Foreign Involvement and Firm Productivity: An Analysis for Indian Manufacturing, Service, Construction and Mining Sectors

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1 Introduction

In recent years, there have been important changes in the nature of firms. The dramatic rise in trade, outward foreign direct investment (OFDI), offshoring and outsourcing reflect the new way firms organize their activities (Gattai 2006). Firms are investing abroad in an increasing range of markets, industries and products, experiencing changes in their technology sourcing, contractual patterns and asset structures. Foreign production/activities range from the export substituting, horizontal or market-seeking OFDI (Markusen 1984; Brainard 1997; Helpman et al. 2004 (hereon HMY)), to vertical or resource-seeking OFDI (Helpman 1984), to complex integration strategies (Yeaple 2003). Although there has been an impressive increase in both the *intensive* and *extensive margins* of trade and OFDI,[1] Bernard et al. (2012) among others document that micro-level empirical studies have shown that international activity is concentrated among a few very large firms that are active in more than one

[1] *Extensive margin* for exports is the number of firms involved in exports, while *intensive margin* is the average firm-level exports conditional on exporting. Likewise, for OFDI, *extensive margin* is the number of firms involved in OFDI, while *intensive margin* is the average firm-level OFDI flows conditional on doing OFDI.

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country and in more than one industry.[2] In explaining the observed *heterogeneity* in the foreign involvement decision of firms, empirical insights from the trade literature (Bernard and Jensen 1995, 1999, 2004) placed within-industry *heterogeneity* in firm productivity (e.g. Bartlesman and Doms 2000) in a dominant position. Further, within theoretical constructs of the *new new trade theory* (Melitz 2003; HMY) firm productivity explains the *self-selection* of firms into foreign markets. Firm productivity has also been taken as an important result of the *learning effects* from foreign contact, following Clerides et al. (1998).

Indian FDI outflows have increased noticeably from $.119 billion in 1995 to $11.304 billion (1.6% of gross fixed capital formation) in 2017, while OFDI stock has increased from $.495 billion in 1995 to $155.340 billion (6.3% of gross domestic product) in 2017.[3] Based on a large sample of Indian firm-level data obtained from the Centre for Monitoring the Indian Economy (CMIE) *Prowess* database for 1995–2010, for the *mining*, *manufacturing*, *construction* and *services* (information and communication) sectors, this paper seeks to establish if there is a positive link between firm productivity and organization of international activities through exports and/or OFDI. Although the positive link could be due to the most productive firms self-selecting themselves into foreign markets (e.g. Goldar 2016; Thomas and Narayanan 2017; Chawla 2019), it could also reflect learning effects through foreign engagements (e.g. EXIM Bank 2017).

Estimates of firm productivity are obtained from applying two alternative specifications of the production function, and two methodologies, namely, gross output (GO) specification based on the Levinsohn and Petrin (2003) (hereon LP) approach and value-added (VA) specification based on a modification of the LP approach, proposed by Wooldridge (2009) (hereon WLP). Within each of these two approaches, productivity estimates are also compared for two alternative classifications of exporters, and outward investing firms (S1 and S2, respectively, refer Sect. 4).

This paper begins in Sect. 2 by reviewing the related theoretical literature on firm productivity and multinational firms. Section 3 highlights the important contributions of the empirical firm productivity, exports and OFDI literature. Section 4 describes the sample and outlines the construction of real output and input series required for estimating firm productivity. Section 5 discusses methodological issues and the alternative productivity estimation approaches. Section 6 presents descriptive statistics. Section 7 compares distributions of firm productivity for firms that export as well as invest abroad, pure exporters and firms that serve the domestic market only. Section 8 concludes. The appendices present additional tables and figure.

[2] In support, the present study finds that Indian foreign investment activity is very much concentrated. In 2009 and 2010, of the sampled firms, the top 1% outward investors from manufacturing account for 64.5% and 68% of the total investment outside India, respectively (*Prowess4* database and own calculations).

[3] World Investment Report (WIR), Annex Tables, UNCTAD 2018.

2 Theoretical Considerations

Early empirical findings on firm heterogeneity and trade, Bernard and Jensen (1995, 1999) observed that only a few firms export, and others in the same industry do not, and exporters are marked by clear defining characteristics in terms of size, productivity, capital intensity, skill and wages. On the theoretical side, this was at odds with the *new trade theory* (Krugman 1979) where all firms export. Theoretical research on the firm and international trade in the *new new trade theory* framework associated with Melitz (2003), and Bernard et al. (2003) introduce firm heterogeneity that underlies comparative advantage. The productivity ordering pattern between exporters and purely domestic firms in trade (Melitz 2003) has been extended to outward investing firms (HMY; Head and Ries 2003 (hereon HR)).

In HMY, firms face the 'proximity-concentration' trade-off. Self-selection entails the least productive firms to exit from the industry, less productive firms cater only to the domestic market and more productive firms choose to export as they can cover the higher cost of export. At some point, these firms are able to afford the sunk costs of OFDI and make the transition to the next level and invest abroad. The model predicts the sorting of firms into different organizational forms based on their productivity draw. The HMY model with its focus on firm heterogeneity can be related to a wider literature on firm-specific advantages and firm-level determinants of OFDI.

An alternative model to get the HMY predictions is developed by HR, which also consider the empirical complementarity between exports and OFDI to extend the choice from exports *or* OFDI to exports *and* OFDI, that could result with differences in fixed costs across destinations. The prediction of the productivity ordering between domestic firms, exporters and firms that export and invest abroad is closer to the empirical literature in developing economies that suggests that it is exporters that graduate to the next level and invest overseas. In the context of the literature on emerging market MNEs, while the asset-seeking motive may dominate over asset exploitation, some firm-level capacity to absorb resources is required.

Next, for the services industries, Oldenski (2012) argues that the standard predictors of the export versus OFDI decision do not hold, as they do for manufacturing. The traditional 'proximity-concentration' models that emphasize physical transportation costs and market size are augmented to a task-based framework, wherein each industry is decomposed into the tasks required for production. Considering the costs of transmitting information, it is predicted that industries requiring direct communication with consumers, such as services, are more likely to be produced in the destination market. However, the hidden cost of OFDI, namely, the difficulty of contracting nonroutine activities to foreign affiliates suggests that services (that are more intensive in nonroutine activities) are more likely to be produced at multinationals' headquarters for export, partially offsetting the communication effect. That manufacturing and services differ in these two task measures is likely to generate different export to OFDI proportions at the industry level. Empirical support is found for these predictions using firm-level data from the US.

3 Related Empirical Literature

3.1 Exports and Productivity

On the empirical side, the bulk of the early studies established the superior performance of exporters of *manufactured goods* over domestic producers using estimated export premia, tested for differences in average productivity, and tested for stochastic dominance of productivity distributions (e.g. Delgado et al. 2002; ISGEP 2008). Early theoretical inquiries into trade in producer *services* (e.g. Markusen 1989) characterize these services as intermediates with significant degrees of scale economies (due to high knowledge intensity of many producer services) and/or product differentiation. A recent literature examines the link between exports of services and firm productivity. Breinlich and Criscuolo (2011) for UK, Love and Mansury (2009) for business service firms in US, Temouri, Vogel and Wagner (2013) for business services firms in France, Germany and the United Kingdom, and Minondo (2014)[4] for Spain find that as in manufacturing, trade in services is characterized by strong heterogeneity at the firm level. There is a positive link between productivity and export status,[5] and the *self-selection* hypothesis is confirmed for services firms as well.[6]

It has thus been suggested as in Breinlich and Criscuolo (2011) that the existing heterogeneous models for goods trade seem to be a good starting point also for the interpretation of trade in services. Unlike goods trade, however, Chang and Marrewijk (2013) for a study of 15 developing countries in Latin America find that the export productivity premium is negative for the services sector in contrast to the manufacturing sector. Lööf (2010) instead finds the premium to be larger than in manufacturing.

3.2 Exports, OFDI and Productivity

HMY find support for their model in their analysis of the relationship between exports-to-OFDI ratio of four-digit US manufacturing industries. Regressing log of productivity (VA per worker) on a set of controls, HMY find that an export firm has a productivity advantage of around 39% over non-exporters, while an outward

[4]Minondo (2014) further finds that the productivity premium is higher in services not related with the internet than in Internet-related services.

[5]Grublješić and Damijan (2011), however, note that firm size seems to be related to the strong concentration of trade in services on a small number of firms as most exports of services are a function of the number of employees. On the other hand, external trade in knowledge-based services is concentrated with the small- and medium-sized firms (SMEs).

[6]Most of these studies consider trade in business services that represents the tradable component of services.

investing firm has a productivity advantage of around 15% over an average export firm.

The scope of the coverage of the microeconometric evidence on testing the predictions of HMY is wide. HR replicate the HMY prediction without imposing constant-elasticity-of-substitution (CES) preferences and 'iceberg' transportation costs. For 1,070 large Japanese firms in 1991, the study shows that there exists a hierarchy in productivity levels of firms investing abroad, exporting firms and purely domestic firms, although the differences tend to be statistically insignificant and there is weak correlation between firm size and productivity.

Girma et al. (2004), for Ireland in 2000, find that while the most productive firms engage in OFDI, no significant differences are discernible between exporters and domestic firms. Kimura and Kiyota (2006) for Japan in 1996–2002 also find similar patterns. Wagner (2006) for Germany in 1995, Bogheas and Gorg (2008) for Ireland,[7] and Arnold and Hussinger (2010) for Germany find support for HMY. Damijan et al. (2007) for Slovenia find no statistically significant advantage of firms with foreign affiliates over exporting firms although firms that export and engage in OFDI are twenty percent more productive than firms that serve only domestic markets.[8]

Tian and Yu (2012) for firms in the Zhejiang Province of China[9] find that over 2006–2008, there is positive correlation between firm productivity and OFDI, higher productivity firms are more likely to undertake OFDI and the greater is their OFDI. Castellani and Zanfei (2007) for Italy find that productivity is highest for firms with manufacturing activities abroad, followed by firms with only non-manufacturing activities abroad (an intermediate category, considered to have lower commitment to foreign markets), followed by exporters and then domestic producers. Tomiura (2007) for Japanese manufacturing firms in 1998 sorts productivity by the modes (combination) of foreign activities and finds that firms engaged in OFDI or in multiple globalization modes are more productive than foreign outsourcers and exporters, which are in turn more productive than domestic firms.

Yeaple (2009) demonstrates that the HMY sorting extends to the scale and scope of multinational enterprises and finds that the most productive US firms invest in a larger number of foreign countries and sell more in each country in which they operate. Aw and Lee (2008) focus on the production location decision of Taiwanese electronic multinationals in 2000 and find that more productive firms engage in OFDI, and firms that invest in US have higher productivity than those that invest in China as well as those that have no overseas assets.

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[7] Bogheas and Gorg (2008), however, note that studies that focus on only a couple of the many alternative strategies for global engagement may potentially yield wrong predictions and demonstrate the superiority of capturing a greater variety of organizational forms.

[8] That the HMY prediction does not hold in the comparison between firms with foreign affiliates and exporters is, however, traced to transition-specific transitory factors related to inherited foreign investments of large inefficient firms. TFP nevertheless has a positive effect on the probability of investing in the first-ever foreign affiliate.

[9] Zhejiang Province being the largest province in the number of OFDI firms in 2007 and the largest in OFDI in 2010.

Engel and Procher (2012) note that while theoretically the HMY model applies to market-driven OFDI, empirically it is difficult to disentangle between different motives for OFDI.[10] For a large sample of French firms from all business sectors that include manufacturing and services sectors, with the exception of the construction industry, the HMY model is confirmed, with MNEs exhibiting the highest productivity followed by exporters and domestic companies. Findings support the HR prediction in Europe with more market-driven outward investing firms exhibiting higher productivity than comparatively less market-driven ones. That MNEs with investments in high-wage countries do not outperform MNEs with investments in low-wage countries in firm productivity is taken as evidence that high-wage countries are also targets of substantial vertical OFDI (for R&D seeking, for instance).

For India, Bhattacharya et al. (2012) (hereon BPS), for 2000–2008, find differences between manufacturing and services industries with regard to the productivity ordering between exporters and OFDI. While the HMY predictions hold for a manufacturing industry, namely, chemicals where firms with OFDI are more productive than exporters, a symmetric analysis for software services industry reverses the predictions with the least productive firms self-selecting themselves into OFDI.

Using German services firms' data, Wagner (2013) finds support for BPS. However, Kox and Rojas-Romagso (2010) for Netherlands find that only the most productive Dutch service firms participate in exports and FDI. Also, Federico and Tosti (2017) for Italy find that as in HMY, smaller and less productive firms are more likely to export than to sell through foreign affiliates. Using labour productivity data on nine service product groups that include six producer services, namely, construction, transport, auxiliary transport, post and telecommunication, data processing, and R&D, and three business services, namely, management services, advertising and personnel services, Kelle et al. (2013) show that for Germany in 2005, the more productive service sector firms are more likely to export and more likely to choose foreign-affiliate sales instead of cross-border sales.[11] Further, Tanaka (2011) for Japan finds that OFDI firms are more productive than non-OFDI services firms, as in manufacturing, suggesting that the standard firm heterogeneity model can well explain OFDI by firms in the services sector.[12]

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[10] Two alternative approaches for classifying firms' foreign investments into resource-driven and market-driven OFDI can, however, be used to enhance the empirical precision of the HMY hypothesis. The study distinguishes between the *host country approach* of HR, whereby low productive firms enter only low-wage but not high-wage countries and the *NACE approach* that requires similar industry affiliation of the parent company and its subsidiary for market-driven OFDI, and vertical subsidiaries active in upstream (or downstream) industries from their parent's industry for resource-driven OFDI.

[11] As studies on exports, OFDI and productivity in services are fewer than in manufacturing, some studies that relate productivity to the likelihood of OFDI are included in this review, even if they do not compare the productivity distributions of firms.

[12] Service sector firms are, however, assumed to only have the choice of domestic production or OFDI as the dataset does not contain services exports, while manufacturing firms can choose between exports and OFDI. It is also demonstrated theoretically that none of the services firms can exceed the export cut-off productivity level that is sufficiently high enough for them.

4 Sample Description

4.1 Criteria for Firm Categorization

Following Narayanan and Bhat (2011) among others, for this study, identification of firms with foreign investments (that may also export) is done on the basis of the *investment outside India* data field in *Prowess*. The outward investing firm's industrial classification by National Industrial Classification (NIC)-2008 is based only on its activity, not that of its affiliates outside India. As in HR, among others, firms are categorized into D, DX, DXI and DI. These are, namely, firms that only serve the domestic market (D), firms that also export (DX),[13] firms that export and invest abroad (DXI), and firms that invest abroad but do not export (DI). In this study, the DXI and DI categories are merged to form the OFDI firms' category (hereon DIDXI).

Further, in the absence of information in the *investment outside India* data field in *Prowess* about the percentage holding by Indian firms in their affiliates abroad, while some studies identify an OFDI firm on the basis of the existence of positive overseas assets, some use cut-offs on the fraction of OFDI to total assets (as, for instance, >1%). In making the cross-sectional comparisons of the productivity distributions, an attempt is made to see whether the stricter basis for classifying foreign investors affects the nature of productivity rankings by firm categories. For this purpose, two specifications are used: S1, where DX represents firm-years where firms' export/sales ratio (*export intensity*) is positive, while DXI represents firm-years where firms' export intensity, and investment outside India/total assets ratio (*foreign investment intensity*) is positive, and S2, where a 1% cut-off on firms' export intensity is imposed to define firm-years as DX, while in addition to the 1% cut-off on firms' export intensity, a 1% cut-off on firms' foreign investment intensity is required to define firm-years as DXI. Likewise, DI covers non-exporter firms with foreign investment intensity of 1% and above.

4.2 Data and Construction of Variables[14]

Using *Prowess* data, a panel of 127 firms (1,196 observations) for mining and quarrying (NIC 05 to 09), 6,068 firms (57,698 observations) for manufacturing (NIC 10 to 32), 247 firms (2,036 observations) for construction (NIC 41, 42) and 683 firms (5,145 observations) for services sector (NIC 58, 61, 62, 63) is constructed, after data cleaning (Table 1). To reduce potential bias due to sample selection, the data or

[13] DX covers continuing exporters (firms that export continuously over the sample period) but also firms that switch their export status from domestic to exporter in the current year.

[14] For details on data sources, data cleaning, variable construction, econometric issues, and methodology of TFP estimation (based on LP), refer to Goldar et al. (2019).

Table 1 Number of firms in the sample, 1994/95 to 2009/10

Panel 1a: by year		Panel 1b: by industry							
		Two-digit NIC code	NIC-2008 description	No. of three-digit industries	Firms		Firm-year count[b] (All)	Firm-year count (DXI)[c]	
								S1	S2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Year	**Count**		**Mining and quarrying**		**No.**	**Share of sector (%)**			
1995	41	05	Mining of coal and lignite	2	11	08.2	154	–	–
1996	58	06	Extraction of crude petroleum and natural gas	2	02	01.54	29	–	–
1997	54	07	Mining of metal ores	2	17	13.4	149	01	–
1998	61	08	Other mining and quarrying	2	89	70.3	768	52	–
1999	58	09	Mining support service activities	1	08	06.56	96	05	–
2000	65			**09**	**127**	**100**	**1,196**	**58**	–
2001	68								
2002	73								
2003	88								
2004	98								
2005	101								
2006	96								
2007	98								
2008	93								
2009	75								
2010	69								
	1,196								
Year	**Count**		**Manufacturing[a]**						

(continued)

Table 1 (continued)

Panel 1a: by year		Panel 1b: by industry							
		Two-digit NIC code	NIC-2008 description	No. of three-digit industries	Firms		Firm-year count[b] (All)	Firm-year count (DXI)[c]	
								S1	S2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1995	2,503	10	Food products	8	695	11.45	6,408	200	90
1996	2,758	11	Beverages	1	124	2.04	1,068	20	4
1997	2,925	12	Tobacco products	1	08	.13	105	14	–
1998	3,054	13	Textiles	2	696	11.47	6,527	265	87
1999	3,253	14	Wearing apparels	1	107	1.76	844	42	16
2000	3,371	15	Leather and related products	2	64	1.05	558	62	24
2001	3,402	16	Wood and products of wood and cork, except furniture	1	32	.52	318	07	–
2002	3,486	17	Paper and paper products	1	228	3.75	2,057	18	07
2003	3,842	18	Printing and reproduction of recorded media	2	23	.37	164	03	02
2004	4,035	19	Coke and refined petroleum products	2	41	.67	292	22	04
2005	4,222	20	Chemicals and chemical products	3	802	13.21	7,934	478	211
2006	4,353	21	Pharmaceuticals, medicinal chemical and botanical products	1	437	7.20	4,267	471	298
2007	4,378	22	Rubber and plastics products	2	362	5.96	3,550	265	124

(continued)

Table 1 (continued)

Panel 1a: by year		Panel 1b: by industry							
		Two-digit NIC code	NIC-2008 description	No. of three-digit industries	Firms		Firm-year count[b] (All)	Firm-year count (DXI)[c]	
								S1	S2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2008	4,303	23	Other non-metallic mineral products	2	225	3.70	2,312	143	52
2009	4,106	24	Basic metals	3	695	11.45	6,427	232	94
2010	3,707	25	Fabricated metal products, except machinery and equipment	2	195	3.21	1,767	67	40
	57,698	26	Computer, electronic and optical products	5	224	3.69	1,937	159	82
		27	Electrical equipment	6	299	4.92	2,884	115	39
		28	Machinery and equipment n.e.c.	2	360	5.93	3,692	222	81
		29	Motor vehicles, trailers and semi-trailers	1	15	.24	159	37	13
		30	Other transport equipment	4	335	5.52	3,558	203	111
		32	Other manufacturing	5	101	1.69	870	124	72
				57	**6,068**	**100**	**57,698**	**3,169**	**1,451**
Year	**Count**		**Services: information and communication**		**No.**	**Share of sector (%)**			
1995	74	58	Publishing activities	1	42	06	395	31	10
1996	98	61	Telecommunications	4	89	13	594	48	33

(continued)

Table 1 (continued)

Panel 1a: by year		Panel 1b: by industry							
		Two-digit NIC code	NIC-2008 description	No. of three-digit industries	Firms		Firm-year count[b] (All)	Firm-year count (DXI)[c]	
								S1	S2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1997	116	62	Computer programming, consultancy and related activities	1	446	65	3,514	1009	900
1998	129	63	Information service activities	2	106	16	642	132	108
1999	184			**08**	**683**	**100**	**5,145**	**1,220**	**1,051**
2000	235								
2001	299								
2002	318								
2003	392								
2004	433								
2005	469								
2006	497								
2007	507								
2008	504								
2009	465								
2010	425								
	5,145								

(continued)

Table 1 (continued)

Panel 1a: by year		Panel 1b: by industry							
		Two-digit NIC code	NIC-2008 description	No. of three-digit industries	Firms		Firm-year count[b] (All)	Firm-year count (DXI)[c]	
								S1	S2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Year	**Count**		**Construction**						
1995	81	41	Construction of buildings	1	54	22	474	28	–
1996	86	42	Civil engineering	3	193	78	1576	144	–
1997	94			**04**	**247**	**100**	**2,036**	**172**	–
1998	95								
1999	103								
2000	102								
2001	110								
2002	120								
2003	136								
2004	150								
2005	160								
2006	174								
2007	184								
2008	167								
2009	148								
2010	126								
	2,036								

Notes

[a]Excluding NIC 31 (Manufacture of furniture), NIC 33 (Repair and installation of machinery and equipment)

[b]Firm-year count at each 2-digit level is based on the sample for which LP estimates are obtained

[c]Firm-year count for DXI

Source Prowess 4 and own calculations

firm coverage is not restricted to large firms alone. Wider industry coverage allows cross-industry heterogeneity.

Some modifications are applied towards the construction of real output (GO, VA) and input series (intermediate inputs, namely, raw materials, energy and services; labour and capital) required for estimating firm productivity. The 'combined' intermediate input series is formed using separate three-digit-specific price deflators for raw materials, energy and services using Input–Output Transactions Tables (IOTT) 1993–94 and 2003–04. Incomplete coverage of the labour input in the database leads to the need for imputation of the labour input (also see Chawla 2012). Given the widely noted heterogeneity in wages across firms, the Annual Survey of Industries (ASI)-based method of imputing firm employment[15] has been criticized for its implicit assumption of a uniform wage rate among all firms belonging to an industry (Goldar et al. 2004; Siddharthan and Lal 2004, among others). An adjustment is made to the imputed estimates of the labour input following the 'ASI-based approach' for a 'wage premium' based on firms' ownership categories.[16] Physical real capital stock is constructed following the Perpetual Income Method (PIM), allowing for disaggregated growth of investment, and is combined with 'knowledge' or R&D 'capital' stock.

5 Estimation of Firm Productivity

For the GO specification of the Cobb–Douglas production function (in logs), with output (y_{it}) as function of capital (k_{it}), labour (l_{it}) and intermediate inputs (m_{it}), log total factor productivity (TFP) is the estimated residual:

$$\widehat{\omega}_{it} = (y_{it} - \widehat{\beta}_k k_{it} - \widehat{\beta}_l l_{it} - \widehat{\beta}_m m_{it})$$

In the VA specification, with VA (v_{it}) as function of primary inputs of capital (k_{it}) and labour (l_{it}), estimated log TFP is

$$\widehat{\omega}_{it} = (v_{it} - \widehat{\beta}_k k_{it} - \widehat{\beta}_l l_{it})$$

[15]The 'ASI-based approach' involves the computation of an average wage rate (emoluments per employee, at the 2-digit or 3-digit industry level), obtained by dividing Annual Survey of Industries (ASI) data on total emoluments by the total persons engaged. Subsequently, by dividing each firm's wage bill obtained from the company database by this computed average wage rate, an imputed measure of the employment in the firm is arrived at.

[16]For consistency with the wage adjustment as performed for manufacturing firms, the reported compensation to labour for group, government and foreign firms is adjusted downwards (by the same percentage as worked out for manufacturing) before imputing employment.

5.1 Methodological Issues

5.1.1 'Simultaneity Bias' Due to Correlation Between Observed Input Levels and Unobserved Productivity

In the context of productivity measurement, comparisons are drawn between the alternative methods that attempt to overcome 'simultaneity bias', namely, LP and WLP. The *semi-parametric, proxy variables* LP approach shows that when the demand for an observed input decision of the firm, that is, intermediate inputs (a function of state variables of the firm, namely, productivity and capital), is strictly positive, and the invertibility condition is satisfied, unobserved productivity can be expressed only as a function of the observable inputs (that is, capital and the proxy variable), and can thus control for 'simultaneity bias'. The estimation algorithm in the *first stage* involves the identification of the labour coefficient, while the *second stage* involves the identification of the capital and materials coefficients.

Ackerberg et al. (2015) (hereon ACF), however, point out that under the assumption that labour and materials are both chosen simultaneously, they are likely to be functions of the same state variables, namely, productivity and capital. Under the LP invertibility condition, $l_{it} = f_t\left(g_t\left(k_{it}, m_{it}\right), k_{it}\right)$ where $g_t = m_t^{-1}$, such that in the first stage, the coefficients on the variable inputs are non-parametrically unidentified due to collinearity with the inverted function. ACF attempt to recover the input coefficients by modifying the timing assumption, wherein, as in LP, capital k_{it} is assumed to be chosen at time $t-1$, intermediate inputs m_{it} at time t, but adjustment time for hiring and firing labour allows labour to be chosen by the firm at time $t-b$, where $0 < b < 1$ so that it is 'less variable' than intermediate inputs, and being determined prior to intermediate inputs enters the set of variables that affect the choice of the intermediate inputs ($m_{it} = f_t\left(\omega_{it}, k_{it}, l_{it}\right)$).

WLP modifies the LP estimator to address the collinearity issues raised above by a joint GMM estimation of the system, such that the first stage of LP provides identifying information for parameters on the variable inputs (such as labour) and efficiently accounts for serial correlation and heteroscedasticity in the errors. The contemporaneous state variable, k_{it}, any lagged inputs and functions of these are taken as instrumental variables in estimation.

5.1.2 Value-Added Bias

Some studies point out that the relative superiority of exporters in comparison to purely domestic firms may result from several sources of potential bias in productivity estimates, also related to the selection of the functional form of the production function, namely, GO vs.VA (Gandhi et al. 2011, 2013; Rivers 2013).[17] Output heterogeneity among firms thus reflects not only variation in productivity, but that in

[17]For Indian manufacturing, Pradhan and Barik (1998) find through a statistical test that primary and intermediate inputs are not separable in the production function, thus weakening the option of using VA for TFP estimation.

excluded inputs (intermediate inputs) as well. As intermediate input usage is likely to be correlated with productivity, it could overstate the true degree of productivity heterogeneity. Also, the correlation between intermediate input usage and inputs that are controlled for (capital and labour) may cause biased output elasticity estimates for these inputs, the bias consisting of two components: (i) 'transmission bias' that results from the correlation between productivity and primary inputs and (ii) 'value-added bias' that results from the failure to subtract intermediate inputs from GO to fully control for the contribution of intermediate inputs to output (Gandhi et al. 2011).

5.2 Empirical Specification: Production Function Estimation

Two sets of input coefficients are estimated in an attempt to explore whether similar concerns are of importance when investigating the relative superiority of OFDI firms (that also export). Estimates of firm productivity and relative firm productivity index (following Pavcnik 2002) are obtained from applying GO–LP,[18] and VA–WLP,[19] at the two-digit industry/industry group level. For the revenue production function (GO–LP), estimated input coefficients are bounded away from zero, with the materials input coefficient being higher than those of labour and capital. For VA–WLP, vectors of the exogenous, endogenous and instrumental variables follow Petrin et al. (2011). The production function coefficients obtained by WLP are mostly significant at the 1% level. Results of the overidentification tests of the joint null hypothesis that the instruments are valid, that is, they are orthogonal to the error term, and the excluded instruments are correctly excluded from the estimated equation (as given by the *p*-values for the Hansen *J* statistic test), indicate that for most cases, the validity cannot be rejected at a cut-off of 10%. The WLP procedure yields TFP estimates from 1997 onwards as inputs used during the first 2 years of the sample period are used as lagged inputs.

[18]The LP approach is implemented using the levpet command (Petrin et al. 2004).

[19]The WLP method is implemented using the program available at http://www.econ.umn.edu/~petrin/programs.html using (ivreg2.do). Under ivreg2, the estimator option gmm2s (that produces the IV/2SLS estimator, standard errors consistent under homoscedasticity) when combined with the cluster option, generates two-step efficient GMM (EGMM) estimates (that is statistics robust to heteroscedasticity and clustering at the firm level). cluster standard errors are robust to both arbitrary heteroskedasticity and arbitrary intra-group correlation. The ivreg2 Stata module developed by Baum et al. (2012), available at http://ideas.repec.org/c/boc/bocode/s425401.html, is used for estimation.

6 Descriptive Statistics

6.1 Sectoral Classification and Broad Features by Firm Category

Table 2 shows that in *manufacturing*, only a small fraction of observations (5.84% S1, 2.9% S2) correspond to foreign investors,[20] while a large proportion (51.89% S1, 45.82% S2) correspond to exporters.[21]

Also, in 2009/10, DIDXI accounted for 53% of sales of all firms in the sample (by S1) and 19.67% (by S2). For *construction* firms, DIDXI accounted for 62.75% of sales in the same year. The export and foreign investment intensity varies greatly between firms. For instance, in 2009/10, for *manufacturing*, among the 1,771 exporters, about 18.4% export less than 1% of their sales, while another 34.5% export between 1 and 10% of their sales, 32.9% export 10 and 50% of their sales, 7.5% export 50 and 75% of their sales and 6.5% export 75 and 100% of their sales. Also, of the 444 outward investors, 48.4% hold less than 1% assets abroad and 35.6% hold 1–10% assets abroad; another 15% invest between 10 and 50% assets abroad, while .006% hold 50–75% assets abroad. In the *construction* sector, for the same year, of the 40 firms that export (DX + DXI) around 30% export less than 1% of sales, 37.5% export between 1 and 10% of sales, 27.5% export between 10 and 50% of sales and 6.66% export between 50 and 100% of sales. Also, 73.3% firms have a foreign investment intensity of less than 1%, while the remaining 26.6% invest between 1 and 10% of their assets abroad. Several empirical studies have shown that exporting and foreign investing firms are generally larger in size (e.g. Bernard et al. 2007). Characterizing the data along the size dimension, Chawla (2015) indicates that firm size (by sales) is positively related with the percentage of firms participating in overseas investment in *manufacturing* and *construction*, while the overseas investors in *services* are less concentrated in the largest size class.

Table 4 in Appendix A for *manufacturing* shows broad features of the structure of firms with foreign operations compared to those that do not. For both specifications (S1 and S2), as in the literature, the median firm in outward investing firms' categories (DI and DXI) is more productive than firms not engaged in OFDI (DX and D), while the median DX firm is more productive than the D firm. The median firm in the D sample is smaller (in sales/total assets/number of employees) than firms in the DX sample, while DXI firms are much larger. The median DX or DI/DXI firm produces more output and has higher VA than the D firm. DXI firms have

[20] Following S2, however, may cause a firm's classification to change to a non-exporter and/or a non-overseas investor firm if a change in exports (and/or investment outside India) and/or in sales/total assets causes these ratios to fall below 1% (as for *Videocon Industries* in 2006) among others, instead of an actual change in the firm's trajectory between export and/or overseas investment and the domestic market over any given period.

[21] Unlike the empirical findings wherein *few* firms export (e.g. Bernard et al. 2007 for US, where exporters represent only 18% of the total population), the relatively large share of exporting firms in the sample reflects the oversampling of the relatively large and medium firms in the database.

Table 2 Firm-years (in percentages), by foreign involvement, 1995–2010

	S1					S2				
	D	DX	DXI	DI	DIDXI	D	DX	DXI	DI	DIDXI
Manufacturing	42.26	51.89	5.49	.35	5.84	51.27	45.82	2.51	.39	2.9
Services	33.43	40.58	23.71	2.27	25.99	39.75	37.8	20.43	2.02	22.45
Mining	48.24	46.66	4.85	.42	5.10					
Construction	65.71	23.23	8.44	2.6	11.05					

Note For the *mining* and *construction* sub-samples, percentages of observations are reported only for specification S1 due to the small absolute number of firm-years in the DIDXI category using specification S2
Source Prowess 4 and own calculations

Table 3 Mean productivity (*ln* TFP index) of OFDI firms, pre- and post-OFDI

(*a*)							
Time periods	$t-3$	$t-2$	$t-1$	$t0$	$t+1$	$t+2$	$t+3$
Ln TFP index	.0323	.0545	.0557	.0659	.0718	.0725	.0731
(*b*)							
	Pre-OFDI (merging time periods $t-3$, $t-2$, $t-1$)			Post-OFDI (merging time periods $t+1$, $t+2$, $t+3$)			*t*-test Post > Pre (*p*-value)
Mean *ln* TFP index (No. of obs.)	.0477 ($n = 1520$)			.0724 ($n = 1560$)			.0143

Source Prowess 4 and own calculations

higher export intensity than DX firms (reflecting market-seeking export behaviour and interdependencies across modes of internationalization). DXI firms also spend more on R&D, indicating creation of 'knowledge' capital.[22] This evidence from manufacturing is in line with Narayanan and Bhat (2011) that for 2000–2005 find multinational firms from the information technology (IT) industry having higher export intensity, and making more technological effort than other IT firms in the sample. There is also slight difference in DXI and DI qualitatively (for both S1 and S2) as regards overall characteristics of firm categories.

Further, for manufacturing, it is examined whether there is any change in the mean productivity of OFDI firms over time, that is, in comparing pre- and post-OFDI time periods. For this, using productivity estimates for GO–LP, for S1, if $t = 0$ is the year in which a firm i switches into becoming an OFDI firm by investing abroad for the first time, for 599 OFDI entries over various years of the sample period, Table 3 shows the mean productivity (*ln* TFP index) of DIDXI firms at time $t \pm s$, where $s = 1, 2, 3$, that is, s years pre- and post-OFDI entries, respectively.

Merging pre- and post-OFDI time periods ($t-3, t-2, t-1$) and ($t+1, t+2, t+3$), respectively, mean productivity for the post-OFDI time period is significantly higher (at the 5% level) for the one-sided *t*-test, that is, the average of the post-OFDI time period is higher than that for the pre-OFDI time period.

6.2 Inter-sectoral and Inter-industry Comparison

Comparison of the *inter-sectoral* foreign investment intensities, conditional on outward investment (Fig. 1), shows that firms in the services and manufacturing sectors are much more internationalized than those in the construction and mining sectors.

[22]Chawla (2015) shows that DXI category has slightly lower capital–output ratio, combined material, raw material and energy intensity although their services intensity is slightly higher than of D category.

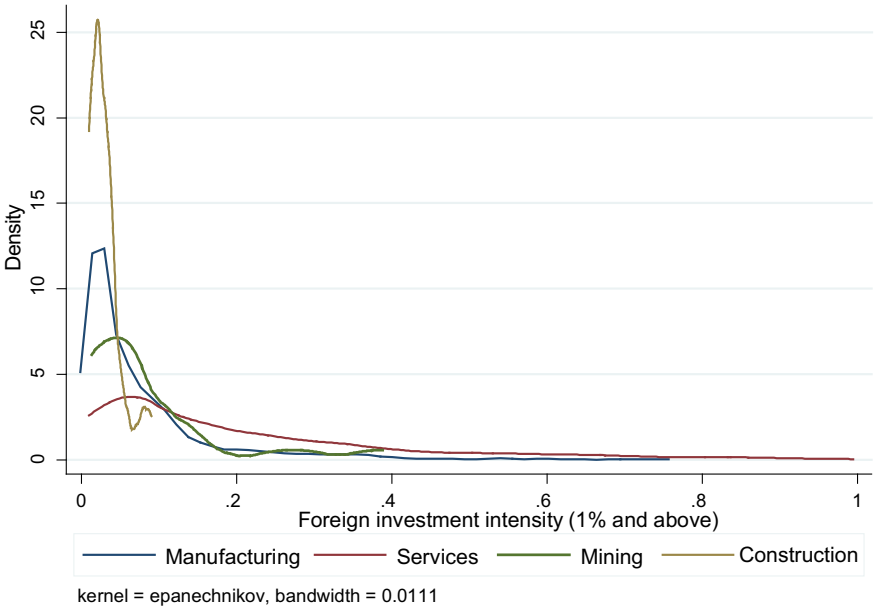

Fig. 1 Density plots of foreign investment intensity by sector, for S2, 1995–2010 *Source Prowess* 4 and own calculations

At the two-digit level, in manufacturing, Table 1 shows substantial variation in the extent of internationalization across industries within manufacturing. For instance, in 2009/10, the wood products industry is much less internationalized than the chemicals/pharmaceuticals industries that are strongly involved in OFDI.[23] *Inter-industry* comparison for manufacturing (Fig. 2) is indicative of considerable heterogeneity in the outward orientation of firms at the three-digit industry level. Industry-specific effects, partly attributable to the nature of products produced, are suggestive of the outward orientation of firms belonging to the industry groups.

[23]However, the largest home-based transnational corporations (TNCs) for 2010 as in *India country sheet*, WIR, UNCTAD (2013) represent manufacturing industries with varying degrees of technological sophistication: Reliance Industries Ltd., Essar Oil Ltd. (coke, petroleum and nuclear fuel), Tata Steel Ltd., Hindalco Industries Ltd., MMTC Ltd., JSW Steel Ltd., Ispat Industries Ltd. (metals and metal products), Tata Motors Ltd., Mahindra and Mahindra Ltd., Bajaj Auto Ltd. (motor vehicles and other transport equipment), Suzlon Energy Ltd. (machinery and equipment), ITC Ltd. (food, beverages and tobacco), Hindustan Unilever Ltd., Ranbaxy Laboratories Ltd., Tata Chemicals Ltd., Dr. Reddy's Laboratories Ltd. (chemicals and chemical products), Videocon Industries Ltd., Siemens Ltd., Crompton Greaves Ltd. (electrical and electronic equipment), Apollo Tyres Ltd. (rubber and plastic products) and Ambuja Cements Ltd., Ultratech Cement Ltd. (non-metallic mineral products).

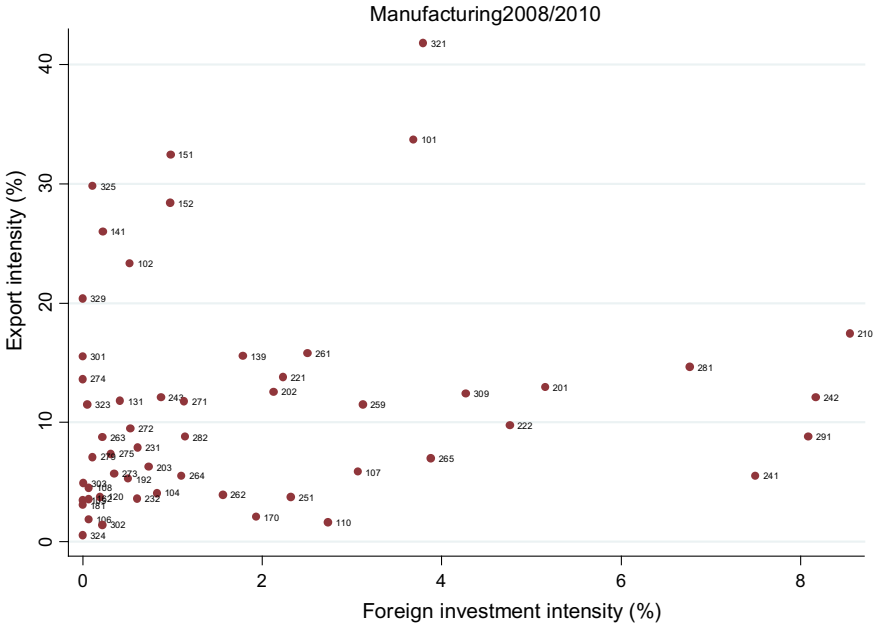

Fig. 2 Scatter plots: average export and foreign investment intensity by three-digit industry, manufacturing, for S1, 2008–2010. *Notes* NIC191 and NIC103 are excluded as the number of outward investing firms is below five. *Source Prowess* 4 and own calculations

7 Productivity Comparisons

7.1 Testing Procedure: Kolmogorov–Smirnov (KS) Test

To assess if there are any significant differences between distributions of productivities of firms based on their foreign engagements, Sect. 7.2 employs the non-parametric test of first-order stochastic dominance (FOSD) that makes no assumption about the sample distributions,[24] and tests for differences in all moments of the distributions. Differences in marginal moments such as mean and standard deviation do not reflect the entire distribution of productivities. Following Girma et al. (2004), Engel and Procher (2012), and Wakasugi and Natsuhara (2012) among others, these are comparisons of unconditional distributions, that is, are not controlled for other covariates such as size, age, innovation, group and industry fixed effects.

The hypothesis to be tested is that if productivity differences between firms at any point in time reflect *self-selection* and/or *learning effects*, the productivity distribution of the outward investing firms (that may export as well) should dominate that of the pure exporting firms that should in turn dominate the productivity distribution of

[24]The test is more robust than the *t*-test that requires the normality assumption.

the purely domestic firms.[25] FOSD of the cumulative distribution function (CDF) of productivity, F_{DIDXI} relative to F_{DX} requires $F_{DIDXI} - F_{DX} \leq 0$ uniformly in $z \in$ R, with strict inequality for some z. The test requires that the null hypothesis of the *two-sided* test:

H_0: $F_{DIDXI}(z) - F_{DX}(z) = 0$ for all $z \in$ R versus H_1: $F_{DIDXI}(z) - F_{DX}(z) \neq 0$ for some $z \in$ R can be rejected while that of the *one-sided* test:

H_0: $F_{DIDXI}(z) - F_{DX}(z) \leq 0$ for all $z \in$ R versus H_1: $F_{DIDXI}(z) - F_{DX}(z) > 0$ for some $z \in$ R cannot be rejected.

This allows us to conclude (1) that the two distributions are not identical, and (2) that one distribution dominates the other. Graphically, F_{DIDXI} is to the right of F_{DX}, that is, is on the higher productivity side, or that overseas investors' productivity distribution stochastically dominates that of exporters. Further, to maintain the independence assumption, the hypothesis is tested separately for each year of the sample period. Table 5 in Appendix A reports the *D-statistic* and the *p*-value (the probability that the two distributions are the same) for manufacturing (by S1).[26,27]

7.2 Results

7.2.1 Manufacturing Sector

Figure 3 compares the productivity differences among firm types (DIDXI, DX, D) for the two alternative productivity measures, for S1. Column (1) depicts GO–LP for 1995–2010, while column (2) depicts VA–WLP for 1997–2010.

A comparison of the graphs in panel (a) for trend in mean productivity (*ln* TFP index)[28] for foreign investors (DIDXI), exporters (DX) and purely domestic firms

[25] As Girma et al. (2004, p. 319) note, 'although these tests encompass the possibility that firms of the same productivity level may choose different forms of commerce, the degree of uncertainty in behaviour cannot be too large such that the structure of commerce and firm heterogeneity are no longer meaningfully related'.

[26] 'The directional hypotheses are evaluated with the statistics: $D^+ = \max_x\{F(z) - G(z)\}$, $D^- = \max_x\{F(z) - G(z)\}$ where F(x) and G(x) are the empirical distribution functions for the samples being compared. The combined statistic is: $D = \max(|D^+|,|D^-|)$ which identifies the maximum vertical difference between the two empirical cumulative distribution functions. The *p*-value for this statistic may be obtained by evaluating the asymptotic limiting distributions' (*Stata Base Reference Manual Vol. 2, Release 10, p. 109*).

[27] Similar tables (reporting KS test results), for manufacturing (S2), services (S1, S2), construction (S1) and mining (S1) not reported here, are available in Chawla (2015), results discussed below.

[28] The mean productivity for the sample DIDXI is not shown for 1995–1999, as due to the small number of firms in this time period, the mean values are subject to larger variations.

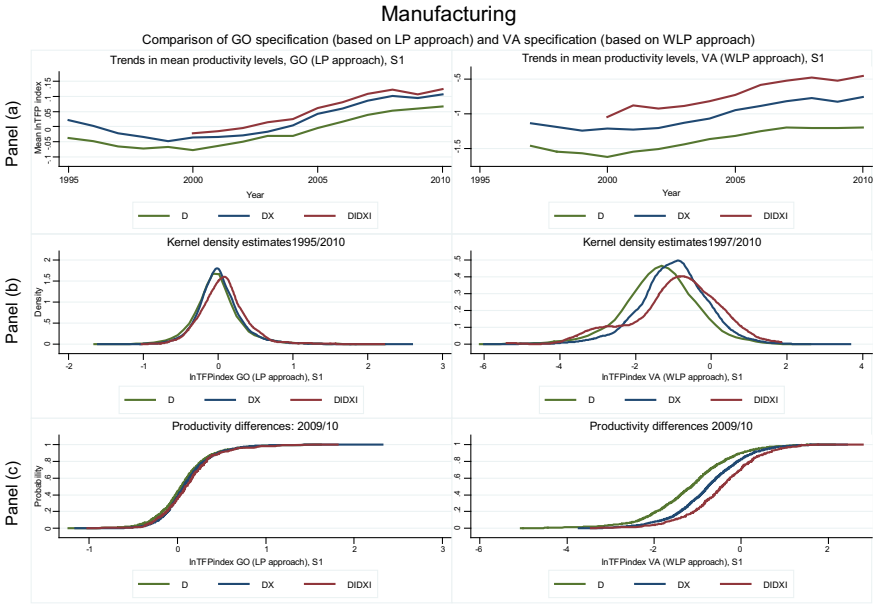

Fig. 3 Differences among firm types (DIDXI, DX, D), based on TFP estimates, comparing methods, manufacturing, S1, 1995–2010. *Source Prowess* 4 and own calculations

(D) displays stronger differences across firm types under VA rather than GO specification.[29] Panel (b) shows that kernel density estimate[30] of the productivity distribution for DIDXI lies to the right of the distribution for DX, and even further to the right from the distribution for D, consistent with HMY (and HR) prediction.[31] For 2009/10, panel (c) shows that the CDF of firm productivity for DIDXI lies to the right of that for DX and more so for D, indicating FOSD. Productivity rankings thus favour DIDXI over DX, DX over D and DIDXI over D (which also follows by transitivity). Firms that invest abroad have higher productivity than firms that export only or that only operate domestically.

[29] Both columns, however, show that the impact of the negative demand shock for Indian firms in 2008 (Q2) to 2009 (Q2) has been more so for firms with foreign engagements than purely domestic firms.

[30] Epanechnikov kernel, with varying bandwidth.

[31] As the HMY model deals with horizontal FDI alone, and although a large fraction of FDI by Indian firms goes to the developed countries for market access (RBI *Bulletins*), it seems reasonable to test the HMY predictions. Nunnenkamp et al. (2012) also find that the location choice of Indian direct investors is dominated by the motive of market-related factors, much less so for access to raw materials or for superior technologies. In so far as OFDI is also guided by vertical or complex integration strategies, also related to the internationalization of R&D, in the absence of the fraction of OFDI directed by the underlying motives, testing the HMY predictions, may, however yield partial insights.

The differences across firms are, however, more pronounced for VA specification indicating a 'value-added bias' that remains even after controlling for the 'transmission bias' with WLP productivity estimation technique that is robust to the ACF (2015) criticism (Gandhi et al. 2013; Rivers 2013). Density plots of estimated productivity at the two-digit level/combined groups (Fig. 10 in Appendix B) indicate that the relationship between firm productivity and foreign involvement is stronger in some industries, for instance, in textiles (NIC 13), coke and refined petroleum products, chemicals (NIC 19, 20), pharmaceuticals (NIC 21), basic metal and fabricated metal (NIC 24, 25), and machinery and equipment n.e.c. (NIC 28) than in the rest.

Table 5 in Appendix A presents the number of firms by each firm type for each year of the sample period, in columns (2) to (4),[32] with mean values of productivity (*ln* TFP index) in columns (5) to (7). KS test statistics of productivity differentials are presented for exporters and non-exporters (DX vs. D) in columns (8) to (10), outward investors and exporters (DIDXI vs. DX) in columns (11) to (13), firms that export and invest abroad, and exporters (DXI vs. DX) in columns (14) to (16), and outward investors and domestic firms (DIDXI vs. D) in columns (17) to (19), respectively, for GO–LP. Rest of the columns correspond to VA–WLP for corresponding comparisons. Tests are applied separately to each category for every year of the sample period.

DX versus D: The null hypothesis of equality between both distributions can be rejected at the 1% level for several years (mainly after the year 2000). The null hypothesis that the direction of the difference is as expected, that is, DX have greater productivity than D, cannot be rejected at any reasonable significance level for most years. **DIDXI versus DX**: The equality of both productivity distributions cannot be rejected at any reasonable significance level in the earlier years of the sample period 1995–2000. Although productivity differences between DIDXI and DX are rather modest in GO specification, it is only after 2001 that they favour DIDXI over DX as suggested by the test statistics for the one-sided test, column (12).[33] Qualitatively similar results obtain in comparing DXI with DX, i.e. DXI > DX, columns (14) and (15). **DIDXI versus D**: For 2001 onwards, DIDXI stochastically dominate D firms. Chawla (2015) reports KS test results that show that limiting the lower bound for qualifying as an exporter and foreign investing firm (S2), lend support to HMY (and HR) models for most but not all years of the sample period. Graphically, differences in firm categories are, however, less pronounced for S2 than for S1 (Fig. 4).

[32]The number of observations is reported for GO–LP approach. Under WLP, as noted above, the overall sample size is smaller.

[33]The year 2001 onwards has also witnessed a significant increase in the number of outward investing firms.

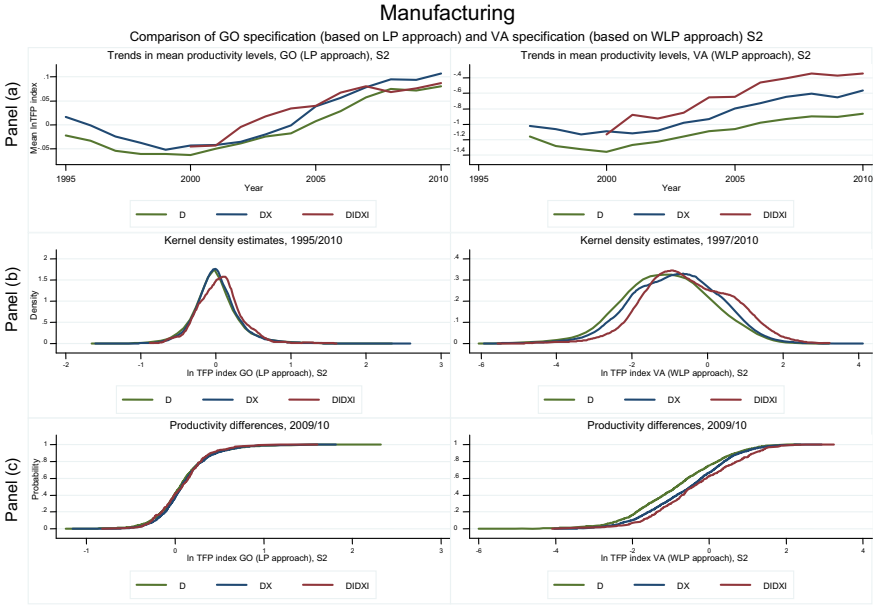

Fig. 4 Differences among firm types (DIDXI, DX, D), based on TFP estimates, comparing methods, manufacturing, S2, 1995–2010. *Source Prowess* 4 and own calculations

7.2.2 *Services Sector*[34]

Figure 5 shows similar comparisons for service sector firms (analysis restricted to NIC 61, 62 and 63) for S1.[35] Panel (a) shows that as in manufacturing, the trend

[34]DXI and DX firms are engaged in industries such as 'basic telecom services, internet access by the operator of the wireless infrastructure, other wireless telecommunications activities, other telecommunications activities, providing software support and maintenance to the clients (software service and consultancy), news agency activities (television broadcasting media, cable television broadcasting media (DX only), other information service activities n.e.c. (information technology enabled service/BPO), activities of maintaining and operating paging, cellular and other telecommunication networks (DX only)' (based on *Prowess 4*). Several firms in the services sector have established large overseas positions, for instance, in 2009/10, while the largest stock of overseas assets was held by Bharti Airtel Ltd., Silverline Technologies Ltd, H O V Services Ltd., Four Soft Ltd. and Mindteck (India) Ltd. had a foreign investment intensity of over 80%. Further, Bharti Airtel Ltd., Reliance Communications Ltd., Tata Communications Ltd., United Breweries Holdings Ltd. (transport, storage and communications), Tata Consultancy Services Ltd., Wipro Ltd., Infosys Ltd., HCL Technologies Ltd., Satyam Computer Services Ltd., Mphasis Ltd., Tech Mahindra Ltd. (business services, the high-skill intensive category of services) list in the largest home-based TNCs for 2010 (WIR, *Investment Country Profiles*, India, UNCTAD, 2013). Tata Consultancy Services Ltd., Infosys Ltd., Wipro Ltd., Tech Mahindra Ltd., HCL Technologies Ltd. were also the largest service exporters in 2010.

[35]NIC 58 is not included in the graphical display to bring out any distinct features of this group that is dominated by NIC 62 in terms of firm coverage.

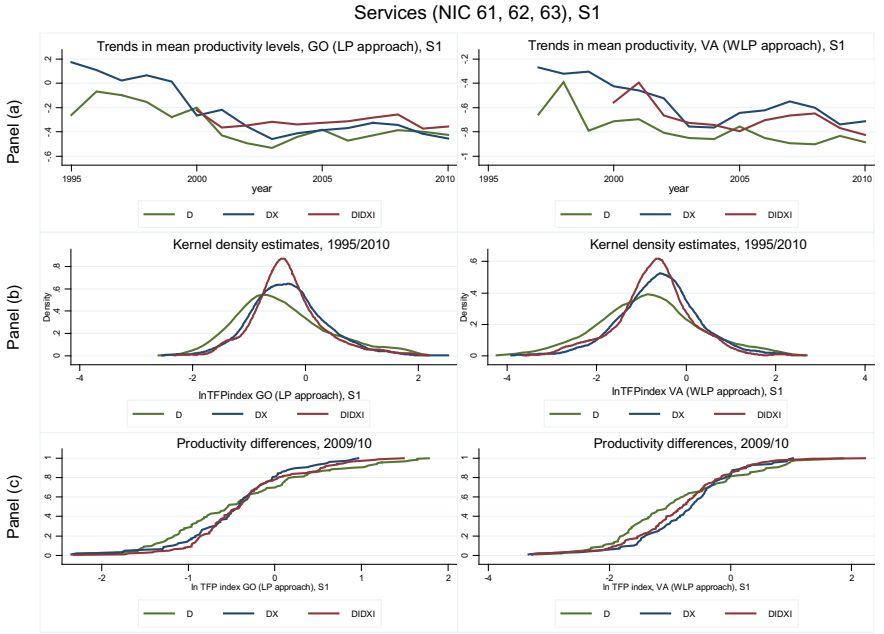

Fig. 5 Differences among firm types (DIDXI, DX, D) based on TFP estimates, comparing methods, services, S1, 1995–2010. *Source Prowess* 4 and own calculations

in mean productivity (*ln* TFP index)[36] for DIDXI, DX and D displays stronger differences under VA–WLP than under GO–LP.[37] While mean productivity (*ln* TFP index) for D consistently lies below that for DX for both productivity measures, the left column for GO shows that DIDXI lie above the other two categories for most time periods while the right column is more in line with BPS theorising.

Panel (b) shows that the density plots for DX lie to the right of that for D for both productivity measures although there is a small overlap with D towards the right tail. Further, due to the crisscrossing of DIDXI and DX plots, and the CDFs (for 2009/10) in panel (c), graphically, the dominance of one group over the others is not very obvious over the whole distribution, although CDFs in the left panel seemingly favour DIDXI over DX, while the right panel favours DX over DIDXI.[38]

DX versus D: Year-wise results of the KS test indicate that the hypothesis of identical distribution of productivity for DX relative to D can be rejected for most years of

[36]The mean productivity for the sample DIDXI is not shown for 1995–1999, as due to the small number of firms in this time period, the mean values are subject to larger variations.

[37]Due to the relatively small number of firms in the services sector for which productivity could be estimated in the 1995–1999 period, the broad trends for this sector are more meaningful for the 2001 onwards time period.

[38]The density plot for DXI (not shown in the plot) is close to that of DIDXI.

the sample period for both productivity estimation methodologies and specifications. The one-sided test supports the view that DX category has higher productivity than D, in line with several studies for other countries. The KS test methodology followed in this study, however, does not allow for comparison of the productivity advantage of exporters of services vis-à-vis that of exporters of manufactures over domestic producers.

Minondo (2014) refers to Francois and Hoekman (2010) in making the argument that since services face much larger barriers to trade than manufactures, as they require the coincidence of suppliers and customers in space and time, it is expected that there would be a very strong link between exporting and productivity in services. However, a weaker link is expected in services where the movement of the supplier is inherent to the activity, as in transport services, and in services that can be supplied through the internet (e.g. call centres), or whose final output can be digitized and transferred through the Internet. As the present sample under services mainly consists of IT, this reasoning could be relevant. Based on the same methodology, results for services and manufacturing firms are qualitatively similar. In such cases, Breinlich and Criscuolo (2011) note that the existing goods trade models might be suitable for firm-level services trade as well.[39]

DIDXI versus DX: The equality of productivity distributions for these two categories could not be rejected at standard significance levels.[40] Unlike manufacturing where there are significant productivity differentials between DIDXI and DX (especially under VA), and BPS wherein TFP distribution for DX dominates over that for DXI,[41] in the present study, the productivity ranking of DX lying to the right of DIDXI indicating stochastic dominance could not be established in the information and communication sector.

For 2009/10, the VA approach in Panel (c), however, suggests DX domination, although not for the entire distribution. Part of the difference in results between BPS and the present study could be due to production function specification. For software services, BPS adopt a two-input GO production function. On another view, the HMY model deals with horizontal OFDI alone, motivated by market-seeking considerations. As a large fraction of OFDI by Indian IT firms goes to developed countries, OFDI could also be guided by vertical or complex integration strategies, related to the internationalization of R&D with firms investing abroad for technology-seeking motives, or agglomeration economies (due to clustering in specific regions). These considerations could also have a bearing on the observed relationship between

[39] BPS compares DXI to DX but not DX to D.

[40] Comparisons of DIDXI with DX and D, respectively, for 1995–99 are not presented due to the small number of DIDXI firms in the same time period.

[41] Two key characteristics that identify software service companies are near-zero transportation costs for software services that are posited to encourage production at home while software services being non-commoditized, with a range of intangible characteristics, are posited to make customers feel it is risky to buy software services from a distant country, considered to encourage FDI.

firm productivity and foreign involvement. These results also differ from Engel and Procher (2012) that finds HMY ranking for French firms in manufacturing, wholesale and retail trade, transport, financial intermediation, real estate, IT services and services for companies. **DIDXI versus D**: Even while DX does not differ significantly from DIDXI, the KS test confirms that DIDXI is significantly more productive than D. These results support the findings of Tanaka (2011) for Japan. Figure 6 for S2 conveys a similar picture, although several firms that are now classified as D raise the productivity of this category, so that its domination by DIDXI and DX is now less clear-cut, more so in the left panel.

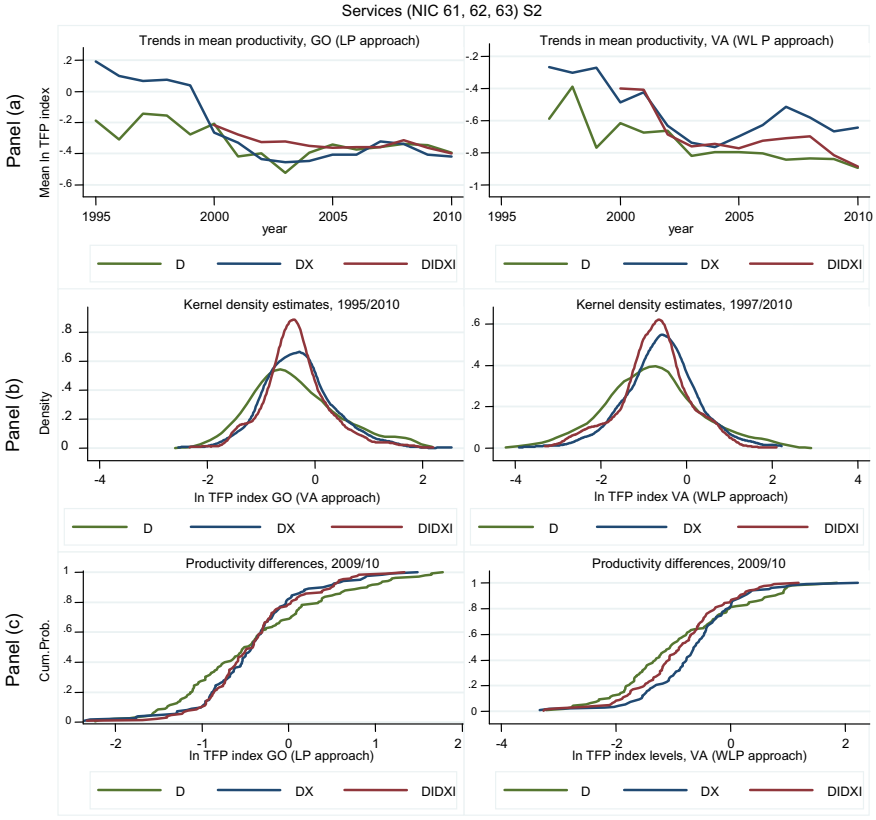

Fig. 6 Differences among firm types (DIDXI, DX, D), based on TFP estimates, comparing methods, services, S2, 1995–2010. *Source Prowess* 4 and own calculations

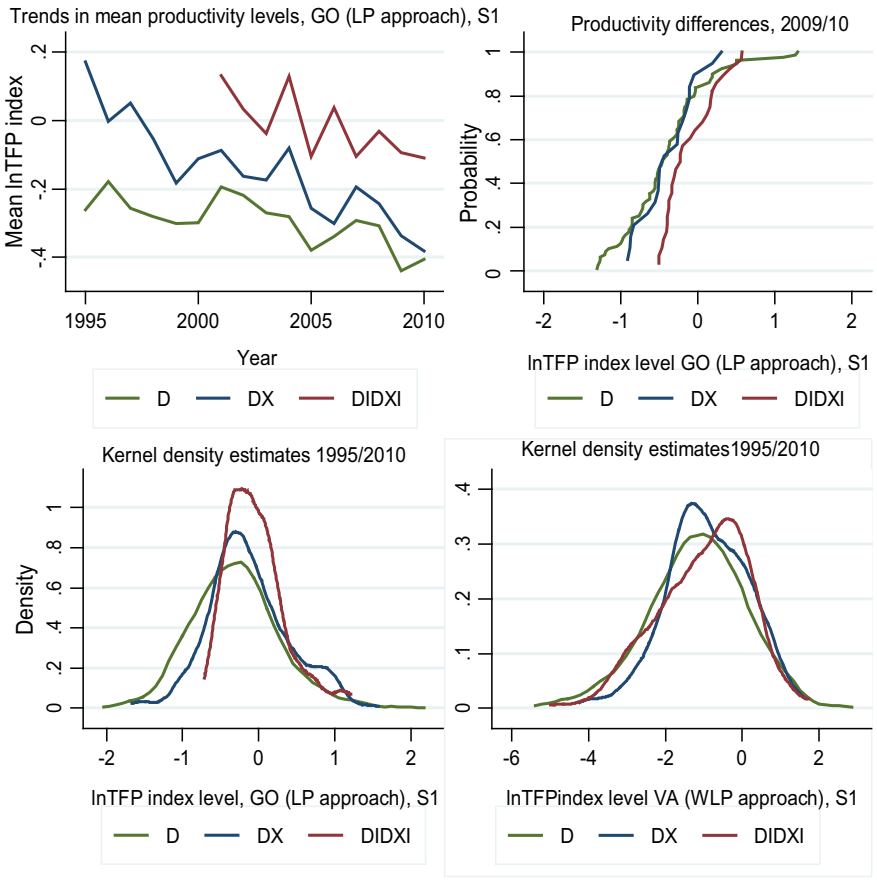

Fig. 7 Differences among firm types (DIDXI, DX, D), based on TFP estimates, comparing methods, construction, S1, 1995–2010. *Source Prowess* 4 and own calculations

7.2.3 *Construction Sector*[42]

Figure 7 illustrates productivity comparisons for construction firms, for S1. Due to the relatively small number of outward investing firms from this sector, results are not presented for S2. For comparison, VA–WLP is shown in the right bottom panel only. Trends in mean productivity for the three firm categories suggest an ordering of

[42]Construction firms involved in exports and outward investment belong to industries such as 'construction of buildings carried out on own-account basis or on a fee or contract basis, construction and maintenance of motorways, streets, roads, other vehicular and pedestrian ways, highways, bridges, tunnels and subways, construction of utility projects n.e.c., and other civil engineering projects n.e.c.' (based on *Prowess4*). For 2010, Larsen and Toubro Ltd., Punj Lloyd Ltd. and Gammon India Ltd. are the largest home-based TNCs from the construction sector (WIR, UNCTAD 2013).

DIDXI, DX and D, respectively.[43] Density plot for DX lies to the right of D for both productivity measures, and for DIDXI even further to the right (for GO–LP) although there is an overlap with DX towards the right tail. The CDFs (for 2009/10) suggest the stochastic dominance of DIDXI. Comparison of DIDXI with DX for VA–WLP is less marked. Both productivity measures suggest the productivity advantage of DIDXI over D.

DX versus D: For some years, the two-sided and one-sided test for both productivity specifications supports the view that DX firms have higher productivity than D. **DIDXI versus DX**: Similar results are revealed in the comparison of DIDXI/DXI with DX. **DIDXI versus D**: For several years in the sample period, the KS test confirms that DIDXI is significantly more productive than D, but mainly for GO–LP. As the sample size under VA–WLP is smaller than that under GO–LP, the number of DIDXI firms in the WLP sample may be considerably less for a meaningful comparison of the two productivity methods. The results for the construction sector in the present study are at odds with those for construction firms in France in the study of Engel and Procher (2012) that does not find any clear productivity patterns between foreign investors, exporters and domestic firms. Engel and Procher (2012, pp. 15–16) point out:

> The two-sided KS test regarding the equality of distribution between DX and DI and both one-sided tests between D and DX (i.e., D < DX and DX > D) do not lead to the null hypotheses being rejected. Two considerations might help to explain these results. The construction and building market is dominated by local players and transport costs play a fundamental role because of typically bulk-sized and low-margin products. Closeness to the customer is of utmost importance. Hence, transnational expansion in this industry might be governed by different motivations compared to other industries. In addition, temporally project-oriented co-operations with the involvement of a large number of consortium partners are quite common in the construction industry. Here, sunk costs of OFDI might be comparatively low so that the difference between exporters and multinational becomes negligible.

Results of this study are consistent with HMY (and HR) models for most but not all years in the sample period. In 2009/10, for instance, according to the RBI dataset on 'Overseas Investments by Indian Companies',[44] construction firms have mainly invested in several developing countries with major investments in Mauritius (likely due to round-tripping), United Arab Emirates, Spain, Cyprus and Singapore. These infrastructure and real estate developments indicate that Indian overseas investors could be providing appropriate level technology at a reasonable cost, an idea associated with an earlier literature (e.g. UNCTAD, 1993) on the ownership advantages of firms from developing countries and as in the product cycle model of Vernon (1966).

[43] Over 1995–2010, the estimated average annual growth rate of the real physical capital stock (real NFA) for this sector is comparatively higher (Chawla 2015). If output has not risen in accordance, higher growth of the capital input could partly explain the downward slant in the mean TFP over the years. The yearly fluctuations in mean productivity could reflect the small sample size in each category for which the mean has been computed.

[44] https://rbi.org.in/Scripts/Data_Overseas_Investment.aspx.

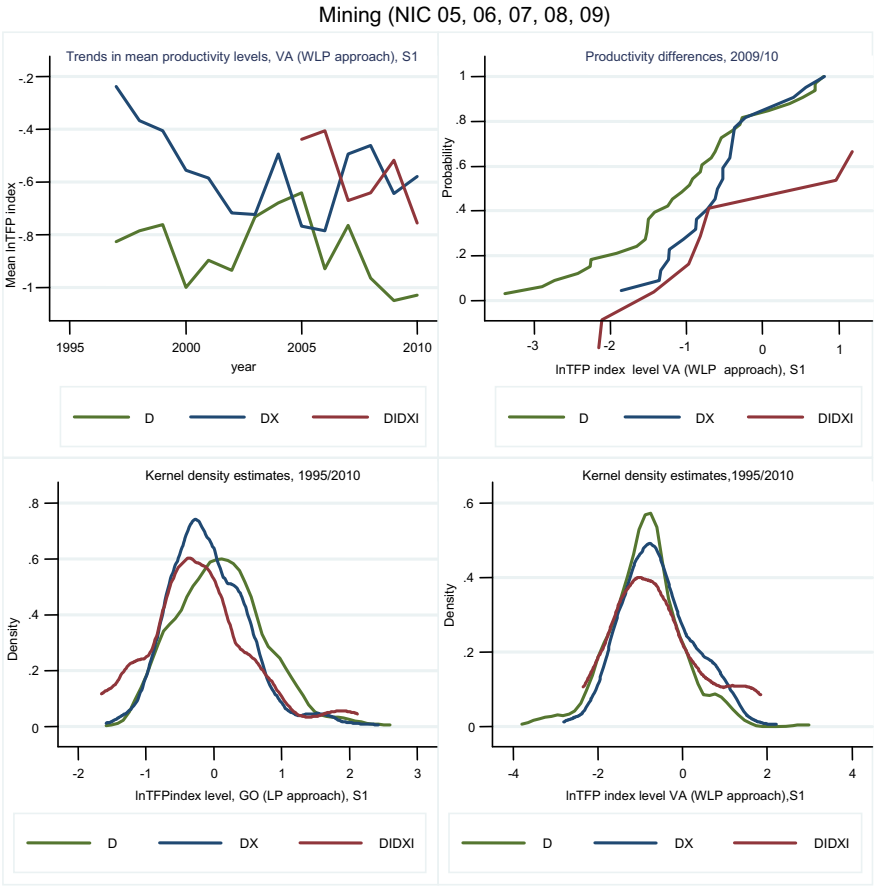

Fig. 8 Differences among firm types (DIDXI, DX, D), based on TFP estimates, comparing methods, mining, S1, 1995–2010. *Source Prowess* 4 database and own calculations

7.2.4 Mining Sector

Overseas investments (mainly acquisitions of oil and gas assets) by Indian natural resource-based firms have mainly been directed at the extractive sector of Africa and elsewhere as a source for energy and raw material supplies.[45] Figure 8 shows that the trend of mean productivity for DX is higher for most years than for D, and

[45]DX and DXI firms in the mining sector belong to industries such as 'on shore extraction of crude petroleum and natural gas, mining of iron and other ores, quarrying of granite, mining of clays, salt mining, quarrying, screening, etc., extraction and agglomeration of peat, services incidental to off shore oil extraction, and other operations relating to mining and agglomeration of hard coal' (e.g. Oil and Natural Gas Corp. Ltd. (ONGC), Sterlite Industries (India) Ltd.). TFP estimates for ONGC could, however, not be obtained as its raw material data is not available. Even though the firm has large overseas stakes in exploration, it is thus not part of the sample of firms.

although that of DIDXI and DX categories is not perceptibly higher or lower than the other, that for DIDXI is higher than that for the D category. Kernel density plots show that GO–LP suggests that the productivity distribution of D lies to the right of DX that in turn lies to the right of DIDXI. The VA specification, however, shows no clear pattern except in the right tail. CDF based on VA–WLP also suggests that DX dominates the other two categories but not over the entire distribution.

Results of the KS test for the three firm categories (reported in Chawla 2015) indicate that in comparison to the other three sectors considered for analysis, the number of outward investing firms is considerably smaller in mining. DX that includes relatively more observations is thus more indicative of the productivity characteristics of the internationalized firms. Although the fact that there are only a small number of outward investing firms in mining severely restricts checking the validity of HMY (and HR) models, the hypothesis may nevertheless not hold good as the underlying motives for OFDI may be mixed, resource-driven as well as market-driven. **DX versus D**: From 2003 onwards, GO–LP supports the view that the productivity distribution of DX dominates that of D. For the years for which the two-sided KS test hypothesis can be rejected for VA–WLP, the one-sided test favours the FOSD of DX over D. **DIDXI versus DX**: The number of firms in the DIDXI category is fewer than five before 2005 that restricts the acceptance of the KS test results. From 2005 onwards, the KS test does not support the hypothesis that the productivity distributions of DIDXI and DX differ, for both productivity specifications. **DIDXI versus D**: Similar considerations as in the comparison above are relevant here as well. From 2005 onwards, for GO–LP, the null hypothesis of the two-sided KS test can be rejected for only 3 years, for which the one-sided test supports FOSD of D over DIDXI. Part of the explanation for this result could be identification concerns associated with a GO production function. With VA–WLP no clear-cut differences between productivity distributions of DIDXI and D could be established.

7.3 Robustness Analysis

For the manufacturing sector, this section discusses whether results are sensitive to the choice of data set, choice of TFP measure (GO vs. VA) and choice of methodology of production function estimation, respectively. First, examining the choice of data set (comparing S1 and S2), Chawla (2015) and Figs. 3 and 4, it is observed that irrespective of whether LP or WLP are employed, the same pattern of productivity rankings is obtained. Results are thus robust to covering the data set that includes firms with small overseas positions. Second, in examining the choice of TFP measure, even for the same methodology of production function estimation (say, LP), comparing distributions based on GO specification (Fig. 3, left-hand panel) and VA specification (Fig. 9) shows that the 'pecking order' as in HMY is obtained for both specifications of the production function although VA-based distributions suggest stronger differences among firm categories. Results are thus robust to the choice of TFP measure (GO vs.VA). Third, for the same productivity measure (say, VA) and specification (say,

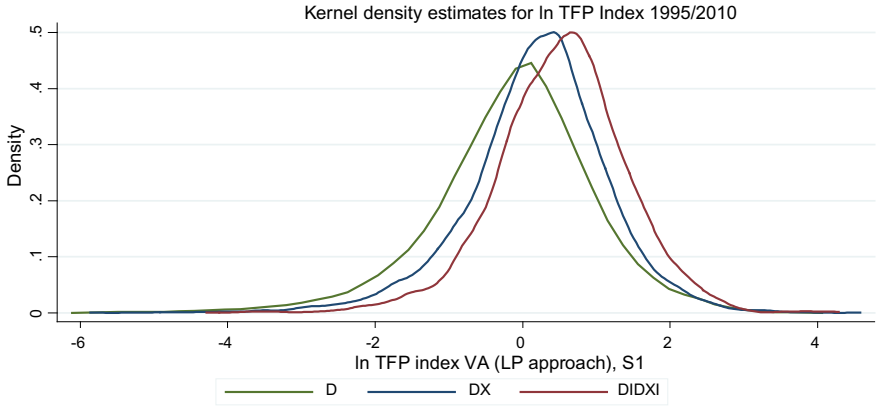

Fig. 9 Kernel density estimates for *ln* TFP index, VA specification (for LP), S1, 1995–2010. *Source Prowess* 4 and own calculations

S1) comparing distributions based on LP and WLP approaches (Fig. 9, and Fig. 3, right-hand panel) confirms that results are robust to choice of method of production function estimation.

8 Conclusions

Using firm-level data for the period 1995 to 2010, based on two methodologies and two specifications of the production function to estimate TFP, non-parametric methods were used to examine the nature of productivity differentials between firm categories (based on foreign involvement). Attempts were also made to refine the criterion for firm classification as OFDI firms. For firms in the *manufacturing* sector, it was found that overseas investing firms (DIDXI) are more productive than the other firm categories, while pure export firms (DX) have intermediate productivity levels. These results are in agreement with such results from similar studies for several countries including Tian and Yu (2012) for China that also finds a positive correlation between firm productivity and OFDI. Cross-sectional findings of a positive link between firm productivity and foreign involvement could be due to the most productive firms self-selecting into foreign markets, and/or learning effects through foreign engagements.

Although DIDXI and DX categories dominate over the purely domestic firms (D) for both production function specifications, the gross output (GO) specification based on Levinsohn and Petrin 2003 (LP) approach suggests quantitatively smaller differences in productivity between firm categories. The value-added (VA) specification based on Wooldridge 2009 (WLP) approach thus validates the Helpman et al. 2004 (HMY), and Head and Ries 2003 (HR) hypothesis more strongly than the GO specification (based on LP approach). These results compared with Gandhi et al.

(2013) and Rivers (2013) show that accounting for intermediate inputs using the GO specification substantially reduces the estimated productivity advantage of exporters over non-exporters. This suggests that controlling the 'value-added bias' is important and it is not sufficient to control only for the 'transmission bias'.

Further, productivity differentials vary, sometimes considerably by two-digit industry/industry groups. In manufacturing, the HMY (and HR) pattern obtains, more so in textiles (NIC 13), coke and refined petroleum products, chemicals (NIC 19, 20), pharmaceuticals (NIC 21), basic metal and fabricated metal (NIC 24, 25), and machinery and equipment n.e.c. (NIC 28) than in the rest. Also, although similar patterns obtain, yet graphically, differences in firm categories are less pronounced for S2 than for S1.[46]

For the *services* sector, for both productivity approaches and specifications, DX firms were found to have higher productivity than D firms as found in several other studies. However, unlike the results for the manufacturing sector and unlike the findings of Bhattacharya et al. 2012 (BPS) for software services, the study did not find any clear differences in firm productivity between pure exporters (DX) and OFDI firms that also export (DIDXI). The stochastic dominance of DX over DIDXI as suggested for software services in BPS could not be established. This suggests that Indian IT firms' OFDI that is mainly located in developed countries could also be guided by vertical or complex integration strategies, related to the technology-seeking motives and agglomeration economies (due to clustering in specific regions). DIDXI firms, however, come out to be more productive than the D category. Furthermore, expanding the sample of outward-oriented firms to include firms with small international positions does not qualitatively alter the nature of the relationship between firm productivity and foreign involvement.

For the *construction* sector, unlike Engel and Procher (2012) that does not find any clear productivity patterns between foreign investors (DI), exporters (DX) and domestic firms (D), the above results, presented for S1 only, suggest the HMY (and HR) ordering of DIDXI, DX and D, respectively, for most years in the sample period. This could mainly reflect advantages built at home. DX dominate D, DIDXI dominate DX and DIDXI dominate D. Demirbas et al. (2013) do not include the construction firms in their sample as they point out that the concepts of exporting versus OFDI are blurred in the construction industry. Further, as a limitation of the present exercise, Hall and Mairesse (1995) note that the concepts of both labour productivity and total factor productivity are better measured and more meaningful in manufacturing than in other sectors such as construction and business services.

For firms in the *mining* sector, graphically, the GO specification (based on LP approach) and VA specification (based on WLP approach) suggest a different ranking pattern. As the number of outward investing firms is considerably smaller in

[46]Specification S1: DX if export intensity is positive, DIDXI if export intensity is positive and foreign investment intensity is positive. Specification S2: DX if export intensity $\geq$1%, DXI if export intensity $\geq$1% and foreign investment intensity $\geq$1%, DI non-exporter firms with foreign investment intensity $\geq$1%.

mining, the DX category that includes relatively more observations is more indicative of the productivity characteristics of internationalized firms. Also, the underlying motives for OFDI in mining may be both resource-driven and for market access. For both production function specifications, while from 2003, DX dominate D, yet the dominance of DIDXI over DX could not be established. From 2005 onwards, for the GO specification (based on LP approach) for only 3 years, it is suggested that D dominate DIDXI. The VA specification (based on WLP approach) could not establish any clear-cut differences between the productivity distribution of DIDXI and D firms.

Qualified support is thus found for the 'pecking order' as predicted by heterogeneous firms' theories. As the productivity and other firm characteristics of OFDI firms that initially start small are observed to be similar to those with larger positions abroad, if a constraint on financing is found to be an issue for these firms, the government should support a more liberal financial system for OFDI that could also aim specifically at firms with initially small OFDI. EXIM Bank (2017), for instance, indicates that there is a range over which it is possible to increase firms' OFDI intensity and increase the benefits from OFDI.

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Appendix A: Additional Tables

See Tables 4 and 5.

Appendix B: Additional Figure

See Fig. 10.

Table 4 Descriptive statistics by foreign involvement (after data cleaning), manufacturing, 1995–2010

	S1								S2							
	D		DX		DI		DXI		D		DX		DI		DXI	
Variable	Median	IQ range	Median	IQ range	Median	IQ range	Median	IQ range	Median	IQ range	Median	IQ range	Median	IQ range	Median	IQ range
Ln TFP index	–.028	–.189/.139	.0005	–.151/.166	.068	–.078/.294	.061	–.114/.227	–.018	–.176/.150	–.0004	–.155/.165	.150	–.051/.360	.042	–.149/.189
Ln TFP	.170	–.04/.43	.249	.027/.489	.259	.048/.473	.306	.06/.541	.181	–.029/.443	.257	.029/.496	.343	.063/.543	.255	.049/.474
Sales (in Rs. cr)	21	7/ 55	65	24/173	117	30/772	385	133/1027	26	9/74	69	25/191	212	41/961	408	121/1137
Total assets (in Rs. cr)	18	8/44	60	24/166	143	41/610	414	145/1183	22	9/61	64	25/189	189	50/731	541	141/1421
R&D expenditure (in Rs. cr)	.1	.04/.4	.4	.1/1.4	1	.2/3	2.7	.7/13	.2	.1/.7	.5	.1/2	3	.44/8	4	.8/23
Export intensity (in %)	–	–	8.5	2/28	–	–	17.6	6/42	0	0/0	13	5/35	0	0/.4	22	9/48
Foreign investment intensity (in %)	–	–	–	–	1	.4/4	.9	.1/.4	.2	0/.5	.1	0/.4	3	1/8	4.4	2/10
Output (in 1999/00 rupees)	19	7/49	59	23/157	103	25.4/560	314	112/810	24	8/65	62	23/171	198	31/773	325	100/888
Value added (in 1999/00 rupees)	5	2/13	17	6/52	33	8.5/15	111	37/307	6	2/19	18	6/57	52	15/297	122	34/336
R and D stock (in 1999/00 rupees)	0	0/0	0	0/.3	0	0/.1	.4	0/5	0	0/0	0	0/.3	0	0/.9	.4	0/8
Number of employees (imputed)	127	46/381	450	171/1227	529	216/1569	2074.5	776/5105	165	56/498	484	176/135	704	243/300	2031	744/5593
No. of observations	24,383		29,940		206		3,169		29,580		26,440		227		1,451	

Note Specification S1: DX if export intensity is positive, DIDXI if export intensity is positive and foreign investment intensity is positive. Specification S2: DX if export intensity ≥1%, DXI if export intensity ≥1% and foreign investment intensity ≥1%, DI non-exporter firms with foreign investment intensity ≥1%

Source Prowess 4 and own calculations

Table 5 Productivity level differences between outward investors, exporters and domestic firms; hypotheses test statistics, manufacturing, S1, 1995–2010

				GO specification (based on LP approach), S1														
	DIDXI	DX	D	DIDXI	DX	D	DX versus. D			DIDXI versus. DX			DXI versus. DX			DIDXI versus. D		
Year	No. of observations			Mean (SD)	Mean (SD)	Mean (SD)	Two -way	DX >D	D >DX	Two -way	DIDXI >DX	DX >DIDXI	Two -way	DXI >DX	DX >DXI	Two -way	DIDXI> D	D >DIDXI
							D- Statistic (*p*-value)			*D- Statistic* (*p*-value)			*D- Statistic* (*p*-value)			*D-Statistic* (*p*-value)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
1995	11	1483	1009	−.060 (.212)	.021 (.275)	−.038 (.281)	.107 (.000)	.003 (.989)	−.107 (.000)	.184 (.768)	.184 (.476)	−.099 (.807)	.184 (.768)	.184 (.476)	−.099 (.807)	.189 (.738)	.119 (.734)	−.189 (.457)
1996	7	1657	1094	−.057 (.077)	.002 (.277)	−.047 (.277)	.103 (.000)	.005 (.960)	−.103 (.000)	.336 (.278)	.336 (.207)	−.252 (.412)	.336 (.278)	.336 (.207)	−.252 (.412)	.330 (.300)	.255 (.402)	−.330 (.220)
1997	12	1744	1169	.009 (.196)	−.022 (.268)	−.065 (.287)	.102 (.000)	.003 (.978)	−.102 (.000)	.242 (.367)	.130 (.668)	−.242 (.247)	.242 (.368)	.129 (.669)	−.242 (.247)	.317 (.114)	.070 (.888)	−.317 (.092)
1998	20	1773	1261	−.064 (.195)	−.034 (.284)	−.071 (.288)	.057 (.014)	.000 (1.000)	−.057 (.008)	.125 (.868)	.125 (.536)	−.082 (.764)	.125 (.868)	.125 (.536)	−.082 (.764)	.119 (.905)	.089 (.729)	−.119 (.569)
1999	19	1850	1384	−.127 (-248)	−.047 (.287)	−.067 (.296)	.048 (.044)	.002 (.994)	−.048 (.024)	.261 (.100)	.261 (.076)	−.064 (.853)	.246 (.204)	.246 (.146)	−.057 (.899)	.230 (.194)	.230 (.136)	−.073 (.817)
2000	57	1816	1498	−.022 (.322)	−.036 (.290)	−.077 (.287)	.071 (.000)	.002 (.993)	−.071 (.000)	.100 (.572)	.084 (.457)	−.100 (.329)	.112 (.503)	.106 (.333)	−.112 (.293)	.121 (.334)	.058 (.684)	−.121 (.199)
2001	160	1771	1471	−.015 (.278)	−.034 (.295)	−.063 (.298)	.042 (.099)	.000 (.999)	−.042 (.054)	.075 (.337)	.022 (.865)	−.075 (.189)	.069 (.496)	.020 (.891)	−.069 (.275)	.109 (.052)	.010 (.968)	−.109 (.032)
2002	206	1772	1508	−.004 (.274)	−.029 (.288)	−.049 (.304)	.031 (.386)	.003 (.983)	−.031 (.203)	.101 (.037)	.011 (.950)	−.101 (.023)	.100 (.054)	.012 (.951)	−.100 (.033)	.105 (.030)	.011 (.951)	−.105 (.018)
2003	228	1950	1664	.015 (.293)	−.016 (.284)	−.031 (.305)	.036 (.176)	.022 (.416)	−.036 (.094)	.086 (.078)	.019 (.855)	−.086 (.046)	.088 (.089)	.020 (.859)	−.088 (.053)	.114 (.011)	.009 (.966)	−.114 (.007)
2004	245	2039	1751	.025 (.295)	.005 (.291)	−.030 (.332)	.066 (.000)	.005 (.941)	−.066 (.000)	.081 (.097)	.031 (.652)	−.081 (.056)	.084 (.085)	.032 (.649)	−.085 (.050)	.121 (.003)	.009 (.962)	−.121 (.002)
2005	275	2067	1880	.061 (.306)	.043 (.286)	−.004 (.325)	.079 (.000)	.007 (.907)	.079 (.000)	.074 (.114)	.041 (.426)	−.079 (.065)	.077 (.113)	.047 (.353)	−.077 (.065)	.134 (.000)	.004 (.989)	−.134 (.000)
2006	342	2108	1903	.080 (.294)	.060 (.300)	.016 (.327)	.081 (.000)	.011 (.776)	−.081 (.000)	.069 (.101)	.008 (.956)	−.069 (.059)	.067 (.130)	.010 (.936)	−.067 (.074)	.135 (.000)	.011 (.931)	.135 (.000)
2007	403	2093	1882	.108 (.282)	.086 (.299)	.039 (.330)	.099 (.000)	.010 (.821)	−.099 (.000)	.066 (.089)	.015 (.857)	−.066 (.050)	.063 (.126)	.017 (.829)	−.063 (.071)	.147 (.000)	.024 (.669)	−.147 (.000)
2008	447	2064	1792	.122 (.312)	.102 (.305)	.052 (.347)	.096 (.000)	.013 (.701)	−.096 (.000)	.063 (.092)	.019 (.747)	−.063 (.052)	.051 (.280)	.026 (.614)	−.051 (.153)	.131 (.000)	.021 (.715)	−.131 (.000)
2009	471	1983	1652	.107 (.325)	.095 (.318)	.060 (.345)	.061 (.002)	.012 (.770)	−.061 (.001)	.065 (.067)	.021 (.711)	.065 (.038)	.067 (.063)	.019 (.760)	−.067 (.036)	.097 (.002)	.013 (.870)	−.097 (.001)
2010	472	1771	1464	.124 (.333)	.107 (.307)	.066 (.330)	.065 (.002)	.006 (.926)	−.065 (.001)	.065 (.069)	.033 (.442)	−.065 (.039)	.060 (.136)	.030 (.525)	−.060 (.076)	.107 (.000)	.001 (.998)	−.107 (.000)

(continued)

Table 5 (continued)

	VA specification (based on W–LP approach), SI											
	DIDXI	DX	D	DX versus. D			DIDXI versus. DX			DIDXI versus. D		
Year	Mean (SD)	Mean (SD)	Mean (SD)	Two –way	DX >D	D >DX	Two –way	DIDXI >DX	DX >DIDXI	Two –way	DIDXI >D	D >DIDXI
				D– Statistic(*p*–value)			*D– Statistic*(*p*–value)			*D–Statistic*(*p*–value)		
(1)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)
1997	–.854	–1.133	–1.459	.180	.000	–.180	.264	.124(	–.264	.417	.064	–.417
	(.617)	(.920)	(.944)	(.000)	(.999)	(.000)	(.499)	(.783)	(.329)	(.069)	(.937)	(.064)
1998	–1.195	–1.187	–1.542	.179	.000	–.179	.180	.180	–.129	.283	.054	–.283
	(.633)	(.934)	(1.02)	(.000)	(.999)	(.000)	(.541)	(.335)	(.568)	(.088)	(.905)	(.069)
1999	–1.570	–1.242	–1.570	.191	.002	–.191	.277	.277	–.053	.171	.171	–.168
	(1.00)	(.946)	(.930)	(.000)	(.993)	(.000)	(.135)	(.102)	(.918)	(.691)	(.422)	(.432)
2000	–1.048	–1.213	–1.623	.220	.001	–.220	.181	.058	–.181	.329	.002	–.329
	(.978)	(.881)	(.993)	(.000)	(.998)	(.000)	(.088)	(.744)	(.060)	(.000)	(1.00)	(.000)
2001	–.881	–1.226	–1.545	.152	.000	–.152	.209	.004	–.209	.358	.000	–.358
	(.742)	(.917)	(.954)	(.000)	(1)	(.000)	(.000)	(.995)	(.000)	(.000)	(1.00)	(.000)
2002	–.924	–1.206	–1.509	.170	.000	–.170	.193	.003	–.193	.329	.001	–.329
	(.816)	(.900)	(.956)	(.000)	(.999)	(.000)	(.000)	(.996)	(.000)	(.000)	(.999)	(.000)
2003	–.883	–1.129	–1.437	.165	.002	–.165	.208	.011	–.208	.316	.010	–.316
	(.971)	(.870)	(.915)	(.000)	(.991)	(.000)	(.000)	(.949)	(.000)	(.000)	(.963)	(.000)
2004	–.821	–1.071	–1.366	.155	.003	–.155	.156	.009	–.156	.292	.006	–.292
	(.945)	(.948)	(.946)	(.000)	(.988)	(.000)	(.000)	(.968)	(.000)	(.000)	(.983)	(.000)
2005	–.727	–.944	–1.316	.179	.000	–.179	.139	.009	–.139	.316	.003	–.316
	(.975)	(.914)	(1.00)	(.000)	(1)	(.000)	(.000)	(.957)	(.000)	(.000)	(.993)	(.000)
2006	–.581	–.888	–1.249	.178	.001	–.178	.158	.000	–.158	.327	.000	–.327
	(.855)	(.902)	(1.04)	(.000)	(.995)	(.000)	(.000)	(1.00)	(.000)	(.000)	(1.00)	(0.00)
2007	–.519	–.817	–1.199	.208	.000	–.208	.166	.000	–.166	.361	.000	–.361
	(.839)	(.924)	(.955)	(.000)	(.999)	(.000)	(.000)	(1.00)	(.000)	(.000)	(1.00)	(0.00)
2008	–.476	–.773	–1.207	.224	.000	–.224	.173	.001	–.173	..379	.000	–.379
	(.885)	(.911)	(1.01)	(.000)	(.999)	(.000)	(.000)	(.998)	(.000)	(.000)	(.999)	(.000)
2009	–.519	–.828	–1.207	.186	.002	–.186	.165	.0.00	–.165	.329	.000	–.329
	(.857)	(.935)	(1.02)	(.000)	(.992)	(.000)	(.000)	(1.00)	(.000)	(.000)	(1.00)	(.000)
2010	–.455	–.758	–1.195	.210	.000	–.210	.186	.003	.186	.362	.000	–.362
	(.865)	(.855)	(1.02)	(.000)	(1)	(.000)	(.000)	(.994)	(.000)	(.000)	(1.00)	(.000)

Notes Corrected *p*-values in parentheses. Two-way stands for combined K-S
Source Prowess 4 and own calculations

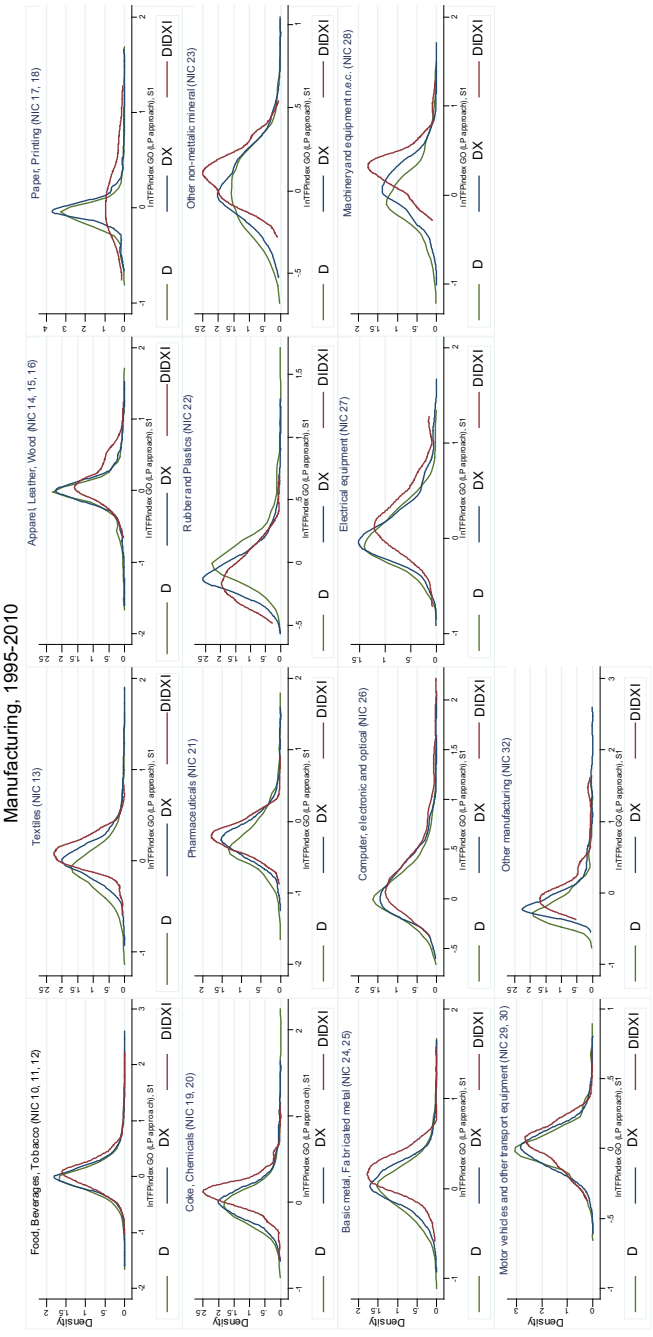

Fig. 10 Density plots of *ln* (TFP) index at two-digit level, manufacturing, 1995–2010. The distribution for DIDXI firms is more shifted to the right for Machinery and equipment n.e.c. (NIC 28). The figure shows the same direction of result for all industries except rubber and plastics (NIC 22). *Source Prowess* 4 and own calculations

References

Ackerberg, D., Caves, K., & Frazer, G. (2015). Identification properties of recent production function estimators. *Econometrica, 83*(6), 2411–2451.

Arnold, J. M., & Hussinger, K. (2010). Exports versus FDI in German manufacturing: firm performance and participation in international markets. *Review of International Economics, 18*(4), 595–606.

Aw, B. Y., & Lee, Y. (2008). Firm heterogeneity and location choice of Taiwanese multinationals. *Journal of International Economics, 75*(1), 167–179.

Bartelsman, E. J., & Doms, M. (2000). Understanding productivity: lessons from longitudinal microdata. *Journal of Economic Literature, 38*(3), 569–594.

Baum, C. F., Schaffer, M. E., & Stillman, S. (2012). IVREG2: Stata module for extended instrumental variables/2SLS and GMM estimation. Retrieved March 7, 2019, from http://ideas.repec.org/c/boc/bocode/s425401.html.

Bernard, A. B., & Jensen, J. B. (1995). Exporters, jobs, and wages in U.S. manufacturing: 1976–1987. *Brookings Papers on Economic Activity, Microeconomics, 1,* 67–119.

Bernard, A. B., & Jensen, J. B. (1999). Exceptional exporter performance: Cause, effect, or both? *Journal of International Economics, 47*(1), 1–25.

Bernard, A. B., & Jensen, J. B. (2004). Why some firms export. *The Review of Economics and Statistics, 86*(2), 561–569.

Bernard, A. B., Jensen, J. B., Redding, S. J., & Schott, P. K. (2007a). Firms in international trade. *Journal of Economic Perspectives, 21*(3), 105–130.

Bernard, A. B., Jensen, J. B., Redding, S. J., & Schott, P. K. (2012). The empirics of firm heterogeneity and international trade, NBER working paper 17627.

Bernard, A. B., Eaton, J., Jensen, J. B., & Kortum, S. (2003). Plants and productivity in international trade. *American Economic Review, 93*(4), 1268–1290.

Bernard, A. B., Redding, S. J., & Schott, P. K. (2007b). Comparative advantage and heterogeneous firms. *Review of Economic Studies, 74,* 31–66.

Bhattacharya, R., Patnaik, I., & Shah, A. (2012). Exports versus FDI in services. *The World Economy, 35*(1), 61–78.

Bogheas, S., & Görg, H. (2008). Organizational forms for global engagement of firms. Kiel Institute for the World Economy working paper 1448. Retrieved March 7, 2019, from https://www.econstor.eu/bitstream/10419/24843/1/579103102.PDF.

Brainard, S. L. (1997). An empirical assessment of the proximity-concentration tradeoff between multinational sales and trade. *American Economic Review, 87,* 520–544.

Breinlich, H., & Criscuolo, C. (2011). International trade in services: A portrait of importers and exporters. *Journal of International Economics, 84*(2), 188–206.

Castellani, D., & Zanfei, A. (2007). Internationalisation, innovation and productivity: How do firms differ in Italy? *The World Economy, 30*(1), 156–176.

Centre for Monitoring Indian Economy (CMIE) Pvt. Ltd. (2011). *Prowess Version 4* (*Prowess4*). http://prowess.cmie.com.

Chang, H.-H., & van Marrewijk, C. (2013). Firm heterogeneity and development: Evidence from Latin American countries. *The Journal of International Trade and Economic Development: An International and Comparative Review, 22*(1), 11–52.

Chawla, I. (2012). A note on the methodology for measuring labour input from company databases. *Economic and Political Weekly, 47*(3), 69–75.

Chawla, I. (2015). The internationalisation of Indian firms through outbound foreign direct investment: nature, determinants and developmental consequences. Ph.D. dissertation, Department of Economics, Delhi School of Economics, University of Delhi.

Chawla, I. (2019). Determinants of firms' initial decision to invest abroad: An application of 'survival' analysis to manufacturing firms in India. *Emerging Markets Finance and Trade, 55*(3), 562–583.

Clerides, S. K., Lach, S., & Tybout, J. R. (1998). Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico, and Morocco. *The Quarterly Journal of Economics, 113*(3), 903–947.

Damijan, J. P., Polanec, S., & Prašnikar, J. (2007). Outward FDI and productivity: Micro-evidence from Slovenia. *The World Economy, 30*(1), 135–155.

Delgado, M. A., Farinas, J. C., & Ruano, S. (2002). Firm productivity and export markets: A non-parametric approach. *Journal of International Economics, 57*(2), 397–422.

Demirbas, D., Patnaik, I., & Shah, A. (2013). Graduating to globalisation: A study of southern multinationals. *Indian Growth and Development Review, 6*(2), 242–259.

Engel, D., & Procher, V. (2012). Export, FDI and firm productivity. *Applied Economics, 44*(15), 1931–1940.

EXIM Bank. (2017). Export import bank of India. The internationalisation of Indian firms through outbound foreign direct investment: nature, determinants and developmental consequences. Occasional Paper No. 183. Retrieved March 7, 2019, from https://www.Eximbankindia.In/Assets/Dynamic/Pdf/Publication-Resources/Researchpapers/Hindi/82file.Pdf.

Federico, S., & Tosti, E. (2017). Exporters and importers of services: Firm-level evidence on Italy. *The World Economy*, 2078–2096.

Gandhi, A., Navarro, S., & Rivers, D. (2011). Does value added overstate productivity dispersion? Identification and estimation of the gross output production function. Retrieved March 7, 2019, from https://www.researchgate.net/publication/267714005_Does_Value_Added_Overstate_Productivity_Dispersion_Identification_and_Estimation_of_the_Gross_Output_Production_Function.

Gandhi, A., Navarro, S., & Rivers, D. (2013). On the identification of production functions: How heterogeneous is productivity?. CIBC working paper. http://www.ssc.wisc.edu/~agandhi/homepage/Amit_Gandhi_files/production_9_25_13_FULL.pdf, accessed on March 7, 2019.

Gattai, V. (2006). From the theory of the firm to FDI and internalisation: A survey. *Giornale degli Economisti e Annali di Economia, Bocconi University, 65*(2), 225–262.

Girma, S., Görg, H., & Strobl, E. (2004). Exports, international investment, and plant performance: Evidence from a non-parametric test. *Economics Letters, 83,* 317–324.

Goldar, B., Renganathan, V. S., & Banga, R. (2004). Ownership and efficiency in engineering firms: 1990–91 to 1999–2000. *Economic and Political Weekly, 39*(5), 441–447.

Goldar, B. (2016). Direction of outward FDI of Indian manufacturing firms: Influence of technology and firm productivity. In F. De Beule, & K. Narayanan (Eds.), *Globalization of Indian industries, productivity, exports and investment*. India Studies in Business and Economics (pp. 71–96). Springer.

Goldar, B., Chawla, I., & Behera, S. R. (2019). Trade liberalization and productivity of Indian manufacturing firms. *Indian Growth and Development Review*. https://doi.org/10.1108/IGDR-10-2018-0108.

Grublješić, T., & Damijan, J. P. (2011). Differences in export behaviour of services and manufacturing firms in Slovenia. *Economic and Business Review, 13*(1–2), 77–105.

Hall, B. H., & Mairesse, J. (1995). Exploring the relationship between R & D and productivity in French manufacturing firms. *Journal of Econometrics, 65,* 263–293.

Head, K., & Ries, J. (2003). Heterogeneity and the FDI versus export decision of Japanese manufacturers. *Journal of The Japanese and International Economies, 17*(4), 448–467.

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

Helpman, E., Melitz, M. J., & Yeaple, S. R. (2004). Export versus FDI with heterogeneous firms. *American Economic Review, 94*(1), 300–316.

ISGEP-International Study Group on Exports and Productivity. (2008). Understanding Cross-Country Differences in Exporter Premia: Comparable Evidence for 14 Countries. *Review of World Economics, 144*(4), 596–635.

Kelle, M., Kleinert, J., Raff, H., & Toubal, F. (2013). Cross-border and foreign-affiliate sales of services: Evidence from German micro-data. *The World Economy, 36*(11), 1373–1392.

Kimura, F., & Kiyota, K. (2006). Exports, FDI and the productivity of firms: Dynamic evidence from Japanese firms. *Review of World Economics, 142*(4), 695–719.
Kox, Henk L. M., & Rojas-Romagosa, H. (2010). Exports and productivity selection effects for Dutch firms. *De Economist, 158,* 295–322.
Krugman, P. R. (1979). Increasing returns, monopolistic competition, and international trade. *Journal of International Economics, 9*(4), 469–479.
Levinsohn, J., & Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. *Review of Economic Studies, 70,* 317–342.
Lööf, H. (2010). Are services different exporters? *Applied Economics Quarterly, 56*(1), 99–117.
Love, J. H., & Mansury, M. A. (2009). Exporting and productivity in business services: Evidence from the United States. *International Business Review, 18,* 630–642.
Markusen, J. R. (1984). Multinationals, multi-plant economies, and the gains from trade. *Journal of International Economics, 16,* 205–226.
Markusen, J. R. (1989). Trade in producer services and in other specialised intermediate inputs. *American Economic Review, 79*(1), 85–95.
Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica, 71,* 1695–1725.
Minondo, A. (2014). The link between export status and productivity in services: A firm-level analysis for Spain. *Bulletin of Economic Research, 66*(S1), S138–S146.
Narayanan, K., & Bhat, S. (2011). Technology sourcing and outward FDI: A study of IT industry in India. *Technovation, 31*(4), 177–184.
Nunnenkamp, P., Andrés, M. S., Vadlamannati, K. C., & Waldkirch, A. (2012). What drives India's outward FDI? *South Asian Journal of Macroeconomics and Public, Finance, 1*(2), 245–279.
Oldenski, L. (2012). Export versus FDI and the communication of complex information. *Journal of International Economics, 87*(2), 312–322.
Pavcnik, N. (2002). Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants. *Review of Economic Studies, 69,* 245–276.
Petrin, A., Poi, B., & Levinsohn, J. (2004). Production function estimation in stata using inputs to control for unobservables. *Stata Journal, 4*(2), 113–123.
Petrin, A.,White, T. K., & Reiter, J. P. (2011). The impact of plant-level resource reallocations and technical progress on U.S. macroeconomic growth. *Review of Economic Dynamics, 14,* 3–26.
Pradhan, G., & Barik, K. (1998). Fluctuating total factor productivity: Evidence from selected polluting industries. *Economic and Political Weekly, 33*, M-25–M-30.
Rivers, D.A. (2013). Are exporters more productive than non-exporters?. CIBC working paper 2. Retrieved March 8, 2019, from https://ir.lib.uwo.ca/cgi/viewcontent.cgi?article=1091&context=economicscibc.
Siddharthan, N. S., & Lal, K. (2004). Liberalisation, MNE and productivity of Indian enterprises. *Economic and Political Weekly, 39*(5), 448–452.
Tanaka, A. (2011). Multinationals in the services and manufacturing sectors: A firm-level analysis using Japanese data. REITI discussion paper 11-E-059. Retrieved March 8, 2019, from http://www.rieti.go.jp/jp/publications/dp/11e059.pdf.
Temouri, Y., Vogel, A., & Wagner, J. (2013). Self-selection into export markets by business services firms: Evidence from France, Germany and the United Kingdom. *Structural Change and Economic Dynamics, 25,* 146–158.
Thomas, R., & Narayanan, K. (2017). Determinants of outward foreign direct investment: A study of Indian manufacturing firms. *Transnational Corporations, 24*(1), 9–26.
Tian, W., & Yu, M. (2012). Outward foreign direct investment and productivity: Firm-level evidence from China. *China Economic Quarterly, 11,* 383–408.
Tomiura, E. (2007). Foreign outsourcing, exporting, and FDI: A productivity comparison at the firm level. *Journal of International Economics, 72*(1), 113–127.
United Nations. (1993). *Transnational corporations from developing countries: Impact on their home economies*. New York: United Nations.

Vernon, R. (1966). International investment and international trade in the product cycle. *Quarterly Journal of Economics, 80,* 190–207.
Wagner, J. (2006). Exports, foreign direct investment, and productivity: Evidence from German firm level data. *Applied Economics Letters, 13*(6), 347–349.
Wagner, J. (2013). Exports, foreign direct investments and productivity: Are services firms different?. *The Service Industries Journal*, 1–14.
Wakasugi, R., & Natsuhara, T. (2012). Productivity and FDI of Taiwanese firms: A review from a nonparametric approach. REITI discussion paper 12-E-03. Retrieved March 7, 2019, from http://www.rieti.go.jp/jp/publications/dp/12e033.pdf.
Wooldridge, J. M. (2009). On estimating firm-level production functions using proxy variables to control for unobservables. *Economics Letters, 104*(3), 112–114.
World Investment Report. (2018, 2013). United Nations Conference on Trade and Development (UNCTAD).
Yeaple, S. R. (2003). The complex integration strategies of multinational firms and cross-country dependencies in the structure of foreign direct investment. *Journal of International Economics, 60*(2), 293–314.
Yeaple, S. R. (2009). Firm heterogeneity and the structure of U.S. multinational activity: An empirical analysis. *Journal of International Economics, 78,* 206–215.