Country Origin of Foreign Direct Investment in Indian Manufacturing and Its Impact on Productivity of Domestic Firms

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1 Introduction

There have been a large number of studies on the impact of foreign direct investment (FDI) on productivity of firms in the host country. Some of these studies have been undertaken in the context of developed countries, and it seems, a much larger number of studies have been done for developing countries. The significance of such studies (on the impact of FDI) for developing countries arises from the fact that the developing countries have a great deal of interest in attracting FDI with the hope of gaining substantially from it. FDI in such countries is expected to bring in advanced technology, superior management practices, export contacts, etc. Transfer of technology and knowledge from industrialized countries to developing countries is expected to help the domestic firms in developing countries improve their productivity and competitiveness, directly or indirectly.

Several studies have found that FDI firms, i.e. the firms with FDI (defined in terms of foreign promoters' equity holding in the firm being beyond a threshold of say 10% or 25%), have higher productivity than domestic firms (see, for example, Harris and Robinson 2002, 2003; Karpaty 2004; Harris 2009), or that the acquisition of equity in a domestic firm by a foreign firm beyond a threshold of say 10% (hereafter termed as foreign acquisition for brevity) makes the productivity of the acquired domestic firm to go up (see, for example, Karpaty 2007; Arnold and Javorcik 2009; Li et al.

[1]It should be noted that there are some studies which have found that foreign acquisition did not raise the productivity of the acquired domestic firm; Benfratello and Sembenelli (2006) for Italy, Petkova (2012) for India, Kaitila et al. (2013) for six small open economies of the EU (Austria, Belgium, Denmark. Finland, Sweden and the Netherlands), and Gelübcke (2015) for Germany.

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2009; Liu and Qiu 2017).[1] One may ask: why should a foreign-owned firm have an advantage in productivity in comparison with a domestic firm? Going by the theoretical and empirical literature on foreign direct investment, referring particularly to the analyses undertaken by Aitken and Harrison (1999) and Pfaffermayr and Bellak (2002), it seems right to argue that foreign firms often possess some firm-specific advantages that give them an edge over domestic firms. These advantages include specialized knowledge about production, superior management and marketing capabilities, export contacts and coordinated quality-oriented relationships with suppliers and customers. Evidently, it is these advantages that drive the multinational enterprises (MNEs) to locate their subsidiaries overseas so that they can exploit the advantages. It is therefore not surprising that many empirical studies have found FDI firms to have typically higher productivity than domestic firms. By the same line of reasoning, as an MNE acquires a portion of the equity in a domestic firm, this act of the MNE creating bonds between the two firms makes it possible for the domestic firm to raise its technological standards, adopt superior management practices, exploit the new export contacts to increase sales, and thus raise its level of productivity.

It is important to note that FDI not only improves the level of productivity, competitiveness and technological capabilities in the domestic firms in which the investment is made but also in other domestic firms through the 'spillover effects'. Indeed, there has been a great deal of research interest in the spillover effects of FDI, especially in developing countries, leading to the emergence of a huge literature on productivity spillover from FDI (hereafter referred to FDI spillover).

Though one can advance persuasive arguments for postulating/hypothesizing a positive FDI spillover effect in developing countries, empirical studies on developing countries have reported mixed results. Some studies have found evidence of a positive spillover effect, while some others have found evidence of a negative spillover effect. In a meta-analysis of FDI spillover estimates obtained in various studies undertaken for developing countries (1450 spillover estimates made in 69 empirical studies for 31 developing countries, for the period 1986–2013), Demena and van Bergeijk (2017) report that the results are mixed—17% of the spillover estimates are negative and statistically significant, 21% negative and statistically insignificant, 32% positive and statistically significant and 30% positive and statistically insignificant.[2] Some of the studies that have found a positive spillover effect include Kokko (1994, 1996) for Mexico, Sjöholm (1999) for Indonesia, Kokko et al. (1996) for Uruguay and Chuang and Lin (1999) for Taiwan. In a recent review of empirical studies on FDI spillovers, te Velde (2019) identifies six major determinants of the effects and spillovers of

[2]Lest one gets the impression that on balance the empirical evidence is indicative of a positive FDI productivity spillover in developing countries, it should be pointed out that Demena and van Bergeijk (2017) observe moderate to substantial publication bias in the spillover estimates reported in the studies, which means that the average of the spillover estimates reported in the studies tends to exaggerate to some extent the beneficial productivity spillover from FDI in developing countries. There is also the issue of model misspecification, which affects the spillover estimates obtained.

FDI in developing countries, including sector of investment, value-chain linkages, level of financial development, employee training and labour mobility, technological capabilities and firm-specific characteristics (such as firm size, degree of ownership, etc.).

The more recent studies in this area have recognized that the realization of potential productivity spillover from FDI is conditioned and moderated by domestic firms' technological capabilities. Even among these new-generation studies which take into account domestic firms' capabilities in assessing the spillover effects, the results are mixed. Several studies undertaken for developing countries of Latin America and Africa find negative or negligible FDI productivity spillover (for example, Mebratie and Bedi 2013 for South Africa and Jordaan 2008 for Mexico). On the other hand, several such studies for developing countries of Asia find positive spillover effects. These include the studies undertaken by Khalifah and Adam (2009) for Malaysia, Takii (2009) for Indonesia and Nguyen (2008) and Van Thanh and Hoang (2010) for Vietnam. For China, some empirical studies—such as Abraham et al. (2010), Ito et al. (2010), Xu and Sheng (2012) and Long et al. (2014)—find evidence of a positive FDI spillover effect, while others find different results.[3]

In the empirical literature on spillover effects of FDI, a distinction has been made between horizontal spillover (the effect from an FDI firm to other firms in the same industry) and vertical spillover (the effect from an FDI firm in an industry to domestic firms in other industries which supply to the FDI firm or buy from the FDI firm). The horizontal spillover effects occur through several channels—competition, demonstration effect and inter-firm workers mobility or turnover. If the competition faced by domestic firms in an industry from FDI firms in that industry is intense, the horizontal spillover can be negative. The negative effect of competition may offset or neutralize the positive effects arising from demonstration and worker mobility. Making an overall assessment of the available estimates of horizontal spillover effects, one may conclude that in most cases horizontal spillover effects are found to be either negative or insignificant, especially when the recipient is a developing country (see Guo 2016, who makes this observation based on a review of studies, and who finds such results from the analysis of FDI spillover undertaken for China).[4] For vertical spillover in developing countries, several studies document a positive effect—for example, Ito et al. (2010) and Xu and Sheng (2012) for China, and Newman et al. (2015) for Vietnam.[5] Some studies have found a positive spillover through backward linkage; some others have found a positive spillover through forward linkage. From

[3] See Jefferson and Ouyang (2014) for review of 16 papers and a discussion on differences in results.

[4] Guo (2016) observes, however, that there is a measurement error in TFP in most of the existing studies since they do not consider the learning process among domestic firms triggered by FDI in the industry for which a portion of labour is devoted. This may give a wrong impression that horizontal spillover effect is negative. When the correction for learning is made, the effect would not be found to be negative and the future effect of FDI on productivity of domestic firms of the industry (horizontal spillover) will be positive.

[5] Javorick (2004) argues that FDI spillover is more likely to be vertical than horizontal. Also, spillovers are most likely to take place through backward linkage, i.e. domestic firms supplying to multinational firms operating in the country. Also see, Havranek and Irsova (2011) in this connection.

a meta-analysis of FDI spillover effects, Havranek and Irsova (2011) conclude that gains from backward linkages are relatively more likely than gains from forward linkages.[6]

There is increasing recognition that the country of origin of FDI makes a difference to the spillover effect. There is a nascent but growing literature on this subject. Javorick and Spatareunu (2011) emphasize the importance of geographic distance between the source country of FDI and the host country in determining the spillover effect. The core idea is that if the investor firm is located in a country very far from the host country, there is greater inducement for local sourcing, leading to productivity spillover. Monastiriotis and Alegria (2011) build a similar argument on the basis of cultural proximity. In this case, the argument is that greater cultural proximity leads to local sourcing which in turn generates spillover effects.[7]

Besides these two, there are several studies that have been undertaken to investigate if the country of origin of FDI makes a difference to spillover effects. Xu and Sheng (2012), in their study of FDI productivity spillover in China, distinguish between FDI from Hong Kong and Taiwan and that from other countries. Their results indicate that Western firms produce more substantive spillovers than do overseas Chinese firms.[8] Monastiriotis (2014) examines the spillover effect of FDI from EU as against that from other countries. The analysis is done for the central and eastern Europe (CEE), SEE (the Bulkans) and eastern neighbourhood policy (ENP) regions. The results show that investment from EU has a much more favourable productivity spillover effect than investment from other countries. Ni et al. (2015) study the spillover effects of FDI in Vietnam distinguishing between different source countries. They consider FDI from ASEAN, East Asia, Europe and North America. They find that horizontal spillover is negative for FDI from ASEAN, East Asia and Europe. There is positive vertical spillover in certain cases. According to their empirical results, the presence of Asian firms in downstream sectors positively impacts productivity of Vietnamese firms in the supplying industries, but no significant relationship is found in the case of European and North American affiliates being in the downstream industries.[9] Among Asian countries as sources of FDI, the gain to

[6]Notwithstanding this conclusion drawn by Havranek and Irsova (2011), from their meta-analysis of spillover effect estimates, it should be noted that some studies do find evidence of positive forward linkage—sometimes even bigger than backward linkage (for example, Xu and Sheng 2012 for China; Takii and Narjok 2012, for Indonesia).

[7]A different line of argument connected with country of origin is that if there are FDI inflows from diverse countries then it is beneficial and promotes greater positive spillovers. In such a situation, a greater variety of FDI knowledge gets transmitted to local firms through vertical linkages. Also, there is a better demonstration effect. With diverse technologies and management practices available, domestic firms can recombine the technologies and practices to create their own competitive strength. Some studies have examined this issue. To give an example, such a study has been undertaken by Zhang et al. (2010) for Chinese firms. Their results support the hypothesis that diversity of FDI country of origin promotes productivity spillover.

[8]This finding is apparently consistent with the argument of Javorick and Spatareunu (2011) that bigger distance between the source and host country promotes greater spillover.

[9]This goes against the (distance-based) argument of Javorick and Spatareunu (2011), but may have an explanation in cultural proximity as argued by Monastiriotis and Alegria (2011). Note, however,

Vietnamese firms through vertical productivity spillover is relatively greater for FDI from East Asian firms excluding Japan and South Korea. Interestingly, the authors report that there is not much gain to productivity of Vietnamese firms if the buyer firms in the downstream industry belong to Japan and South Korea because such firms tend not to source locally.[10]

The country of origin should make a difference not only to the spillover effects, but also to the direct effect of FDI on the productivity of the firms in which the investment is made. This aspect has been investigated for the USA by Chen (2011) who looks at the source of FDI and how that impacts the performance of the target firms. The main empirical finding of the study is that increases in labour productivity in the target firms are greater when the acquiring firms are from industrialized countries than when the targets are acquired by domestic firms. On the other hand, labour productivity increases in the target firms are lower when these are acquired by firms from developing countries than when the target firms are acquired by domestic firms. It may be inferred accordingly that FDI from industrialized countries has a bigger productivity-enhancing effect on the acquired domestic firms in the USA than FDI from developing countries.

This paper attempts to analyse the impact of FDI on productivity of Indian manufacturing firms taking into account the country of origin of FDI. The study is perhaps the first of its kind for India and contributes to the growing international literature on the role played by country of origin of FDI in determining its impact on productivity of domestic firms. Both the direct effect of FDI and indirect effect through spillovers are examined. The period covered for the analysis is 2000–01 to 2014–15. The analysis is confined to the corporate manufacturing sector and is done using firm-(company) level data from *Prowess*.

The paper is organized as follows. The data sources and variable construction are discussed in Sect. 2. A key variable for the analysis is the level of total factor productivity (TFP) in different firms in different years. The methodology adopted for the measurement of TFP is explained in Sect. 2, which also contains a discussion on the variables used for estimation of econometric models aimed at assessing the impact of FDI. Sections 3 and 4 deal with the direct effect of FDI on the productivity of domestic firm in which investment takes place—the former compares TFP levels between FDI firms and domestic firms in India, to ascertain if it is relatively higher in FDI firms, and the latter examines whether TFP of a domestic firm is positively impacted when it gets acquired by a foreign firm. This is followed by an econometric analysis of spillover effects, which is taken up in Sect. 5. Finally, the main findings of the study are summed up in Sect. 6 along with some concluding remarks.

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that the cultural proximity argument does not seem to hold when one considers the Japanese and South Korean investments in Vietnam.

[10]In contrast, Anaya (2013) finds that Japanese FDI generates backward spillover effect in Mexico but US FDI does not generate such an effect. For both of them, Japanese and US FDI, no forward spillover effect is found. The absence of backward spillover effect from US FDI in Mexico (Anaya 2013) and that from Japanese and Korean FDI in Vietnam (Ni et al. 2015) is consistent with the argument of Javorick and Spatareunu (2011) that the distance between the source country of FDI and host country of FDI plays a role in determining backward spillover effects.

Before concluding this section, a brief discussion on earlier studies on the impact of FDI on productivity of Indian manufacturing firms would be in order. There have been only a small number of studies on the direct impact of FDI on the productivity of the acquired firm. These include Goldar et al. (2004), Banga (2004), Petkova (2012) and Sahu and Solarin (2014). By comparison, there have been a large number of studies on FDI productivity spillover effects in India. These include Kathuria (2001, 2002, 2010), Siddharthan and Lal (2004), Bergman (2006), Sasidharan and Ramanathan (2007), Bhattacharya et al. (2008), Pant and Mondal (2010), Marin and Sasidharan (2010), Mishra (2011), Malik (2011), Behera et al. (2012a, b), Mondal and Pant (2014, 2018), Sahu and Solarin (2014), Thakur and Burange (2015) and Klein (2017).

Goldar et al. (2004) in their study of engineering firms in India found that foreign firms have higher productivity than domestic firms. Sahu and Solarin (2014) too found that foreign firms have higher productivity than domestic firms (covering manufacturing companies in their study). By contrast, Petkova (2012) does not find a significant positive effect of FDI on productivity of acquired domestic manufacturing firms in India. Banga (2004) is perhaps the only study on the impact of FDI on productivity of Indian firms, which has taken into account the country of origin. She made a distinction between Japanese and US firms in India and found from her analysis that Japanese affiliation had a significant positive effect on productivity growth in Indian firms while the impact of US affiliation was not found to be significant.

Turning now to the studies on spillover effects of FDI in India, the results are mixed. A number of the studies do not find FDI to be productivity enhancing through spillover effects. These include Kathuria (2001, 2002, 2010), Bergman (2006), Sasidharan and Ramanathan (2007), Marin and Sasidharan (2010), Mishra (2011) and Mondal and Pant (2014). On the other hand, Siddharthan and Lal (2004), Bhattacharya et al. (2008) and Behera et al. (2012a, b) find evidence of positive FDI productivity spillover effect. Among the more recent studies, Klein (2017) finds evidence for productivity spillovers in technology-intensive sectors. Positive spillovers are also found in less technology-intensive sectors, but these are more concentrated at the top of the productivity distribution. Similarly, the empirical results obtained by Sahu and Solarin (2014) indicate positive productivity spillover effects of FDI in India.

2 Data Sources, Estimation of TFP and Construction of Variables

2.1 Data Sources

The primary database used for empirical analysis in this study is Prowess, a firm-level dataset for India. Created by the Centre for Monitoring Indian Economy Pvt. Ltd. (CMIE), it draws data from company balance sheets and income statements

of listed, as well as some unlisted, public and private limited companies. For the purpose of this study, we restrict ourselves to manufacturing firms and collect data on company sales, output, labour, foreign direct investment,[11] export, import, etc. As part of data cleaning, we remove observations with real value-added to labour or capital ratio below the first percentile or above the 99th percentile, observations with negative values for sales/output or value-added and firms that report data for less than three years. We also exclude the following industries from analysis: NIC 34 (diversified), NIC 35 (electricity), NIC 42 (civil engineering), NIC 68 (real estate) and NIC 98 (undifferentiated goods). Finally, we have compiled a panel for around 7338 Indian firms and used data for 15 years from 2000–01 (hereafter 2001) to 2014–2015 (hereafter 2015). The number of firms reporting data in each year varies but is roughly between 3000 and 5000 in a year, except for 2015 for which there are only about 2000 firms.

2.2 Estimation of TFP

To estimate firm-level TFP, we follow the literature and use the Levinsohn–Petrin (L-P) approach (Levinsohn and Petrin 2003), where consistent productivity estimates are obtained by using firms' material inputs as a proxy for unobserved productivity shocks, which may be correlated with firm inputs. A similar technique was employed by Olley and Pakes (OP) (1996) who used investment as a proxy. However, given that the OP approach requires investment to be strictly increasing with productivity, only nonnegative values of investment can be used in estimations. Since this would lead to a significant loss of efficiency, we prefer the L-P approach in our paper and obtain the L-P TFP estimates using the 'levpet' command in Stata. Developed by Petrin et al. (2004), this command estimates a Cobb–Douglas value-added production function, with capital and labour as inputs.[12] We have taken real energy as a proxy for productivity shocks. Section 2.2.1 explains construction of variables used in TFP estimation, and Table 1 provides summary statistics for these variables.

[11] It needs to be pointed out that wholly owned foreign companies are not covered in Prowess. This is obviously a limitation of the data when used for the purposes of studying the impact of FDI.

[12] After applying the levpet command and obtaining the estimate of lnTFP for different firms for different years, i.e. $\ln TFP_{it}$ where *i* denotes firm and *t* denotes time (year), the TFP index has been rebased by subtracting $\ln TFP_r$ from $\ln TFP_{it}$ where TFP_r is the TFP level of the reference firm. For the TFP index formed in this study, the average firm in 2013–14 has been taken as the point of reference. Thus, TFP_r is the simple average of TFP estimates of various firms for the year 2013–14 obtained by the 'levpet' command.

Table 1 Summary statistics of variables used in TFP estimation

Variables	Observations	Mean	STD	Min	Max	Units
Real value-added	62,170	14.11	186.23	0	13,041	Rs. Million
Labour (total persons engaged)	36,310	1093	4840	0	193,628	Number of employees
Real energy	60,810	1.45	8.78	0	536	Rs. Million
Real capital	62,585	1296.2	13,274.5	0	1,238,902	Rs. Million
Service input	62,508	467.85	3561.36	0	288,857	Rs. Million
TFP (index)	34,230	0.966	1.417	0.008	27.5	

Source Prowess and authors' computations

2.2.1 Construction of Variables Used in TFP Estimation

Real Value-Added

We first estimate nominal value-added for a firm by subtracting the nominal value of intermediate inputs from the nominal value of gross output. We construct gross output of a firm by adding its sales with change in stock of finished and semi-finished goods. For value of intermediate inputs, we add expenses on materials (raw materials, stores and spares and value of packaging and packing expenses), energy and services. Next, we deflate nominal value-added using 3-digit industry-level price deflators, constructed from the wholesale price index (WPI) series obtained from the Office of the Economic Advisor, Ministry of Commerce and Industry, Government of India. Series with 1993/94 and 2004/05 as base years are spliced and rebased to 2004/05.

Labour Input

While Prowess provides data on wages and salaries given to employees, the number of employees is reported for very few firms. Therefore, for constructing firm-level labour input in our study, we use emoluments and employee data from Annual Survey of Industries (ASI), Central Statistics Office, Government of India. First, for each three-digit industry in ASI (according to National Industrial Classification, NIC), we calculate the average industrial wage-rate by dividing total emoluments with total employees. Next, we match each three-digit ASI industry to a five-digit NIC industry (2008 classification) in Prowess using concordances. This gives us the average industrial wage-rate for each firm in our panel. It is important to note here that in the existing literature, there is documented evidence of foreign-owned firms paying higher wages to their employees. To account for such heterogeneity in wages across firms, we follow Goldar et al. (2004) and add a 10% wage-premium on the average wage-rate calculated for foreign firms using the ASI data. Lastly, we divide wages and salaries reported by each firm in Prowess with its corresponding average wage-rate to get firm-level labour.

Capital Input

While some empirical studies that estimate industrial productivity using ASI data calculate fixed capital stock using the perpetual inventory method, others employ a blanket deflation procedure (see Haidar 2012 for an example). In this study, we use the latter approach, despite its known limitations. To construct real capital stock, we first collect data on net fixed assets for each firm in our panel, using the Prowess dataset, and then deflate it using the implicit deflator for fixed capital formation in manufacturing, computed using *National Accounts Statistics* with base year 2004–05 (combined with the new series on National Accounts).

Energy Input

We first calculate the nominal energy input for a firm as the sum of its expenses on power and fuel, in current prices, obtained from Prowess. To construct the energy deflator, we use price indices of coal, petroleum products, natural gas and electricity for industrial use from the official WPI series and other sources. We combine the price series with 1994/94 as the base year with series using base prices 2004/05, and splice and rebase the combined series to 2004–05.

Services Input

The services input of a firm is calculated as the sum of its expenses on heterogeneous services comprising of rent and lease, repair and maintenance, outsourced manufacturing jobs, outsourced professional jobs, insurance, selling and distribution expenses and financial services. This is measured in current prices. We also make an estimate of the component of imported services.

2.2.2 Descriptive Analysis for TFP Growth

In Fig. 1, we represent the value-added weighted average growth in TFP across different industries in the period 2001/02 to 2014/15 (based on firms level TFP estimates explained above). It shows that highest growth has been in 'other manufactures' sector, which includes firms engaged in manufacture of jewellery, sports goods, games and toys, medical and dental instruments and musical instruments. There has also been relatively higher productivity growth in sectors of: computer, electronics and optical instruments electrical equipment, wearing apparels and beverages. Low productivity growth is observed for tobacco, motor vehicle and basic metals sectors.

2.3 Construction of Foreign Ownership Variables

The main explanatory variables in our analysis are based on ownership data reported in Prowess. Consistent with the literature, we treat a firm as being foreign-owned if 10% or more than 10% of its equity shares are held by foreign promoters. If a firm

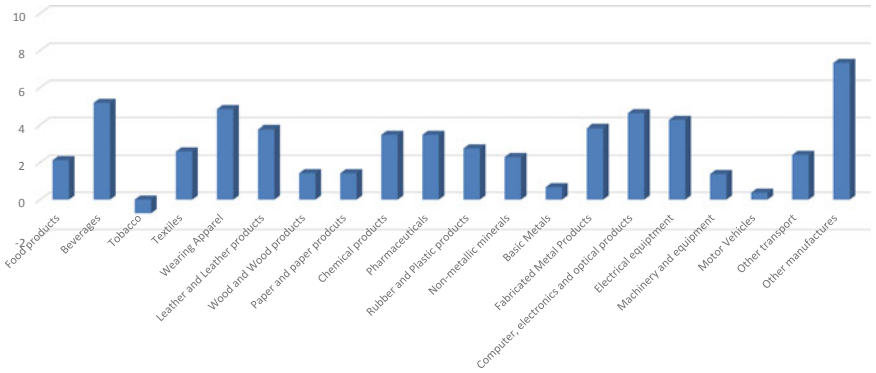

Fig. 1 Annual average growth rate in TFP (% per annum), 2001–02 to 2014–15, by industry. *Source* Based on authors' estimations

has been identified as a foreign-owned firm in a given year, then it remains (or is treated as) a foreign firm for the rest of the following years in our panel. We observe that 6.65% of observations in our panel are classified as foreign firms (alternatively called FDI firms).

Using firm-level foreign ownership data, we construct three spillover variables. First, we estimate horizontal spillovers as the sales-weighted average foreign shares in each two-digit industry. Next, we create a backward spillover variable for each industry that reflects the degree of foreign presence in the other industries to which it supplies, i.e. foreign presence in downstream industries. Similarly, we create a forward spillover variable for each industry, capturing the degree of foreign presence in the industries from which it buys its input, i.e. foreign presence in upstream industries. The spillover variables have been constructed at NIC 2–digit level and then applied to all firms belonging to those industries. The construction of these spillover variables is given in more detail in Sect. 5, and summary statistics are presented in Table 2.

Table 2 Summary statistics of FDI variables

Variables	Observations	Mean	STD	Min	Max
Foreign share	65,549	2.20	10.56	0	97.09
FDI share	64,900	6.12	3.90	0	28.95
Forward FDI spillovers	65,549	5.64	1.99	2.012	12.78
Backward FDI spillovers	64,900	3.57	2.25	0.0329	11.93

Note Foreign share variable represents equity share of foreign promoters in the firm (%). FDI share, on the other hand, is computed as sales-weighted average foreign shares in the industry to which the firm belongs. FDI share, forward FDI spillovers and backward FDI spillovers are computed at two-digit industry level as explained in the text
Source Authors' computations

An important piece of information for the study is the country source of origin of the FDI in the foreign-owned firms. Most of FDI directed to India originates from Europe and North America (each accounting for 37% of total investments in this country), while Japan and the Four Asian Tigers account for 9 and 6% of inward FDIs in India (Zanfei et al. 2019). However, at the firm level, Prowess does not report on origin of FDI, requiring the use of other sources. Even with these inputs, the country of origin could not be determined for a portion of the foreign-owned firms.[13]

In the sample, about 400 firms were identified as FDI firms. Of these, 49% have investment from USA or Europe, 12% from Japan, 11% from developing countries of Asia, and 5% from Mauritius (which is treated separately). In about 21% of cases, the country origin of FDI could not be determined.

2.4 Construction of and Summary Statistics on Control Variables

The estimation of the productivity spillover effects of FDI in Sect. 5 has been done by estimating econometric models. The same applies to the assessment of TFP differences between FDI firms and domestic firms in Sect. 3 and impact of foreign acquisition of domestic firms by foreign firm on the level of TFP of acquired firms in Sect. 4. For estimating the econometric model, a number of variables have been used as controls in the regression analysis. The definition of the variables and summary statistics are provided in Tables 3 and 4.

Table 3 Construction of variables used in regression analysis

Variable	Construction	Data sources used
Export intensity	Export of goods/sales (in %)	Prowess
Import intensity	Total imports/sales	Prowess
Size	ln (total assets), ln (deflated sales)	Prowess
Age of the firm	Reporting year − year of incorporation	Prowess
Services export intensity	Export of services/sales (in %)	Prowess
Services import intensity	Imported services/total services used	Prowess
R&D intensity	R&D expenditure/sales	Prowess
Leverage	ST debt/current assets	Prowess
Liquidity	(current assets − current liabilities)/total assets	Prowess

[13] Valuable inputs on country origin of investors in the identified FDI firm have been provided by Dr. K. S. Chalapati Rao (Institute for Studies in Industrial Development, New Delhi) and Dr. Amrita Goldar (Indian Council for Research in International Economic Relations, New Delhi). We are grateful to them for providing this information.

Table 4 Summary statistics, variables used as controls in regression analysis

Variable	Observations	Mean	STD	Min	Max
Export intensity (in %)	65,510	12.20	23.12	0.00	132
Import intensity	65,549	0.09	0.629	0.00	86.84
Deflated Sales	64,900	38.22	379.34	0.0004	2371
Total assets	62,422	37.58	299.49	0.00	18,416
Service import intensity (in %)	62,203	1.24	7.58	0.00	150
Services export intensity (in %)	65,547	0.32	3.88	0.00	100
R&D intensity (in %)	65,547	0.18	1.28	0.00	97
Age (years)	65,014	24.86	17.82	0.00	136
Liquidity	60,540	0.17	0.30	−15.59	0.71
Leverage	50,697	0.16	0.11	0.00	0.63

Note Total assets are reported in Rs. Million. The same applies to deflated sales
Source Prowess and authors' computations

3 Do FDI Firms Have Higher Productivity?

The methodology of estimation of TFP for Indian manufacturing firms undertaken in this study has been discussed in the previous section. This section is devoted to an analysis of inter-firm differences in the level of TFP. The aim is to ascertain whether the level of TFP is relatively higher among FDI firms in comparison with non-FDI firms, referred to as domestic firms. Also, a comparison is made between FDI firms with FDI from developed countries and those with FDI from developing countries. A similar comparison is made between FDI originating in the USA and Europe (excluding emerging economies of Europe) and FDI originating in Asian countries.

For the purpose of these analyses, aimed at making inter-firm TFP (level) comparisons, a multiple regression equation is estimated. The regression equation for making a comparison between FDI firms and domestic firms is specified as:

$$\ln \mathrm{TFP}_{ijt} = \alpha_0 + \alpha_j + \alpha_t + \beta_1 F_{ijt} + \gamma X_{ijt} + u_{ijt} \tag{3.1}$$

In this equation, TFP_{ijt} is the level of TFP of firm i in industry j in year t, F_{ijt} is a dummy variable for FDI firms (takes value one if the share of foreign promoter(s) in equity of the firm is 10% or more, zero otherwise),[14] X_{ijt} is a set of control variables, and γ is the corresponding vector of parameters, and u_{ijt} is the random effort terms. The terms α_j and α_t are for the industry and time (year) fixed effects. This model specified above bears some similarity to the approach taken in the study of Harris (2009) who estimated a Cobb–Douglas production function from panel data and introduced FDI firm dummy as one of the explanatory variables. While Harris used a one-step approach to assess the impact of foreign ownership on TFP which has

[14] As pointed out earlier, if a domestic firm turns into an FDI firm in a year, it is treated as an FDI firm for all subsequent years in the panel.

been used in a number of other studies, in this study, a two-step approach is used: estimation of TFP at firm level in the first step and assessment of the impact on foreign ownership on TFP in the second step.[15] One can find other studies in which an equation similar to Eq. 3.1 has been estimated from firm-level data (see, for example, Karpaty 2004).

In the above equation, no distinction is made in regard to the country of origin of FDI. An alternative specification that has been used takes note of this distinction. This may be written as:

$$\ln \mathrm{TFP}_{ijt} = \alpha_0 + \alpha_j + \alpha_t + \beta_1 F_{ijt}^{\mathrm{DVLD}} + \beta_2 F_{ijt}^{\mathrm{DVLG}} + \beta_3 F_{ijt}^{\mathrm{OTHR}} + \gamma X_{ijt} + u_{ijt} \tag{3.2}$$

In this equation, three FDI firm dummies are used: one for those firms which have FDI from developed countries (denoted by F_{ijt}^{DVLD}), second for firms which have FDI from developing countries (denoted by F_{ijt}^{DVLG}) and the third for other FDI firms (denoted by F_{ijt}^{OTHR}). To explain this further, the first dummy (denoted by F_{ijt}^{DVLD}) takes value one for a firm with FDI from a developed country (with foreign promoters share in aggregate being 10% or more) and zero otherwise.[16] If the foreign promoter share in the firm was more than 10% in year t and below 10% in year $t-1$, then dummy variable takes value one for year t and zero for year $t-1$. If the foreign promoter share falls below 10% in year $t+1$, the dummy variable is still assigned value one (as explained earlier). Evidently, after estimating the model above, a comparison of parameters, β_1, β_2 and β_3 will reveal the relative productivity level of the three categories of FDI differentiated according to the country origin of FDI.

It should be noted here that in the dataset used for the analysis, detailed data are available on the pattern of equity holding. It thus becomes possible to ascertain the percentage of equity held by the foreign promoter(s), and this information is used to designate FDI firms. However, as noted in Sect. 2 earlier, the dataset does not contain information on the country origin of the foreign promoter(s). For determining country of origin of investment in FDI firms, additional information obtained from diverse sources has been used. While for a large portion of the FDI firms, it has been possible to determine the country of origin of major foreign promoter(s), for others it has not been possible to do so. Also, for a number of FDI firms, the source country is found to be Mauritius. There are grounds to believe that certain investments

[15] There is an econometric issue of endogeneity in the model specified. It may be argued that there is heterogeneity among domestic firms in terms of their productivity level, and foreign investments which turned the domestic firms into FDI firms may have been made selectively in the relatively more productive firms (and therefore, the status of the firm, FDI or domestic, may be determined by its level of productivity). This issue is ignored in the analysis presented in this section. In some ways, the concern is addressed in the analysis presented in the next section.

[16] There is a possibility that the foreign promoters of a company may belong to different countries. In this situation, the condition we use is that the aggregate equity share of promoters should be 10% or more, and the country of origin of FDI is decided by the country to which the main foreign promoter belongs.

are being routed through Mauritius because of tax benefits and the true country of origin is not known (in addition there is the issue of round-tripping investments, i.e. investments being made by Indian entrepreneurs through Mauritius). It seems, therefore, that for the estimation of the model described above, it would not be right to treat investments being made through Mauritius as FDI originating in developing countries. Thus, for FDI firms having FDI from Mauritius, the third dummy variable (F_{ijt}^{OTHR}) is used, which also covers firms in which investments have been made by non-residents Indians (NRIs) on individual capacity rather than a corporate body and firms for which the country of origin of FDI could not be ascertained due to lack of data.

An alternate model that has been estimated makes a distinction between FDI originating in the USA and Europe, FDI originating in Asia (including Japan) and FDI from other sources. The model is specified as:

$$\ln \text{TFP}_{ijt} = \alpha_0 + \alpha_j + \alpha_t + \beta_1 F_{ijt}^{\text{US/Europe}} + \beta_2 F_{ijt}^{\text{Asia}} + \beta_3 F_{ijt}^{\text{OTHR}} + \gamma X_{ijt} + u_{ijt} \tag{3.3}$$

The equation is similar to Eq. 3.2 and hence does not require to be explained.

The estimates of Eq. 3.1 are presented in Table 5. In Regressions (1) and (2), all

Table 5 TFP difference between FDI and domestic firms, regression results (dependent variable: ln TFP)

Explanatory variable	Regression-1	Regression-2	Regression-3	Regression-4
FDI firm dummy	0.150 (6.68) #	0.149 (6.57) #	0.165 (6.73) #	0.182 (7.31) #
Firm size	0.141 (42.35) #	0.143 (41.62) #	0.151 (38.62) #	0.145 (36.23) #
Age	0.016 (17.33) #	0.017 (18.81) #	0.018 (16.66) #	0.017 (15.84) #
Age-squared	−0.0001 (−7.94) #	−0.0001 (−9.95) #	−0.0001 (−8.78) #	−0.0001 (−8.07) #
Year effects	Yes	Yes	Yes	Yes
Industry effects	Yes (3-digit NIC)	Yes (5-digit NIC)	Yes (3-digit NIC)	Yes (5-digit NIC)
R-squared (F-value)[Prob > F]	0.192(209.3) [0.000]	0.251(201.8) [0.000]	0.163(171.6) [0.000]	0.216(161.5) [0.000]
No. of observations	33,960	33,960	23,240	23,240

Note Firm size is measured by logarithm of total assets. For defining FDI firms, the cut-off level of foreign promoter equity ownership is taken as 10%. Data for industries belonging to NIC codes 20–30 are covered in Regressions (3) and (4). All manufacturing industries (NIC codes 10–32 and 58) are covered in Regressions (1) and (2)

t-values in parentheses. # statistically significant at 1% level

Source Authors' computations

manufacturing industries are covered (NIC codes 10–32 and 58 according to NIC-2008). In Regressions (3) and (4), data for industries belonging to NIC codes 20–30 are covered. This has been done because about 80% of the FDI firms belong to these industries, and in most of these two-digit industries, FDI firms account for more than 5% of total firms in the industry. Regressions (1) and (3) differ from Regressions (2) and (4) in regard to the industry fixed effects. In the former cases, 3-digit industry dummies have been included, and in the latter cases, 5-digit industry dummies are included.

Two control variables have been included in the regressions. These are firm size measured by logarithm of total assets and age of the firm (based on year of incorporation). Age-squared variable is included to allow for nonlinear effect of age on TFP.

The model estimates presented in Table 5 clearly indicate that after controlling for firm size, age of the firm, industry affiliation and time (year fixed effects), the TFP level of FDI firms is significantly higher than domestic (non-FDI) firms. The gap in the level of TFP is found to be about 15–18%.

A similar analysis done by Sasidharan (2006) for Indian firms reveals that FDI firms have significantly higher TFP than non-FDI firms. He has taken the cut-off for equity share of foreign promoters as 10% for defining FDI firms as done in this study. The results reported by Sasidharan indicate that the gap in the level of TFP between FDI firms and domestic firms is about 13%, which is broadly in agreement with the estimates obtained in this study.

The empirical results of Goldar et al. (2004) for firms of engineering industries in India and the empirical results of Sahu and Solarin (2014) for manufacturing firms of India also indicate that FDI firms have higher productivity than domestic firms. These findings match with the findings of this study.

The model estimates looking into the differential impact of FDI on firm productivity according to the source country of origin is taken up next. The estimates of Eqs. (3.2) and (3.3) are presented in Tables 6 and 7, respectively. In both cases, the sample is restricted to NIC codes 20–30. The inter-industry heterogeneity is captured by using industry dummy variables at 5-digit level of NIC.

In both Tables 6 and 7, the results obtained by using the sample for the industries NIC 20 to NIC 30 are shown in the first column of the table. Then, separate estimates of the model are presented for the following three broad industrial groups: (a) chemicals and chemical products, pharmaceutical products, rubber and plastic products and non-metallic mineral products (NIC codes 20, 21, 22 and 23), (b) basic metals, metal products and non-electrical machinery (NIC codes 24, 25 and 28) and (c) electrical machinery, computers and electronic products and transport equipment (NIC codes 26, 27, 29 and 30).

The results presented in Table 6 indicate that the TFP level of FDI firms with FDI from developed countries is significantly higher than that of domestic firms. This is, however, not found for FDI firms in which the investments have originated from developing countries. Rather, from the regression results, it appears that TFP level of FDI firms having investment from developing countries is lower than that of domestic firms. Similar results are found when a comparison is made between

Table 6 TFP difference between FDI and domestic firms, regression results, distinguishing by source country of origin of FDI (dependent variable: ln TFP)

Explanatory variable	Category of manufacturing industries			
	Industries belonging to NIC 20–30 (covering industries listed in the next three columns)	Chemicals and chemical products, pharmaceutical products, rubber and plastic products and non-metallic mineral products	Basic metals, metal products and non-electrical machinery	Electrical machinery, computers and electronic products and transport equipment
Firm with FDI originating from developed countries (dummy)	0.265 (9.39)***	0.265 (6.33)***	0.276 (4.84)***	0.271 (5.38)***
Firm with FDI originating from developing countries (dummy)	−0.428 (−4.82)***	−0.484 (−4.07)***	−0.279 (−1.77)*	−0.186 (−0.77)
Firm with FDI from other sources (dummy)	−0.011 (−0.27)	0.027 (0.54)	−0.197 (−1.78)*	0.061 (0.58)
Firm size	0.144 (35.96)***	0.159 (28.40)***	0.110 (14.62)***	0.159 (18.17)***
Age	0.017 (15.39)***	0.014 (9.11)***	0.021 (10.27)***	0.015 (6.66)***
Age-squared	−0.00009 (−7.55)***	−0.00007 (−4.39)***	−0.00017 (−6.57)***	−0.00005 (−1.59)
Year effects	Yes	Yes	Yes	Yes
Industry effects	Yes (5-digit NIC)	Yes (5-digit NIC)	Yes (5-digit NIC)	Yes (5-digit NIC)
R-squared (*F*-value)[Prob > *F*]	0.218(148.7) [0.000]	0.242(84.4) [0.000]	0.170(32.9) [0.000]	0.230(43.9) [0.000]
No. of observations	23,240	10,431	7432	5377

Note For defining FDI firm, the cut-off level of foreign promoter equity ownership is taken as 10%. These firms are then sub-divided into three categories according to the country sources of FDI, considering the main source

t-values in parentheses. *, ** and *** statistically significant at 10, 5 and 1%, respectively

Source Authors' computations

FDI from USA/Europe with FDI from Asia (Table 7). While the regression results indicate that the firms with FDI from USA and Europe have, on average, higher TFP than domestic firms, this is not found for firms with FDI originating in Asia. It seems that the average TFP of firms with FDI from Asia does not significantly exceed the average TFP of domestic firms.

Table 7 TFP Difference between FDI and domestic firms, regression results, distinguishing by source country of origin of FDI (alternate grouping of countries) (dependent variable: ln TFP)

Explanatory variable	Category of manufacturing industries			
	Industries belonging to NIC 20–30 (covering industries listed in the next three columns)	Chemicals and chemical products, pharmaceutical products, rubber and plastic products and non-metallic mineral products	Basic metals, metal products and non-electrical machinery	Electrical machinery, computers and electronic products and transport equipment
Firm with FDI originating from USA and Europe (dummy)	0.305 (9.46)***	0.371 (8.01)***	0.310 (5.06)***	0.214 (3.21)***
Firm with FDI originating Asia (dummy)	0.001 (0.01)	−0.268 (−3.56)*	−0.307 (−2.44)**	0.315 (4.51)****
Firm with FDI from other sources (dummy)	−0.010 (−0.25)	0.013 (0.26)	−0.042 (−0.43)	0.040 (0.39)
Firm size	0.144 (35.97)***	0.160 (28.63)***	0.108 (14.38)***	0.160 (18.20)***
Age	0.017 (15.64)***	0.014 (9.36)***	0.021 (10.42)***	0.015 (6.74)***
Age-squared	−0.0001 (−7.95)***	−0.00008 (−4.68)***	−0.00017 (−6.82)***	−0.00005 (−1.61)
Year effects	Yes	Yes	Yes	Yes
Industry effects	Yes (5-digit NIC)	Yes (5-digit NIC)	Yes (5-digit NIC)	Yes (5-digit NIC)
R-squared (*F*-value)[Prob > *F*]	0.217(147.4) [0.000]	0.244(85.8) [0.000]	0.171(33.0) [0.000]	0.229(43.9) [0.000]
No. of observations	23,240	10,431	7432	5.377

Note For defining FDI firm, the cut-off level of foreign promoter equity ownership is taken as 10%. These firms are then sub-divided into three categories according to the country sources of FDI, considering the main source

t-values in parentheses. *, ** and *** statistically significant at 10, 5 and 1%, respectively

Source Authors' computations

The regression results presented in Table 6 indicate that after controlling for firm size, age of the firm, industrial heterogeneity and time, the average level of TFP of FDI firms with FDI originating in developing countries is lower than that of FDI firms with FDI originating in developed countries in all three industry groups considered for the analysis, particularly in industry groups (a) and (b) which cover chemicals,

rubber, plastics, non-metallic mineral products, metals and metal products and non-electrical machinery. Somewhat similar results are found in the comparison made between FDI from USA/Europe and FDI from Asia (Table 7). Thus, firms with FDI from Asia have a disadvantage in terms of TFP vis-à-vis firms with FDI from USA and Europe in industry groups (a) and (b). However, there is no disadvantage in industry group (c) which includes electrical machinery, computers and electronic products and transport equipment. Rather, firms with Asian investment (sample being dominated by Japan and Korea) seem to be performing better than the firms with US/European investment in industry group (c).

From the results of regression analysis presented in Tables 6 and 7, one would infer that TFP level of FDI firms in India with FDI from developed countries is normally higher than that of FDI firms in India with investment from developing countries. This applies also to a comparison of TFP between FDI from US/Europe and FDI from Asian countries. These findings are corroborated by the Kolmogorov–Smirnov tests, undertaken using data for 2013–14. The test statistic is found to be statistically significant at one per cent level when firms having US-European FDI are contrasted with firms having Asian FDI and at 5 per cent level when firms having FDI from developed countries are contrasted with firms having FDI from developing countries.

4 Does Foreign Acquisition of Domestic Firms Raise Their Productivity?

The analysis presented in the previous section indicated that after controlling for industry affiliation and some other firm characteristics, an FDI firm tends to have higher TFP than a domestic firm. Such findings have been reported in several earlier studies including some studies undertaken for India. The next issue to be considered is a related one: whether acquisition of a domestic firm by a foreign firm causes the TFP of the domestic firm to rise. This question is investigated in this section.

The finding that FDI firms tend to have relatively higher TFP than domestic firms, revealed by the results of the econometric analysis in Sect. 3, does not by itself mean that foreign acquisition has led to an improvement in TFP. There is a possibility of cherry picking by foreign investors, and they may have invested in relatively more productive firms, a point noted earlier.[17]

An approach that may be taken to study the impact the foreign acquisition on productivity, which will not be affected by the issue of cherry picking raised above, is to consider the change that took place in the level of TFP is a domestic firm when it got acquired by a foreign firm and thus got transformed into an FDI firm, and

[17]For a discussion of the issue of cherry picking, see Kaitila et al. (2013), among others. Kaitila and associates have reviewed a number of earlier studies. They report that out of the 31 studies they have analysed, they find that 14 studies have come to the conclusion that foreign firms acquired the relatively more productive firms. On the other hand, only two studies concluded that foreign firms acquired local firm with below average productivity.

compare it with the change that took place in a similarly placed domestic firm which did not get transformed into an FDI firm (making use of the difference-in-difference estimator). This type of analysis can be undertaken by applying the commonly used methods of assessing treatment effect. To give an example here, Arnold and Javorcik (2009) have undertaken such an analysis and found a significant positive effect of foreign investment on productivity of industrial plants in Indonesia. Other studies in which such a methodology has been applied for the purpose of assessing FDI impact on firm productivity include Bandick (2011), Chen (2011) and Petkova (2012).[18]

A brief discussion on the methodology in question is in order here. Let the change of ownership, from domestic to foreign (foreign ownership in equity going over a particular threshold, say 10%), occurring in a particular year T, be called an event taking place in time T, and the firms that experience the event be called treated firms (i.e. the firms that get treated in that year). Also, let the firms that remain in domestic hands and do not experience the event be called control group firms. Thus, to judge the effect of foreign acquisition, the average change in a performance indicator (say logarithm of TFP) between years T and $T-1$ for treated firms could be compared with that for control groups firms, after ensuring proper matching. This provides the average treatment effect on the treated (ATT).

It is evident that for making a valid comparison, the control group firms need to be properly matched with the treated firms. There are several different ways by which matching may be done. When one works with panel data, there are some additional issues to be addressed in the method employed for matching. For their analysis of Indonesian manufacturing plants, Arnold and Javorcik (2009) have applied a procedure which enables them to ensure that for each acquired/treated firm/plant, the match from the control group is assigned from the same year and same industry/sector. The analysis presented in this paper, however, does not make use of the procedure suggested and applied by Arnold and Javorcik though it has certain merits.[19] Instead, a simpler method of matching control group firms and treated firms is adopted. Estimation of ATT has been done by using 'psmatch2' command in *Stata*. Some further details are provided below.

As mentioned earlier, this study covers about 7000 firms. Among them, about 400 are identified as FDI firms. For a majority of these firms, it is found that the foreign equity share was 10% or more in the first year of observation during the period under study, 2000–01 to 2014–15. For the other FDI firms, the foreign equity

[18]Petkova's study is on Indian manufacturing firms. She has considered the effect of foreign investment on TFP and a few other firm performance indicators. It may be pointed out in this context that in a study on Indian manufacturing firms, Goldar and Sharma (2015) have applied treatment effects analysis to examine the impact of FDI on certain indicators of firm performance. They did not consider productivity performance.

[19]Chen (2011) has used a matching method different from that adopted by Arnold and Javorcik, and the same holds for Petkova (2012) and Kaitila et al. (2013). Petkova who has examined the effect of FDI on TFP in Indian manufacturing firms using Prowess data (undertaking a study similar to Arnold and Javorcik 2009) has addressed the issue of timing by following the method given in Eichler and Lechner (2002). She considers the percentage of foreign investment-targeted firms that received treatment each year and proportionately assigns at random hypothetical event dates to the firms that never received treatment.

share was initially less than 10% and then rose to 10% or beyond in some year during the period under study. The former group is excluded from the analysis, since the event of transformation from domestic to FDI is not observed in the data. The latter group provides observations on the event of transformation from domestic to FDI firm. There are 131 such cases in the sample. This reduces to 100 when the analysis is confined to industries with two-digit NIC codes 20–30, as has been done in the study.

For the 100 firms mentioned above which are the treated firms, the growth in TFP accompanying the event is compared with TFP growth attained by the control group of firms (after matching). The choice of control group which includes only domestic firms is made on the basis of matching of propensity score.

Propensity score is computed by estimating a probit model designated to explain which domestic firm gets transformed into FDI firm and which does not. In the probit model, firm size, export intensity, import intensity,[20] leverage, broad industry group affiliation and a time period dummy[21] for the period from 2008–09 onwards are taken as explanatory variables.

Since the transformation of a domestic firm into an FDI firm may take time to have an impact on TFP, the change in ln (TFP) in one year, two years and three years, i.e. years $T = 0$, $T = 1$ and $T = 2$ [relative to the ln (TFP) level in the year $T = -1$, preceding the year of transformation] are considered. Time Period 0 (or year $T = 0$) is the year when the domestic firm got acquired by a foreign firm, i.e. it got transformed into a FDI firm. Thus, TFP growth in Time Period 0 is the increase in ln(TFP) in the current year over that in the previous year.

The estimates of ATT are presented in Table 8. First, all cases of foreign acquisition of domestic manufacturing firm are considered together. Then, the foreign acquisition cases are divided into groups according to country source of origin of FDI and a comparison is made with control group firms.

Two points emerge from Table 8. First, when all foreign acquisition cases are taken together, the estimated ATT is found to be statistically insignificant. This gives the impression that, in general, the transformation of a domestic firm into an FDI firm in India does not lead to a significant increase in TFP. Secondly, there are differences in the impact of FDI on TFP according to the country source of origin of FDI. When a distinction is made between FDI from developed countries and that from other countries/sources,[22] the estimated ATT in the former case is found to be positive for

[20] It may be seen from Table 4 that the import intensity variable takes extremely high values in some observations. The mean is 0.09 and the 99th percentile is about 0.7. Yet, in some observations, the value of the variable exceeds 40. Therefore, for using it as an explanatory variable in econometric analysis, this variable has been winsorized at the 99.5th percentile, i.e. values of the variable above this percentile have been capped at the 99.5th percentile.

[21] The rationale for the period dummy is that in the period 2001–02 to 2007–08, there were on average about 11 cases of foreign acquisition each year (in the sample considered for the study) and in the period 2008–09 to 2014–15, the corresponding figure was much lower at about only 3–4 cases per year. The average per year is 5 for the years 2008–09 to 2010–11 and only 2 for the years 2011–12 to 2014–15.

[22] Since the number of cases of FDI transformation used for the analysis is small, the second and third categories have been clubbed, i.e. cases of FDI from developing countries are clubbed with

Table 8 Estimates of ATT, impact of foreign acquisition on TFP of acquired firm

Time (year)	All foreign acquisition cases	Foreign acquisition cases divided into		Foreign acquisition cases divided into	
		FDI from developed countries	FDI from other countries/sources	FDI from USA and Europe	FDI from other countries/sources
0	−0.027 (0.077)	0.226 (0.136) [1.66]	−0.239 (0.155)	0.100 (0.188)	−0.131 (0.145)
1	0.086 (0.123)	0.080 (0.152)	−0.067 (0.274)	0.278 (0.160) [1.74]	0.035 (0.154)
2	0.074 (0.148)	0.498 (0.243) [2.05]	−0.424 (0.282)	0.380 (0.185) [2.05]	−0.280 (0.208)

Note Standard error in parentheses; *t*-values in square brackets (only those cases where *t*-value is around 1.6 or more than 1.6 are shown)
ATT Average treatment effect on the treated
Source Authors' computations

all three years ($T = 0$, $T = 1$ and $T = 2$), and it is statistically significantly for years $T = 0$ and $T = 2$, but the estimated ATT is negative and statistically insignificant in the latter case for all three years. It may be inferred on the basis of these findings that the acquisition of equity in a domestic manufacturing firm in India by a firm from developed country has a beneficial TFP enhancing effect on the acquired firm, but such acquisition by a firm from developing country does not have a beneficial effect on TFP, which agrees with the findings of Chen (2011) for USA.

When a distinction is made between FDI from USA/Europe and that from other countries/sources, it is found that the estimated ATT for FDI from USA/Europe is positive for all three years and statistically significant for years $T = 1$ and $T = 2$. On the other hand, the estimated ATT is statistically insignificant for firms in which investments were made from Asian countries or other sources. It may therefore be inferred that the effect of FDI on TFP of a domestic firm in which the foreign investment takes place from USA/Europe is significantly positive, but such positive effect may often be absent when the investment takes place from other countries.

The finding of statistically insignificant estimate of ATT when all treated firms are considered together is in agreement with the findings of Petkova (2012). In her estimates too, the estimated ATT for FDI impact on TFP in Indian manufacturing firms was found to be statistically insignificant. However, since the estimate of ATT is found to statistically significant for some sub-group of treated firms, this aspect has been investigated further. Table 9 shows three alternate sets of estimates of ATT that have been obtained when all treated firms are considered together and

cases where the FDI is from Mauritius, NRIs and unknown sources. A similar treatment is given when FDI from USA/Europe is contrasted with that from the rest of the countries including Asian countries.

Table 9 Estimates of ATT, all foreign acquisition cases, alternate estimates

Time (year)	Estimate-1	Estimate-2	Estimate-3	Estimate-4
0	−0.027 (0.077)	−0.108 (0.094)	0.058 (0.079)	0.016 (0.086)
1	0.086 (0.123)	0.272 (0.140) [1.95]	0.156 (0.131)	0.276 (0.150) [1.85]
2	0.074 (0.148)	0.032 (0.157)	0.322 (0.158) [2.04]	0.283 (0.177) [1.60]

Note Standard error in parentheses; *t*-values in square brackets (only those cases where *t*-value is around 1.6 or more than 1.6 are shown). Estimate-1 is taken from Table 8
Source Authors' computations

propensity score-based nearest-neighbour matching is done. In the first alternate estimate (Estimate-2 in the table), the period dummy has been changed. In this estimate, a dummy variable for the years 2011–12 to 2014–15 has been used (instead of a dummy variable for the period 2008–09 to 2014–15). Additionally, a greater number of industry dummy variables have been used in the probit model to capture better inter-industry diversity—besides the two aforementioned dummies for two broad industry groups, four individual two-digit industry dummies have been used. In the second and third alternate estimates (Estimate-3 and Estimate-4 in the table), the specification of the probit model is similar to that in Estimate-2 except that in the former case (Estimate-3) firm-age is introduced as an explanatory variable along with liquidity, and in the latter case (Estimate-4), in addition to firm-age and liquidity another new explanatory variable is introduced, namely total assets per employee.

It is seen from Table 9 that in Estimate-2 which is based on a methodology similar to that for Estimate-1, the estimate of ATT for $T = 1$ (time periods 1, i.e. the growth in TFP between the year following the year of foreign acquisition and the year previous to the foreign acquisition) is positive and statistically significant. The same applies to Estimate-4 which is based on a probit model similar to that for Estimate-2 except that three new explanatory variables are introduced; the estimated ATT is positive and statistically significant for year $T = 1$. In the second alternate estimate of ATT (Estimate-3 in the table), ATT is positive and statistically significant for year $T = 2$, i.e. time period 2. Thus, even though the estimates of ATT in Estimate-1 are found to be statistically insignificant, which are qualitatively in agreement with the ATT estimates of Petkova (2012) [23] for Indian manufacturing firms based on Prowess data for the period 2001–2008, other estimates of ATT presented in Table 9 point in a different direction. Indeed, going by the estimates of ATT presented in Table 9, it appears that foreign acquisition of equity in Indian manufacturing firms did lead to an improvement in TFP in the acquired firm in a majority of cases. This is consistent with the econometric results presented in the previous section.

[23] Petkova's estimates for time period $T = 0$, $T = 1$ and $T = 2$ are −0.019, 0.038 and −0.009, respectively. All these are statistically insignificant.

One weakness of the analysis presented in Table 8 is that these are based on propensity scores computed with the help of a probit model which is based on a dichotomous choice. Thus, when an event associated with FDI from US/Europe is contrasted with control group firms, the domestic firms that got transformed into an FDI firm by getting FDI from other countries/sources are ignored. This is evidently a pairwise average treatment effect, as applied in Chen (2011).[24] A more satisfactory assessment can be done by using a multivalued treatment model which allows multiple treatment possibilities. Such an analysis has been undertaken by using 'teffects ipw' command in *Stata* which involves inverse probability weighting. The methodology is based on a multinomial logit model. For the model, firm size, export intensity, import intensity (winsorized), and leverage have been taken as explanatory variable along with industry group affiliation dummies, age of the firm and a dummy variable for time period beyond 2007–08 (taking value one for years 2008–09 onwards, zero otherwise). The estimates of ATT (average treatment effect on treated) are shown in Table 10.

The results reported in Table 10 are similar to those in Table 8. There are indications that FDI from developed countries has a positive effect on TFP on acquired domestic firm, but this does not hold for FDI from other countries and sources. Similarly, FDI from US/Europe has a positive effect, but FDI from other countries does not have a similar positive effect on TFP. These results are consistent with those reported in Table 8 and in line with the findings of Sect. 3.

Table 10 Estimates of ATT, impact of foreign acquisition on TFP, model incorporating multiple treatment possibilities

Time (year)	Foreign acquisition cases		Foreign acquisition cases	
	FDI from developed countries versus domestic firms	FDI from other countries/sources versus domestic firms	FDI from USA and Europe versus domestic firms	FDI from other countries/sources versus domestic firms
0	0.097 (0.051) [1.89]	−0.178 (0.089) [−1.98]	0.083 (0.064)	−0.132 (0.076) [−1.73]
1	0.230 (0.093) [2.49]	−0.159 (0.099) [−1.62]	0.223 (0.112) [1.99]	−0.124 (0.105)
2	0.307 (0.119) [2.57]	−0.445 (0.143) [−3.11]	0.384 (0.143) [2.69]	−0.376 (0.173) [−2.17]

Note Standard error in parentheses; *t*-values in square brackets (only those cases where *t*-value is around 1.6 or more than 1.6 are shown)
Source Authors' computations

[24] In Chen's study, there are three possible treatments: acquisition by a domestic firm, acquisition by a firm from an industrialized country other than the USA and acquisition by a firm from a developing country. Instead of using a methodology that considers all these choices together, pairwise analysis has been done.

5 FDI Spillover Effects on Domestic Firms

The previous two sections were devoted to the analysis of direct benefits from FDI in terms of the productivity enhancement it causes in firms in which the investment is made. As noted in the introductory section of the paper, besides the direct productivity-enhancing effect of FDI, there is an indirect impact through productivity spillovers on domestic firms. A great deal of econometric research has been undertaken on the spillover effect, including studies undertaken for developing countries. A number of studies have been undertaken on the spillover effect of FDI for Indian manufacturing firms, as mentioned and briefly discussed in the introductory section of the paper.

This section presents an analysis of FDI productivity spillover effect on domestic firms in Indian manufacturing. It is divided into two subsections. Section 5.1 describes the construction of spillover variables and specification of the econometric model estimated. Section 5.2 presents the empirical results. First, an analysis quite similar to that done in a number of earlier studies for India is presented. For this analysis, all FDI firms are considered as a group and the impact of FDI on the productivity of domestic firms through horizontal and vertical spillover effects is studied. In the next step, attention is paid to country of origin of FDI. An attempt is made to assess if the spillover effects of FDI differ according to the country origin of FDI.

5.1 Spillover Variables and Model Specification

The question to be studied is how productivity of a domestic manufacturing firm in India is impacted by (a) FDI in the industry to which the firm belongs and (b) FDI in other industries from which the domestic firm buys its inputs or to which it sells its products. For this purpose, a multiple regression equation is estimated. The level of TFP of the domestic firms is taken as the dependent variable, being determined by a set of explanatory variables including variables representing spillover effects. The explanatory variables include firm size, age and a set of other variables representing various characteristics of the domestic firms. To capture the spillover effects, three spillover variables are used, as has been done in many earlier studies on spillover effects. The three spillover variables are: (i) horizontal spillover variable, (ii) vertical spillover variable capturing backward linkage and (iii) vertical spillover variable capturing forward linkage.

For each domestic firm, the horizontal spillover variable is measured by the extent of FDI in the industry to which the firm belongs. These have been computed at two-digit industry level of NIC-2008 for each year and applied to all domestic firms belonging to that industry in that year. Construction of the horizontal spillover variable follows Javorick (2004). Horizontal spillover for industry j in year t is given by:

$$\mathrm{HRZ}_{jt} = \frac{\left[\sum_{i \text{ for all } i \in j} \mathrm{FS}_{it} Y_{it}\right]}{\sum_{i \text{ for all } i \in j} Y_{it}} \tag{5.1}$$

In this equation, FS_{it} denotes foreign equity share in firm i in year t belonging to industry j and Y_{it} is output (proxied by sales) of firm i in year t. This is hereafter referred to as HRZ or horizontal spillover variable or FDI share.

Again, following Javorick (2004), the backward (BKD) and forward (FRD) spillover variables are defined as:

$$\mathrm{BKD}_{jt} = \sum_{k \text{ if } k \neq j} \alpha_{jk} \mathrm{HRZ}_{kt} \tag{5.2}$$

$$\mathrm{FRD}_{jt} = \sum_{m \text{ if } m \neq j} \sigma_{jm} \left(\frac{\left[\sum_{i \text{ for all } i \in jm} \mathrm{FS}_{it} D_{it}\right]}{\sum_{i \text{ for all } i \in m} D_{it}} \right) \tag{5.3}$$

In Eq. 5.2, α_{jk} denotes the proportion of industry j output that is supplied to industry k. The variable BKD_{jk} basically reflects the degree of foreign presence in the industries that are being supplied by firms of industry j.

In Eq. 5.3, D_{it} represents the portion of output of firm i that is sold domestically; it is equal to production minus exports. The expression in parentheses is a measure of foreign share in equity in industry m using domestic sales of firm output as weights. This ratio is computed for each industry. Then, for each industry j, the variable $\mathrm{FRD}_{\mathrm{jt}}$ is computed as a weighted aggregation, using σ_{jm} as weights, which represent the share of inputs bought by industry j from industry m. This variable reflects the degree of foreign presence in the upstream sectors, i.e. the sectors or industries from which industry j buys its inputs.

To operationalize the variables HRZ_{jt}, BKD_{jt} and FRD_{jt}, computations have been done at two-digit level of NIC and α_{jk} and σ_{jm} have been obtained from the input-output table for India for the year 2007–08 published by the CSO. The values of these variables computed for each two-digit industry for each year have been applied to all domestic firms belonging to those industries for that year.

The regression equation that has been estimated to assess the spillover effects may be written as:

$$\begin{aligned} \ln \mathrm{TFP}_{ijt} = {} & \alpha_0 + \alpha_j + \alpha_t + \beta_1 \mathrm{HRZ}_{jt} + \beta_2 \mathrm{HRZ}_{jt}^2 + \beta_3 \ln \mathrm{BKD}_{jt} \\ & + \beta_4 \ln \mathrm{FRD}_{jt} + \gamma X_{ijt} + u_{ijt} \end{aligned} \tag{5.4}$$

In this equation, HRZ, BKD and FRD denote the horizontal spillover, vertical-backward spillover, and vertical-forward spillover, respectively. X denotes firm characteristics, taken as controls for assessing the spillover effects, and γ is the corresponding vector of parameters. A much larger number of firm characteristics[25] have been considered for estimating Eq. 5.4 than done for estimating Eqs. 3.1–3.3 the results of which were presented in Sect. 3. The level of foreign equity participation in the firm is also included among the firm characteristics considered for regression analysis. This helps in verifying the results obtained in Sect. 3 in respect of productivity differences between FDI firms and domestic firms.

When the country source of origin of FDI is taken into account, the spillover variables get split. The foreign share variable (Eq. 5.1) is computed separately for FDI originating from (i) developed countries, (ii) developing countries and (iii) other countries/sources. A similar splitting is down among FDI from USA/Europe, Asia and other countries. This permits separate assessment of horizontal spillover effects for FDI originating from different countries/regions. In a similar manner, the forward spillover variable has been split, which is discussed later.

Attention may be drawn here to possible reverse causality running from productivity to the FDI share variable in the regressions estimated for studying productivity spillover (see Eq. 5.4). Since the fixed effects model has been applied to estimate Eq. 5.4, the presence of reverse causality will affect the parameter estimates obtained. It seems to us, however, that since FDI share is measured at the industry-level and the dependent variable, ln (TFP), is at the firm level, this might not be an issue, at least not a serious one. Yet, some biases in the parameter estimates caused by reverse causality cannot be ruled out.

Two other issues regarding model specification require a brief discussed here. First, in several studies, an equation similar to the one given in Eq. 5.4, or an equation specifying the production function which implicitly incorporates an equation similar to Eq. 5.4 has been estimated. In some of them, the level of TFP is taken as the dependent variable (directly or indirectly) as done here (e.g. Ito et al. 2010; Long et al. 2014), but in other studies, the equation is estimated in difference form so that the dependent variable is defined as the rate of change or the rate of growth in TFP (e.g. Newman et al. 2015). The rationale for estimating the equation in difference form is that it takes care of unobservable firm-specific and industry-specific effects. In this study, the equation has been estimated in the level form, not in the difference form.

Second, the horizontal spillover variable and its squared term have been included in the equation. This form has been used in Xu and Sheng (2012), but one can find several studies in which the squared term of horizontal spillover variable has not been used. Again, it would be noted from Eq. 5.4 that the vertical spillover variables have been taken in logarithms. This has not been done in Javorick (2004), Xu and Sheng (2012) or Long et al. (2014). Indeed, it is hard to find an earlier study in which the vertical spillover variable was taken in logarithms.

[25] Import intensity is one of the explanatory variables considered. As done in the analysis in Sect. 4, this variable has been winsorized at the 99.5th percentile for the analysis presented in this section.

5.2 Empirical Results

5.2.1 Regression Results Disregarding Country of Origin of FDI

The regression equation described above (Eq. 5.4) has been estimated by the fixed effects model. In the first step, this has been done disregarding the country of origin of FDI. The results obtained are presented in Tables 11, 12 and 13.

From the results in Tables 11, 12 and 13, it is found that there is a positive horizontal spillover effect till a threshold in terms of FDI share and an adverse effect occurs on domestic firms as FDI goes beyond that point (probably reflecting the adverse effect of competition faced by domestic firms from FDI firms). It may be mentioned here that the results reported by Xu and Sheng (2012) for Chinese firms is quite similar to

Table 11 FDI spillover effect on firm TFP, fixed effects results, 2000–01 to 2014–15 (dependent variable: ln TFP)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Log FRD	0.138* (0.0766)	0.138* (0.0760)	0.160** (0.0739)	0.160* (0.0822)	0.161** (0.0741)	0.140* (0.0760)
Log BRD			−0.0384 (0.0428)	−0.0384 (0.0352)	−0.0370 (0.0428)	
FDI share	0.0472** (0.0170)	0.0470** (0.0170)	0.0454** (0.0163)	0.0454*** (0.0153)	0.0456*** (0.0161)	0.0472** (0.0167)
FDI share sq.	−0.00228** (0.000810)	−0.00227** (0.000808)	−0.00222*** (0.000782)	−0.00222*** (0.000753)	−0.00224*** (0.000766)	−0.00228*** (0.000792)
Log R&D inten.	0.00297 (0.00185)	0.00302 (0.00183)	0.00296 (0.00180)	0.00296* (0.00159)	0.00292 (0.00180)	0.00297 (0.00184)
Log age	0.338*** (0.0690)	0.338*** (0.0685)	0.337*** (0.0687)	0.337*** (0.0693)	0.336*** (0.0692)	0.337*** (0.0690)
Log liquidity	0.118*** (0.0101)	0.118*** (0.0101)	0.118*** (0.0102)	0.118*** (0.00879)	0.118*** (0.0101)	0.118*** (0.0101)
Log leverage	−0.00549* (0.00306)	−0.00547* (0.00306)	−0.00543* (0.00307)	−0.00543* (0.00317)	−0.00552* (0.00308)	−0.00555* (0.00307)
Foreign share		0.0199* (0.0100)	0.0197* (0.0101)	0.0197* (0.00996)	0.0195* (0.0101)	0.0198* (0.00999)
Log import intensity					0.00307* (0.00173)	0.00312* (0.00169)
Constant	−5.415*** (0.269)	−5.418*** (0.268)	−5.413*** (0.269)	−5.413*** (0.277)	−5.389*** (0.275)	−5.393*** (0.274)
Standard errors	Robust, clustered on 2-digit industry	Robust, clustered on 2-digit industry	Robust, clustered on 2-digit industry	Robust, clustered on 3-digit industry	Robust, clustered on 2-digit industry	Robust, clustered on 2-digit industry
Observations	21,521	21,521	21,521	21,521	21,521	21,521
R-squared	0.057	0.057	0.058	0.058	0.058	0.058
Number of firms	4013	4013	4013	4013	4013	4013

Note Robust standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
FRD forward linkage, *BKD* backward linkage
Source Authors' computations

Table 12 FDI spillover effect on firm TFP, fixed effects results, 2000–01 to 2014–15, including the effect of trade in services (dependent variable: ln TFP)

Variables	(1)	(2)	(3)	(4)	(5)
Log FRD	0.160* (0.0823)	0.161* (0.0819)	0.165** (0.0820)	0.161* (0.0818)	0.164* (0.0824)
Log BKD	−0.0377 (0.0352)	−0.0370 (0.0352)	−0.0377 (0.0355)	−0.0365 (0.0350)	−0.0360 (0.0348)
FDI share	0.0458*** (0.0152)	0.0456*** (0.0152)	0.0454*** (0.0151)	0.0457*** (0.0152)	0.0464*** (0.0151)
FDI share sq.	−0.00225*** (0.000742)	−0.00224*** (0.000743)	−0.00222*** (0.000744)	−0.00224*** (0.000744)	−0.00227*** (0.000740)
Log R&D inten.	0.00288* (0.00160)	0.00292* (0.00159)	0.00298* (0.00160)	0.00286* (0.00158)	0.00284* (0.00158)
Log age	0.335*** (0.0699)	0.336*** (0.0699)	0.335*** (0.0698)	0.333*** (0.0702)	0.334*** (0.0703)
Log liquidity	0.118*** (0.00881)	0.118*** (0.00881)	0.118*** (0.00881)	0.118*** (0.00885)	0.118*** (0.00886)
Log leverage	−0.00554* (0.00317)	−0.00552* (0.00317)	−0.00543* (0.00313)	−0.00564* (0.00315)	−0.00554* (0.00316)
Log import intensity	0.00308 (0.00191)	0.00307 (0.00191)	0.00298 (0.00191)	0.00260 (0.00201)	0.00258 (0.00200)
Foreign share		0.0195* (0.00999)	0.0197* (0.0101)	0.0190* (0.0101)	0.0191* (0.0102)
Log services export intensity			−0.00137 (0.00239)		
Log export intensity				0.00166 (0.00151)	0.00123 (0.00151)
Log services import intensity					0.00243** (0.00111)
Constant	−5.386*** (0.283)	−5.389*** (0.282)	−5.419*** (0.284)	−5.378*** (0.283)	−5.361*** (0.285)
Times FE	Yes	Yes	Yes	Yes	Yes
Standard errors	Robust, clustered on 3 digit industries	Robust, clustered on 3 digit industries	Robust, clustered on 3 digit industries	Robust, clustered on 3 digit industries	Robust, clustered on 3 digit industries
Observations	21,521	21,521	21,477	21,521	21,520
R-squared	0.058	0.058	0.058	0.058	0.059
Number of firms	4013	4013	4013	4013	4013

Note Services import intensity = imported services/total services
Robust standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Source Authors' computations

Table 13 FDI spillover effect on firm TFP, fixed effects results, 2000–01 to 2014–15, including the effect of trade in services and controlling for firm size (dependent variable: ln TFP)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Log FRD	0.175**	0.156*	0.135	0.160*	0.156*	0.158*
	(0.0726)	(0.0825)	(0.0857)	(0.0824)	(0.0822)	(0.0827)
Log BKD	−0.0193	−0.0392		−0.0386	−0.0376	−0.0372
	(0.0233)	(0.0356)		(0.0360)	(0.0356)	(0.0355)
FDI share	0.0387***	0.0452***	0.0470***	0.0452***	0.0455***	0.0461***
	(0.0123)	(0.0153)	(0.0156)	(0.0151)	(0.0152)	(0.0151)
FDI share sq.	−0.00182***	−0.00221***	−0.00228***	−0.00221***	−0.00223***	−0.00226***
	(0.000545)	(0.000753)	(0.000759)	(0.000745)	(0.000744)	(0.000741)
Log R&D inten.	−0.000798	0.00309**	0.00312**	0.00313**	0.00303**	0.00303**
	(0.00149)	(0.00148)	(0.00150)	(0.00149)	(0.00148)	(0.00149)
Log age	−0.00990	0.344***	0.346***	0.344***	0.343***	0.345***
	(0.0707)	(0.0727)	(0.0727)	(0.0726)	(0.0727)	(0.0730)
Log liquidity	0.112***	0.118***	0.118***	0.117***	0.117***	0.117***
	(0.00828)	(0.00903)	(0.00901)	(0.00905)	(0.00910)	(0.00912)
Log leverage	−0.0156***	−0.00524	−0.00531	−0.00519	−0.00537*	−0.00523
	(0.00312)	(0.00323)	(0.00323)	(0.00318)	(0.00320)	(0.00321)
Log sales	0.487***					
	(0.0274)					
Foreign share	0.0125	0.0197*	0.0199**	0.0198*	0.0190*	0.0191*
	(0.0105)	(0.00997)	(0.00992)	(0.0101)	(0.0101)	(0.0102)
Log total assets		−0.0134	−0.0173	−0.0169	−0.0203	−0.0224
		(0.0240)	(0.0240)	(0.0243)	(0.0240)	(0.0244)
Log import intensity			0.00340*	0.00326*	0.00288	0.00289
			(0.00186)	(0.00186)	(0.00199)	(0.00198)

(continued)

Table 13 (continued)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Log service export int.				−0.00130 (0.00246)		
Log export intensity					0.00187 (0.00150)	0.00143 (0.00150)
Log services import int.						0.00252** (0.00113)
Constant	−5.231*** (0.279)	−5.407*** (0.273)	−5.383*** (0.278)	−5.407*** (0.280)	−5.364*** (0.278)	−5.345*** (0.279)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Standard errors	Robust, clustered on 3 digit industries	Robust, clustered on 3 digit industries	Robust, clustered on 3 digit industries	Robust, clustered on 3 digit industries	Robust, clustered on 3 digit industries	Robust, clustered on 3 digit industries
Observations	21,521	21,521	21,521	21,477	21,521	21,520
R-squared	0.189	0.058	0.058	0.058	0.058	0.059
Number of firms	4013	4013	4013	4013	4013	4013

Note Services import intensity = imported services/total services
Robust standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Source Authors' computations

our results. In their estimates too, the coefficient of FDI share is found to be positive and statistically significant and the coefficient of FDI share squared is negative and statistically significant.

As regards the vertical spillover effect, the backward linkage variable has a negative coefficient which is contrary to expectations. The coefficient is not statistically significant. On the other hand, the forward linkage variable has a positive coefficient which is found statistically significant—in some cases at five per cent level and in a larger number of cases at ten per cent level. Evidently, the results are not strong, but there are indications of a positive vertical spillover effect arising from the forward linkage, i.e. firms in a particular industry gaining in productivity from the foreign presence in the upstream industries perhaps through purchase of intermediate inputs and knowledge spillover associated with such business relationship.

The foreign share variable in the results presented in Tables 11, 12 and 13 stands for the share of foreign promoters in the non-FDI firms in the sample. The coefficient of this variable is found to be positive consistently in all equations estimated and statistically significant at ten per cent level in almost all of them. This result is consistent with the findings of the analysis in Sect. 3.

A limitation of the FDI share variable used in the analysis the results of which are reported in Tables 11, 12 and 13 is that the variable has been constructed at two-digit industry level. Since, typically, a wide range of products are covered in a two-digit industry, there is a possibility that FDI presence is predominant in certain segments of the industry and the domestic firms in other segments may not face much competition from foreign firms nor gain from demonstration effect. To address this issue and thus check the robustness of regression results, the FDI share variable has been constructed also at three-digit level and regression analysis has been undertaken with this changed FDI share variable. The results are reported in Table 16 in the annexure. The coefficient of FDI share is found to be positive and statistically significant and the coefficient of the squared FDI share is found to be negative and statistically significant. These results are similar to those reported in Tables 11, 12 and 13.

How do the results obtained in this study in respect of horizontal and vertical spillover compare with the results of earlier studies? It may be mentioned here that a significant positive horizontal spillover effect has been found for Indian manufacturing firm in the study undertaken by Klein (2017). Thus, the findings obtained in this study are in agreement with the findings of Klien. Behera et al. (2012a, b) and Sahu and Solarin (2014) also found evidence of positive FDI spillover effects, and thus, the findings of this study are in accordance with the findings of Behera et al. (2012a, b) and Sahu and Solarin (2014).

At the same time, it needs to be recognized that many earlier studies on FDI spillover for Indian manufacturing have found the spillover effects to be negative or negligible. Evidently, the findings of our study are at variance with the findings of those studies. To discuss here briefly the findings of some recent studies which conflict with the findings of this study, Thakur and Burange (2015) found positive spillover effects through forward and backward linkages, but horizontal spillover effects are found to be negative. Thus, the finding of Thakur and Burange (2015) in regard to forward linkage spillover agrees with our finding, but our findings regarding

horizontal spillover and backward linkage vertical spillover differ from the findings of Thakur and Burange. It may be added here that Mondal and Pant (2018) in their recent study note that their initial results indicated negative horizontal spillover effects and insignificant spillover effects through vertical linkages, but from further analysis of the data, they find that the domestic firms with some initial technological capabilities, low technology gap with the foreign firms and high complementary capabilities are able to reap productivity benefits from FDI in contrast to other firms within the industry.

5.2.2 Regression Results Taking into Account Country of Origin of FDI

The model results that are obtained when the country source of origin of FDI is taken into account are presented in Tables 14 and 15. In the regression equation estimates presented in Table 14, only the horizontal spillover variable has been split. Since the estimates for backward linkage vertical spillover is not found to be statistically significant in Tables 11, 12 and 13, splitting of the BKD variable does not seem worthwhile. By contrast, the estimate of forward linkage vertical spillover turned out to be positive and statistically significant in our results. Therefore, splitting of the FRD variable has been done and the results are reported in Table 15.

In trying to split the FRD variable according to country of origin of FDI, some difficulties in model estimation were encountered because of inter-correlation among the FRD variables constructed separately for different country groups/regions. To tackles this problem, only two-way splitting has been done. Thus, in the model results presented in Table 15, FDI from USA/Europe and FDI from Asia are considered for the analysis of vertical spillover through forward linkage, leaving out the other sources of FDI. In the same way, FDI from developed and developing countries are considered, leaving out the other sources.

Model results presented in Tables 11, 12 and 13 above indicated that there is a significant horizontal FDI spillover effect till a threshold level of FDI share. The estimates presented in Table 14 bring out that this result holds for FDI from developed countries, not for FDI from developing countries. Similarly, the significant positive horizontal spillover effect holds for FDI from USA/Europe, not for FDI from Asia. These results are broadly in agreement with the findings of Xu and Sheng (2012) who found that FDI from Westerns firms produces more substantive spillovers than FDI from overseas Chinese firms.

It is interesting to note that when country source of FDI is taken into account the estimates of direct impact of FDI on productivity matches the indirect effect through horizontal spillover. In both cases, the productivity-enhancing effect is greater for FDI from developed countries than developing countries and for FDI from USA/Europe than FDI from Asia.

Turning now to Table 15, it is seen that the vertical spillover effect through forward linkage is statistically insignificant for FDI from developed countries and for FDI from USA/Europe. For FDI from developing countries, the spillover effect appears to be small since the relevant coefficient, though positive, is found to be statistically

Table 14 FDI spillover effect, country source of origin of FDI, 2000–01 to 2014–15 (dependent variable: ln TFP)

Variables	(1)	(2)	(3)	(4)
Log FRD	0.172** (0.0720)	0.194*** (0.0726)	0.192*** (0.0720)	0.231*** (0.0731)
Log BKD	−0.0182 (0.0229)	−0.0106 (0.0222)	−0.0107 (0.0216)	−0.0204 (0.0262)
FDI share	0.0388*** (0.0122)			
FDI share sq.	−0.00182*** (0.000537)			
FDI share_developed		0.0394*** (0.0126)	0.0397*** (0.0125)	
FDI share_developed sq.		−0.00184*** (0.000552)	−0.00185*** (0.000548)	
FDI share_developing		−0.0803 (0.0743)	−0.0773 (0.0744)	
FDI share_developing sq.		−0.00307 (0.0130)	−0.00360 (0.0130)	
FDI share_other		0.0461 (0.0295)	0.0472 (0.0297)	
FDI share_other sq.		−0.00298 (0.00526)	−0.00326 (0.00531)	
FDI share_US/Europe				0.0450*** (0.0152)
FDI share_US/Europe sq.				−0.00211*** (0.000750)
FDI share_Asia				−0.00226 (0.0126)
FDI share_Asia sq.				3.58e−05 (0.000700)
FDI share_othercountries				0.0496 (0.0301)
FDI share_othercountries sq.				−0.00428 (0.00514)
Log R&D intensity	−0.000972 (0.00146)	−0.00105 (0.00144)	−0.00104 (0.00144)	−0.000957 (0.00146)
Log age	−0.00398 (0.0723)	0.00249 (0.0707)	0.00245 (0.0711)	0.00139 (0.0720)
Log sales	0.485*** (0.0278)	0.485*** (0.0273)	0.486*** (0.0274)	0.484*** (0.0275)

(continued)

Table 14 (continued)

Variables	(1)	(2)	(3)	(4)
Log liquidity	0.113*** (0.00826)	0.113*** (0.00833)	0.113*** (0.00837)	0.113*** (0.00823)
Log leverage	−0.0157*** (0.00305)	−0.0156*** (0.00303)	−0.0155*** (0.00303)	−0.0157*** (0.00301)
Foreign share	0.0124 (0.0105)	0.0119 (0.0105)	0.0119 (0.0105)	0.0130 (0.0105)
Services import intensity	8.53e−05*** (3.13e−05)		8.51e−05*** (3.18e−05)	
Constant	−5.238*** (0.282)	−5.284*** (0.273)	−5.282*** (0.274)	−5.377*** (0.292)
Standard errors	Robust, clustered on 3 digit industry	Robust, clustered on 3 digit industry	Robust, clustered on 3 digit industry	Robust, clustered on 3 digit industry
Time fixed effects	Yes	Yes	Yes	Yes
Observations	21,623	21,626	21,623	21,626
R-squared	0.189	0.189	0.190	0.189
Number of firms	4018	4018	4018	4018

Note Robust standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Services import intensity = imported services/total services
Source Authors' computations

significant only at 10% level. By contrast, the coefficient for FDI from Asia is positive and statistically significant at one per cent level.

To check robustness of these results in respect of vertical spillover effect through forward linkage reported in Table 15, the models have been re-estimated with a slight change in specification; the forward linkage spillover variable has been used as it is without taking logarithms (as done in several earlier studies). These results are shown in Table 17 in the annexure. The results in respect of the forward linkage variables in Table 17 are similar to those in Table 15. The vertical spillover effect through forward linkage is found to be statistically insignificant for FDI from developed countries and for FDI from USA/Europe, as in Table 15. Also, the coefficient of the forward spillover effect of FDI from developing countries is found to be statistically insignificant. The coefficient for FDI from Asian countries is found to be statistically significant which matches the results in Table 15.

The results in Table 15, considered along with the results in Table 17 in Annexure, suggest that FDI from Asian countries has contributed in a significant measure to productivity increase of domestic firms through forward linkage vertical spillover effects. Since such an effect is not found for developing countries, it appears that the observed positive vertical spillover effect through forward linkage is attributable mainly to the contributions being made by Japanese investment in India.

Table 15 FDI spillover effect, country source of origin of FDI, 2000–01 to 2014–15, additional results (dependent variable: ln TFP)

Variables	(1)	(2)	(3)	(4)	(5)
Log FRD_US/Europe	0.0183 (0.0711)	0.0335 (0.0647)	0.0325 (0.0642)		
Log FRD_Asian	0.0810** (0.0401)	0.108*** (0.0371)	0.106*** (0.0380)		
Log FRD_Developed				0.0912 (0.0685)	0.0897 (0.0679)
Log FRD_Developing				0.0544* (0.0289)	0.0532* (0.0294)
Log BKD	−0.0390 (0.0347)	−0.0237 (0.0221)	−0.0238 (0.0217)	−0.0184 (0.0217)	−0.0185 (0.0212)
FDI share	0.0397*** (0.0149)	0.0311** (0.0124)	0.0312** (0.0125)	0.0355*** (0.0123)	0.0356*** (0.0123)
FDI share sq.	−0.00210*** (0.000733)	−0.00164*** (0.000525)	−0.00164*** (0.000525)	−0.00175*** (0.000530)	−0.00175*** (0.000529)
Log (R&D intensity)	0.00288* (0.00155)	– 0.000972 (0.00147)	−0.000967 (0.00147)	−0.000933 (0.00146)	−0.000929 (0.00146)
Log age	0.340*** (0.0711)	−0.00585 (0.0721)	−0.00590 (0.0724)	−0.00349 (0.0719)	−0.00360 (0.0723)
Log liquidity	0.119*** (0.00867)	0.113*** (0.00820)	0.113*** (0.00823)	0.113*** (0.00819)	0.113*** (0.00822)
Log leverage	−0.00560* (0.00309)	−0.0157*** (0.00305)	−0.0157*** (0.00305)	−0.0156*** (0.00305)	−0.0156*** (0.00305)
Foreign share	0.0193* (0.00985)	0.0120 (0.0104)	0.0120 (0.0104)	0.0124 (0.0105)	0.0125 (0.0105)
Log (size)		0.486*** (0.0276)	0.486*** (0.0277)	0.484*** (0.0277)	0.485*** (0.0278)
Services import intensity			8.55e−05*** (3.19e−05)		8.50e−05*** (3.15e−05)
Constant	−5.076*** (0.239)	−4.858*** (0.240)	−4.859*** (0.240)	−4.991*** (0.236)	−4.990*** (0.236)
Time fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	21,626	21,626	21,623	21,626	21,623
R-squared	0.058	0.189	0.190	0.189	0.189
Number of firms	4018	4018	4018	4018	4018

Note Robust standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Services import intensity = imported services/total services
Source Authors' computations

6 Conclusion

The paper investigated the productivity-enhancing effects of FDI in Indian manufacturing firms, with a particular focus on the differences in FDI impact according to the county of origin of FDI. Data on about 7000 manufacturing companies drawn from Prowess, covering the period 2000–01 to 2014–15, were used for the analysis. A comparison of TFP was made between domestic firms and FDI firms. Then, an analysis of the impact of foreign acquisition of domestic firms on TFP in those firms was undertaken with the help of treatment effect assessment methods. An analysis of productivity spillover from FDI firms to domestic firms was undertaken with the help of regression analysis, considering both horizontal and vertical spillover effects. A comparative analysis of horizontal spillover effects and forward linkage vertical spillover effects by the country of origin of FDI was undertaken, making a distinction between FDI from developed and developing countries and also between FDI from USA/Europe and that from Asian countries.

The main findings of the study are as follows:

- FDI firms have higher TFP than comparable domestic firm.
- FDI firms with FDI from developed countries have higher TFP than such firms with FDI from developing countries.
- FDI firms with FDI from USA/Europe have higher TFP than such firms with FDI from Asia.
- Acquisition of equity in a domestic firm by a foreign firm (beyond a threshold of 10%) has a significant positive effect on TFP of the domestic firm. Generally, this effect is present when the investment is made by a firm from a developed country, but not when the investment is made by a firm from a developing country. Similarly, acquisition of equity in a domestic firm by a foreign firm belonging to USA or Europe often raises the TFP in the domestic firm, but this does not hold for foreign equity participation from a firm in Asia.
- Empirical evidence presented in the paper indicates presence of significant positive horizontal FDI spillover effects, leading to increases in productivity of domestic manufacturing firms in India. Such an effect is found for FDI originating in developed countries, particularly USA and Europe. But, the effect is nil or negligible when we consider FDI originating from developing countries or FDI originating in Asian countries.
- Empirical evidence presented in the paper indicates that vertical spillover effect through backward linkage is negligible or at best rather limited. Estimates of vertical spillover effect through backward linkage were found to be negative and statistically insignificant. On the other hand, the empirical results are indicative of a significant positive vertical spillover effect through forward linkage. The observed forward linkage vertical spillover effect seems to be relatively stronger for FDI from Asian countries, particularly Japanese investment in India.

One limitation of the analysis presented in the paper is that fully owned foreign companies operating in India are not included in the Prowess database. As a result,

some well-known companies are missing. This has affected the measurement of spillover variables, and thus affected the econometric estimates of spillover effects. Many of the earlier studies on FDI spillover in India have been based on Prowess, and therefore share this limitation.

The finding of the study that FDI in India from Asian countries does not have a significant positive effect on productivity of domestic manufacturing firms in India (except for forward linkage vertical spillover effect arising probably from Japanese FDI) needs further scrutiny. Further investigation needs to be carried out to verify this finding of this study. It is important to make an attempt to understand why investments of Asian country firms in India particularly those from developing countries of Asia have not contributed to productivity improvement in Indian domestic firms.

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Annexure

See Tables 16 and 17.

Table 16 Robustness checks with FDI share calculated at the three-digit industry level

Variables	(1)	(2)	(3)	(4)	(5)
	Model 1	Model 2	Model 3	Model 4	Model 5
Log FRD	0.154* (0.0856)	0.154* (0.0860)	0.155* (0.0858)	0.171** (0.0748)	0.151* (0.0858)
Log BKD	−0.0459 (0.0365)	−0.0448 (0.0362)	−0.0442 (0.0360)	−0.0229 (0.0244)	−0.0453 (0.0366)
FDIshare_3digit	0.0124* (0.00725)	0.0128* (0.00724)	0.0128* (0.00726)	0.0144** (0.00592)	0.0126* (0.00728)
FDIshare_3digit_sq	−0.000338*** (9.95e−05)	−0.000346*** (9.92e−05)	−0.000344*** (9.90e−05)	−0.000324*** (7.80e−05)	−0.000340*** (9.91e−05)
Log (R&D intensity)	0.00278* (0.00154)	0.00274* (0.00154)	0.00268* (0.00153)	−0.00105 (0.00145)	0.00284* (0.00143)
Log (age)	0.341*** (0.0703)	0.341*** (0.0705)	0.338*** (0.0709)	−0.00488 (0.0709)	0.348*** (0.0748)
Log (liquidity)	0.119*** (0.00867)	0.120*** (0.00873)	0.120*** (0.00876)	0.113*** (0.00822)	0.119*** (0.00902)
Log (leverage)	−0.00572* (0.00307)	−0.00561* (0.00307)	−0.00574* (0.00307)	−0.0159*** (0.00307)	−0.00548* (0.00311)

(continued)

Table 16 (continued)

Variables	(1)	(2)	(3)	(4)	(5)
	Model 1	Model 2	Model 3	Model 4	Model 5
Foreign share	0.0199* (0.0100)	0.0199* (0.0101)	0.0194* (0.0102)	0.0124 (0.0104)	0.0194* (0.0102)
Log (services import intensity)		0.00262** (0.00110)	0.00244** (0.00110)		0.00251** (0.00111)
Log (export intensity)			0.00146 (0.00143)		0.00168 (0.00139)
Log (sales)				0.486*** (0.0275)	
Log (total assets)					−0.0185 (0.0246)
Constant	−5.290*** (0.279)	−5.262*** (0.282)	−5.250*** (0.284)	−5.149*** (0.267)	−5.240*** (0.278)
Times fixed effects	Yes	Yes	Yes	Yes	Yes
Standard error	Cluster robust	Cluster robust	Cluster robust	Cluster robust	Cluster robust
Observations	21,626	21,622	21,622	21,626	21,622
R-squared	0.057	0.058	0.058	0.188	0.058
Number of firms	4018	4018	4018	4018	4018

Notes Robust standard errors in parentheses ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$, standard error clustered on three-digit industries. FDI share has been contrasted at the three-digit level

Table 17 FDI spillover effect, country source of origin of FDI, 2000–01 to 2014–15, Additional results with changed specification (dependent variable: ln TFP)

Variables	(1)	(2)	(3)	(4)
FRD_Developed	0.0165 (0.0162)	0.0117 (0.0153)		
FRD_Developing/other		0.0470 (0.0320)		
FRD_US/Europe			0.0142 (0.0175)	0.00365 (0.0168)
FRD_Asia/other				0.0617** (0.0281)
Log BKD	−0.00634 (0.0247)	−0.0149 (0.0260)	−0.00477 (0.0247)	−0.0187 (0.0267)
FDI share	0.0377*** (0.0126)	0.0356*** (0.0116)	0.0378*** (0.0126)	0.0343*** (0.0117)
FDI share sq	−0.00183*** (0.000545)	−0.00173*** (0.000507)	−0.00184*** (0.000547)	−0.00170*** (0.000509)
Log (R&D intensity)	−0.000945 (0.00146)	−0.000949 (0.00146)	−0.000938 (0.00146)	−0.000953 (0.00145)
Log age	−0.00426 (0.0724)	−0.00650 (0.0722)	−0.00441 (0.0724)	−0.00695 (0.0728)

(continued)

Table 17 (continued)

Variables	(1)	(2)	(3)	(4)
Log liquidity	0.113*** (0.00828)	0.113*** (0.00832)	0.113*** (0.00829)	0.113*** (0.00833)
Log leverage	−0.0156*** (0.00306)	−0.0157*** (0.00304)	−0.0156*** (0.00306)	−0.0157*** (0.00303)
Foreign share	0.0122 (0.0107)	0.0124 (0.0107)	0.0122 (0.0107)	0.0124 (0.0106)
Log (size)	0.485*** (0.0279)	0.486*** (0.0277)	0.485*** (0.0279)	0.486*** (0.0277)
Services import intensity	8.50e−05*** (3.16e−05)	8.52e−05*** (3.17e−05)	8.48e−05*** (3.16e−05)	8.53e−05*** (3.17e−05)
Constant	−5.014*** (0.238)	−5.016*** (0.233)	−4.999*** (0.241)	−4.992*** (0.234)
Time fixed effects	Yes	Yes	Yes	Yes
Observations	21,623	21,623	21,623	21,623
R-squared	0.188	0.189	0.188	0.189
Number of firms	4018	4018	4018	4018

Note Robust standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Services import intensity = imported services/total services
Source Authors' computations

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