	31
Total Number of Observations	124	124	124	124	124	124	93	93	93	93	93
Period Dummies	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Note: * Significant at 1% confidence level; ** Significant at 5% confidence level; *** Significant at 10% confidence level. All models are controlled for Heteroskedasticity. White Heteroskedasticity-Consistent Standard Errors are reported in parenthesis.