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Abstract

Using Indian firm-level data, this paper examines the combined role of import and export intensity in a context of foreign networks. The more Indian firms are involved in trade networks the more they have a productivity advantage. Finally, information on the origin of import and on the destination of output are used to shed some light on the kind of networks in which firms are involved. We show that the upstream or downstream contact with more developed countries is not correlated with an higher productivity while there it seems to be an advantage for those firms that import and export to the same area.

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Introduction

This paper analyses the performance of Indian firms that participate in international networks defined by the combination of import and export shares. In addition, systematic patterns of firm performance are identified after characterizing networks by the specific origin of import and destination of export.

Here we are considering the firm's upstream and downstream commercial linkages with foreign countries as a whole. The activities shaping these foreign network are both imports and exports as well as foreign ownership[1] as already highlighted by Sjoholm and Takii (2003).

Therefore, we use the combination of import and export intensities to assess the *degree* of involvement of firms in trade networks. From this the relationship with firm performance is explored controlling for foreign ownership. Specifically, using a simultaneity bias consistent measure of performance levels[2] we find that the more Indian firms are involved in foreign networks the more they have a productivity advantage.

Export or import intensities of Indian firms have previously been studied by Hasan and Raturi (2003) and by Driffield and Kambhampati (2003). The first two authors focus on the determinants of export finding that greater usage of imported inputs influence export volumes positively. While, for a sample of 1800 firms in the period 1987-1994, Driffield and Kambhampati (2003), found that import intensity had a positive effect on efficiency only for the textile industry while export intensity seemed to decrease efficiency in sectors such as machine tools and chemicals.

Following the analysis on the *degree* of involvement of our firms in trade network, the subsequent step of our work is the identification of the geographical characteristics of these networks. Our data set has the nice feature of including detailed information on the origin of imports and on the destination of exports. This information is useful to investigate the characteristics of foreign networks, the nature of vertical specialization of Indian firms and the relationship with performance.

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[1] This definition is different from the one used by Rauch (1999) that refers to "ties" and cultural proximity to define trading networks.

[2] Derived applying the Levinshon and Petrin (2003) procedure.

Our main finding is that firms that are in contact with developed countries do not exhibit a productivity advantage while firms that concentrate export and import activities towards a specific area (both developed and developing) are more productive.

Regarding the performance of Indian firms with respect to trade, previous papers have found mixed results. Topalova (2004), for the period 1989-2001, shows a positive correlation between firm level productivity and the lowering of trade restrictions, in line with Krishna and Mitra (1998) results. But besides Driffield and Kambhampati (2003), also Parameswarn (2000), for a sample of 640 firms between 1989 and 1998, finds that trade liberalization has had a negative effect on technical efficiency. For this, India remains an interesting case study. Indian trade policy went trough a series of complex reforms that started in the early 80s. Until 1982-83 Indian trade regime was characterized by numerous quantitative restrictions. Then, in those years, the first step towards liberalization lifted many restrictions on imports of intermediate inputs and capital goods to promote technological upgrading and modernization of the Indian industry. Then in the 1990s, following a balance of payment crisis, the continued reform process showed a consistent commitment of the country towards trade liberalization. The removal of quantitative restrictions on imports was accompanied by a gradual lowering of customs duties in each of the budgets presented from 1991 onwards. However, even if there is a wide recognition that the import-substitution industrial policy has been shifted in favour of more liberalized import and export policies (Hasan et al 2003), the protection level for Indian manufacturing at the end of the various phases of trade liberalization still remains high (Das, 2003)[3]. Furthermore, the resource reallocation following these policies did not necessarily generate, at the firm level, all the expected efficiency gains. On the other side, the country still maintains a consistent domestic market therefore domestic firms are not necessarily obliged to rely on foreign markets to exploit, for example, scale economies. Therefore the combined analysis of import and export intensities can also have important trade policy implications.

[3] From his quantification of Indian trade barriers Das (2003) finds for 2001 an average estimates for the "effective rate of protection" of 40 percent that it is very high if compared with the post reforms protection levels (average tariff rates of manufactures) of other developing countries: Indonesia (1999- 10.7%), Malaysia (1997- 7.5%) and Sri Lanka (1997- 19 %).

The rest of the paper is organized as follows Section 2 presents the theoretical background on the relationship between import, export and performance. Section 3 then contains the description of the dataset. In section 4 we present the simultaneity bias consistent production function estimates obtained with the Levinsohn and Petrin (2003) methodology. Then, such firm level productivity measures are related to foreign network indexes so to identify systematic component after controlling for observed and unobserved plant characteristics and for industry heterogeneity. From this we report the first results. Section 5 develops the analysis on the direction of trade. Finally, the last two sections contain the causality and robustness checks and the conclusions.

2. Imports, exports and performance

In the most recent years, trade literature enriching the "new trade theory" models à la Helpman-Krugman (1985) with firm heterogeneity has focused on the relationship between international activities and firm performance. These previous representative-firm models while taking into account imperfect competition, product differentiation and increasing returns to scale, did not allow for the co-existence in the same sector of firms that serve just the domestic market, firms that serve both the domestic and the foreign markets and firms that are one hundred percent exporters. In fact, in such frameworks, the exogenous industry characteristics induce all firms in the same sector to have the same behavior regardless their specific performances. The heterogeneous firm model, on the contrary, relates the firm's decision to its productivity level (e.g. Melitz 2003).

The development of this recent literature was inspired by many empirical studies on micro data at the firm level[4]. In particular one consistent result of this empirical literature is that, for all industrial sectors, exporting firms are more efficient than non-exporting firms. This is combined with the proven existence of sunk entry costs into foreign markets. Such costs, in addition to the per-unit trade costs, are mainly related to information issues[5]. These stylized facts have been reconciled theoretically by Melitz

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[4] For example Roberts and Tybout (1997), Clerides, Lach and Tybout (1998), Bernard & Jensen (1999) and (2004), Kraay (1999), Aw, Chung and Roberts (2000), Van Biesenbroek, (2003) and De Loecker (2004).

[5] A firm must find and inform foreign buyers about its products and learn about the foreign market. Furthermore it must adapt its product to ensure that it conforms to foreign standards (which include testing, packaging, and labeling requirements). An exporting firm must also set up new distribution

(2003), which shows how the fixed costs generate a self-selection of the most efficient firms into foreign markets. This productivity dynamics is consistent with the findings of Clerides, Lach and Tybout (1998) that have shown, for Colombia, Mexico and Morocco, how the productivity trajectories of exporters were higher that those of non-exporters already *before* starting exporting and they did not change thereafter. However on empirical grounds the possibility that firms benefit from the contact with foreign counterparts has not been ruled out. There are still studies presenting empirical evidence of a learning-by-exporting effect on performance which materialize *after* breaking into foreign markets (e.g. Kraay (1999), Van Biesenbroek (2003), De Loecker (2004) and Girma, Greenaway and Kneller, (2004)).

Hence, the rich debate on the relationship between firm performance and international trade is still open.

Such firm level literature, mostly focused on exports (and foreign direct investment). Much less effort has been devoted to the export counterpart, imports. However, as pointed out by Ethier (1982) and highlighted by Kraay, Soloaga and Tybout (2001), there are strict complementarities between international activities of individual producers. Therefore “studies that focus on one international activity at a time may generate misleading conclusions” (Kraay et al, 2001, p.1).

Furthermore, not only export have a linkage with firm’s performance but also imports can be related to productivity. In fact, imported materials can be a source of learning[6] and as Ethier (1982) noted, it can also be a way of expanding the menu of intermediate inputs available to domestic firms and favor the best match between input mix and desired technology or product characteristics. Hence at the firm level, we can consider the generic “crossing the border” choice as driven both upstream and downstream by the firm’s profit maximization. In fact the firm chooses the most efficient inputs’ source to minimize total costs in the production of an output that has to find its demand domestically or abroad

Therefore our work contributes to the empirical analysis by examining, for a sample of Indian manufacturing plants, the linkage between import participation and exporting

channels in the foreign country and conform to all the shipping rules specified by the foreign customs agency (Melitz 2003 and Roberts and Tybout 1997)

[6] Only few papers have looked at the potential role of imports as a learning mechanism and at its impact on firm’s performance: Macgarvie (2003) for French firms, Keller and Yeaple (2003) for US multinationals and Blalock and Veloso (2004) for Indonesia.

behaviour. Next, we relate the trade intensity index constructed combining import and export intensities[7] to firm performance controlling for foreign ownership to find evidence that firms involved in foreign networks both trough contacts with foreign buyers and with foreign suppliers are advantaged with respect to other firms[8].

These two variables have already been combined in the trade literature when studying, on aggregated data, the relevance of the fragmentation of production processes across borders (Yeats 2001) and of interconnectedness of production processes in vertical trading chains across countries (Hummels, Ishii and Yi 2001). The first author finds that the production-sharing component of all US manufacturing trade is 30 percent while for Hummels, Ishii and Yi (2001) the growth in vertical specialization exports accounts for 25% or more of the growth in overall exports of OECD countries between 1970 and 1990, rising up to 50% for Mexico and Taiwan. These analyses are however limited to the quantification of the phenomenon and the firm level implications of being involved in such networks have not been explored jet.

3. Data and Descriptive Statistics

The data set used in this paper is based on a firm-level survey[9] conducted by the Development Research Group-Investment Climate Unit of the World Bank jointly with the Confederation of Indian Industries (CII) and the Indian Council for Research on International Foreign Relations. Two consecutive rounds of this Investment Climate Survey have been conducted, in 2000 and 2002[10]. The resulting balanced panel dataset

[7] Given that for firms there can be a coexistence of domestic and foreign activities, we focus on the share of output exported, rather than following the traditional approach of using, as main variable of interest, a dichotomous exporting status

[8] It could be the case that firms more involved in foreign networks would be more productive because the combination of import and export engagements is associated with higher knowledge flows and more intense learning processes (MacGarvie, 2003) Or alternatively, the more productive firms, that self select into the export market, also choose to import some of their inputs in order to maintain their competitiveness.

[9] For the sample design see Dollar, Iarossi and Mengistae (2002), Appendix A.

[10] see appendix 2B from Chapter 2 and appendix 4B from Chapter 4 for the sampling frameworks of the two surveys.

includes information on 188 firms belonging to five industries[11], for five years (from 1997 to 2001)[12].

These surveys include plant-based[13] data on sales and input purchases (together with detailed information on export and import), labour and human resources, investment, technology and R&D expenditures, ownership as well as data on objective aspects of the investment climate.

Referring to the 188 firms for which there are five consecutive years of data, 71 percent of them are *exporter*[14], 38 percent of them are *importers*[15] and combining the flows 31 percent are both importers and exporters[16]. Considering the industry beak down, we have 54 firms in the Drugs and Pharmaceutical sector[17], 31 firms in the Electronic Consumer Goods and the Electrical White Goods industries[18] and 103 firms in Textile and Garments sectors[19].

Table 1 reports some descriptive statistics on the characteristics of the firms in the sample. Consistently across sectors, exporters tend to be larger in size than the average firm in the sample and importers are, on average, even larger than exporters. Regarding the share of firms that have at least one foreign shareholder, this is higher among firms engaged in trade practices and in particular, importers are more likely owned by foreign individuals than exporters. The same pattern is followed by public ownership although the share of firms that have a public shareholder is quite negligible in all the sub-samples.

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11 The industries covered are Garments, Textiles, Drugs and Pharmaceutical, Electronic Consumer Goods and Electric White Goods.

12 The small number of firms for which information is reported both in the first and in the second round of the survey is mainly due to high rates of "non response". Therefore it is not possible to make any hypothesis on exit or on entry rates. For this reason, the analysis will be conducted on the balanced panel.

13 only one plant belonging to each firm is considered, even if the survey covers multi-plant firms

14 there are 133 firms for which, in the five years considered, the average ratio of total exports to total sales is positive.

15 There are 72 firms for which, in the five years considered, the average ratio of total imports to total inputs is positive.

16 There are 61 firms that for at least one of the years considered have both imported intermediate inputs and exported part of their output.

17 73 percent of them are *exporters*, 64 percent of them are *importers* and 53 percent are both importers-exporters.

18 45 percent of *exporters*, 21 percent of *importers-only* and 13 percent of both importers-exporters

19 76 percent of *exporter*, 19 percent are importers and 28 percent are both importers-exporters

Table 1. Descriptive Statistics on Selected Variables

	Average Number of employees (Std Dev)				Percent of Foreign owned firms[c)]				Percent of Public owned firms[d)]			
	All sectors	Drugs & Pharma	Electronic & Electrical Goods	Garm. & Tex.	All sectors	Drugs & Pharma	Electronic & Electrical Goods	Garm. & Tex.	All sectors	Drugs & Pharma.	Electronic & Electrical Goods	Garm. & Tex.
Total Sample	306,84 (856,81)	389,79 (646,97)	51,85 (80,17)	339,79 (1045,83)	11,7%	18,5%	3,2%	10,7%	2,1%	1,9%	-	2,9%
Exporters[a)]	418,29 (996,72)	505,31 (720,96)	88,36 (102,72)	434,39 (1176,37)	16,5%	25%	7,1%	13,9%	3%	2,5%	-	3,8%
Importers[b)]	615,41 (1283,74)	541,17 (751,59)	121,06 (124,44)	821,94 (1786,56)	22,2%	28,6%	-	20,0%	4,2%	2,9%	-	6,7%

a) *Exporters* are those firms that in the five years considered have on average a positive ratio of total exports to total sales.
b) *Importers* are those firms that in the five years considered have on average a positive ratio of total imports to total intermediate inputs.
c) percentage of firms with a positive foreign ownership share.
d) percentage of firms with a positive public ownership share.

As mentioned in the introduction, the main objective of this analysis is to explore in details the role of import and export with respect to firm performance.

For this, we will concentrate on the *degree* of exposure to foreign markets. Specifically, more than concentrating on binary variables to identify exporters and importers we will use directly the share of output sold abroad and the share of intermediate inputs imported.

In Table 2 the descriptive statistics on import share and exports share show that the average firm in the sample imports 10 percent of its intermediate inputs while it exports almost 30 percent of its output. Considering that, in our sample, there are many firms which buy intermediate inputs only from domestic suppliers, excluding the latter, the average import share becomes much higher reaching 37 percent. The same thing happens when the sample is restricted to exporters among which the average import share is almost 70 percent higher than the overall mean.

Similar patterns are followed by the export share variable. However, confronting the two sub-samples of importers and exporters it emerges that the average export share of importers is quite close to their average import share while among exporters there is, on average, a wider gap between the two measures in favour of export practices[20].

[20] This of course could reflect the fact that among importers, there is about 80 percent of exporters while among exporters there is only a 40 percent of importers.

In addition, 7 percent of the firms in our sample at least in one of the years considered have imported *all* of their intermediate inputs and 28 percent have exported *all* of their output. In the first case, the hundred-percent importer, the average export share is around 50 percent while the average import share, corresponding to the second cases, the hundred-percent exporters, is only 10 percent.

Table 2. Statistics on trade

Variable	*Obs*	*Mean*	*Std. Dev*
Import Share	731	0,1044	0,2403
of Importers	*203*	*0,3759*	*0,3258*
of Exporters	*389*	*0,1704*	*0,2911*
Export Share	752	0,2792	0,3877
of Exporters	*402*	*0,5222*	*0,3918*
of Importers	*203*	*0,3863*	*0,3829*
Drugs and Pharmaceutical			
Import Share	209	0,1999	0,2953
Export Share	216	0,2345	0,3405
Electronic and Electrical Goods			
Import Share	121	0,0689	0,2102
Export Share	124	0,1129	0,2527
Textile and Garments			
Import Share	401	0,0653	0,2003
Export Share	412	0,3526	0,4235

A more rigorous analysis of these patterns is however called for. For this, we proceed with the estimation of export decision equations following the literature on export market participation (Bernard and Jensen (2004), Bernard and Wagner (2001) among some) and we apply the same framework to the choice of importing, following Macgarvie (2003).

Firms' decision to export (import) depends on the fact that the current value of expected profits from exporting (importing) exceeds the fixed cost incurred in changing the export (import) status, S_{it}. This can be expressed with the following discrete-choice equation:

$$Y_{it} = \begin{cases} 1 & \text{if } \mathrm{E}\left[\pi_{it}^{Y}\right] - S_{it} > 0 \\ 0 & \text{otherwise} \end{cases} \qquad (1)$$

where Y_{it} is the variable indicating export or import. Assuming that $E[\pi_{it}^{Y}] - S_{it}$ is a function of various factors that affect firm's profitability and an error term ε_{it}, the reduced form binary choice equation becomes

$$Y_{it} = \begin{cases} 1 & \text{if } \lambda^{Y} X_{it}^{Y} + \delta_t + \rho_i + \varepsilon_{it}^{Y} > 0 \\ 0 & \text{otherwise} \end{cases} \qquad (2)$$

where Y is the variable identifying export or import status. δ_t is a time effect that should capture the profitability conditions that are common across firms and ρ_i are time invariant firm's characteristics such as industry. According to the above mentioned literature on the determinants of the firm's export decision, the vector X_{it} of firm's characteristics includes employment, capital intensity, wages, the age of the firm and technological proxies as age of machineries and the skill intensity. To avoid causality problems all the firm's characteristics variables are lagged one year. In addition the share of foreign ownership controls for one of the possible channels that would favour the export (or import) decision. With respect to the determinants of firm-level imports there is much less research, though Kramarz (2003) finds that French importers are more capital-intensive and have lower employment than non importers. Following MacGarvie (2003) that also studies French firms we include in the import participation equation the same variables that we use to model the export decision. In addition, to test for the fact that there is a linkage between the activity of buying intermediate inputs from foreign suppliers and of selling output to foreign customers, we also introduce the respective variables in the participation equations.

Therefore after modeling the probability of exporting (importing) as:

$$\Pr(Y = 1 \mid X^{Y}) = \Pr(\varepsilon_{it}^{Y} < \lambda^{Y} X_{it}^{Y} + \delta_t + \rho_i) \qquad (3)$$

we estimate the firm's propensity to trade with maximum likelihood. Table 3 displays the results of the Probit model estimations.

Interesting to note is that import and export are both positively correlated, respectively, to the decision to export and to import. In the case of the export participation equation import intensity has an even higher coefficient than the dichotomous variable (cfr. column 4 and 5) which confirms the results of Hasan and Raturi (2003).

The coefficient on the foreign ownership variable is never statistically different from zero while it seems that the capital and technology variables are positively correlated to the export decision and negatively to the import decision. The first case is in line with the findings of the literature while in the second case there it seems to be a substitution effect between firm's capital and technology and the capital and technology embodied in the imported inputs.

Table 3. Export and Import decision: Probit estimations

	Dep Variable					
	EXP	IMP	EXP	EXP	IMP	IMP
	(1)	(2)	(3)	(4)	(5)	(6)
IMP			0.962			
			[0.191]***			
Import share				1.314		
				[0.380]***		
EXP					0.980	
					[0.187]***	
Export Share						0.483
						[0.206]**
Share of FO	1.782	0.185	1.288	1.451	-0.064	-0.078
	[1.430]	[0.714]	[1.066]	[1.241]	[0.719]	[0.724]
Capital Intensity (t-1)	0.120	0.012	0.122	0.125	-0.022	0.006
	[0.042]***	[0.043]	[0.044]***	[0.043]***	[0.045]	[0.043]
Skill Intensity	0.028	0.236	-0.024	-0.002	0.236	0.232
	[0.060]	[0.062]***	[0.063]	[0.062]	[0.065]***	[0.063]***
Age of machineries	-0.217	0.083	-0.246	-0.251	0.114	0.121
	[0.116]*	[0.123]	[0.122]**	[0.121]**	[0.127]	[0.124]
Employment (t-1)	0.354	0.326	0.277	0.305	0.251	0.305
	[0.070]***	[0.071]***	[0.075]***	[0.072]***	[0.075]***	[0.073]***
Age of the firm	0.295	-0.135	0.326	0.317	-0.195	-0.154
	[0.095]***	[0.102]	[0.099]***	[0.099]***	[0.106]*	[0.103]
Average wage (t-1)	0.092	0.116	0.066	0.072	0.109	0.123
	[0.055]*	[0.055]**	[0.057]	[0.056]	[0.057]*	[0.055]**
Constant	-4.104	-3.120	-3.319	-3.388	-2.920	-3.144
	[0.563]***	[0.555]***	[0.559]***	[0.553]***	[0.574]***	[0.560]***
Observations	501	487	487	487	487	487
Log likelihood	-236.29	-205.53	-219.75	-226.07	-190.86	-202.79
Pseudo R2	0.3152	0.2986	0.3460	0.3265	0.3487	0.3080

Notes:
Robust Standard errors in brackets
Sector and year dummies included in all the equations
* significant at 10%; ** significant at 5%; *** significant at 1%

Naturally, considering import and export we are referring to different decisions nonetheless our analysis shows that there is a linkage between the two. The reasons for this link to be in place can be many. Firstly, it can be that having already a contact with a foreign supplier (or a foreign buyer) favors entry in export market (or the knowledge of available foreign inputs). But beside this information issue there can also be a quality issue. For example, as pointed out by Kraay et al (2001), exporters are relatively likely to use imported capital and intermediate goods because they are granted preferential access to foreign exchange, or because in order to satisfy demanding foreign buyers they need to import high quality inputs that are not domestically available. Similarly input and capital good requirements may accompany licensing agreements. This can likely happen when firms are involved in international production networks importing intermediate goods that need to be first reprocessed and then re-exported. Given the information available in the data set we cannot detangle this issue, though we are interested in exploring the extent of involvement of Indian firms in foreign networks[21] and the relationship with their performance.

4. Foreign networks

Once established that import and export decisions are correlated, we now focus on the measurement of the involvement of Indian firms in foreign networks. For this we construct and index that accounts for both import and export intensities.

The main reference is the "Vertical Specialization" index proposed by Hummels, Ishii and Yi (2001) as measure of foreign valued added embodied in exports. This index is constructed multiplying the export share by the value of imported intermediates. Consequently, the firm level approximation of this index will be, for the firm *i* at time *t*:

$$VS_{it} = \left(\frac{\text{Imported Intermediates}_{it}}{\text{Sales}_{it}} \right) * \text{Exports}_{it} = \left(\frac{\text{Exports}_{it}}{\text{Sales}_{it}} \right) \cdot \text{Imported Intermediates}_{it} \quad (4)$$

If the firm does not use imported inputs or it does not export, the index will be zero. But for this version of the index[22] there is not a definite upper bound and its value can be highly influenced by the size of the firm: large firms that would import even a small quota of inputs would exhibit an high value of the index. For this reason we

[21] Identified both trough backward and forward foreign linkages.

[22] In their paper Hummels, Ishii and Yi choose a sectoral normalization.

choose a firm level normalization of such index dividing by the material inputs used in the production process. Thus, for the firm *i* at time *t* our index will be :

$$\mathrm{IE}_{it} = \frac{VS_{it}}{\text{Material Inputs}_{it}} = \left(\frac{\text{Imported Intermediates}_{it}}{\text{Material Inputs}_{it}}\right) * \left(\frac{\text{Exports}_{it}}{\text{Sales}_{it}}\right) \qquad (5)$$

The main advantage of this second index is that it varies from zero to one. It is zero in the case that the firm does not import any intermediate inputs or it does not export any share of output. While, its upper bound is reached if all the inputs come from abroad and, at the same time, all the output is sold in foreign markets. By some means, this measure can be considered as a proxy for the extent of vertical *integration* of local firms in foreign networks. In fact, this index will be higher the higher are both import and export shares. For example if a firm imports 30 percent of its inputs and exports 70 percent of its output (or vice versa) the index will be 0,21 , lower than the case of a firm with import and export intensities of 50 percent (0,25). This is because or index is meant to combine the *degrees* of the upstream and the downstream linkages and the first case corresponds to a firm mostly concentrated on the export linkage.

One other measure that is worth considering, because of its straightforward interpretation, is the import content of export. Which, for the firm *i* at time *t,* will be defined as:

$$\mathrm{IE\_sh}_{it} = \left(\frac{\text{Imported Intermediates}_{it}}{\text{Exports}_{it}}\right) \qquad (6)$$

This measure is of great importance for trade policy. In fact, when designing trade liberalization measures with the aim of boosting exports it is important to take into account, how much domestic firms are dependent on imports. However, this measure can be constructed only for exporting firms therefore excluding from the analysis those firms that choose to serve the domestic market.

From Table 4, the average value of the IE index (5) appears to be not very high showing how important is, in our sample, the weight of the firms that do not trade. While the second index (6), calculated on the sub-sample of exporters appears surprisingly high especially for the Drugs and Pharmaceutical sector highlighting the high dependence on imported inputs.

Table 4. Degree of Vertical Integration

	All sample			Drugs & Pharmaceutical			Electronic & Electrical Goods			Garment &Textile		
	Obs	*Mean*	*Std. Dev.*	*Obs*	*Mean*	*Std. Dev.*	*Obs*	*Mean*	*Std. Dev.*	*Obs*	*Mean*	*Std. Dev.*
IE	731	0,045	0,147	209	0,066	0,152	121	0,013	0,062	401	0,043	0,160
IE_sh	307	0,968	5,601	76	2,500	7,894	31	0.176	0.361	200	0,501	4,852

5. Empirical Methodology

From this, the next step will be to analyze the correlation between the trade practices of the firms in the sample and their performances. In doing this we follow a standard two step procedure. Firstly, we obtain productivity estimates. Subsequently, such measures are regressed on the trade indexes constructed and on sets of firms' characteristics. Bernard and Jensen (1999) and Aw, Chung and Roberts (2000), among others, adopt this two step approach in evaluating performance of exporters respectively for the United States and for Taiwan and South Korea.

5.1 Productivity

Our measure of firm level performance is Total Factor Productivity calculated as difference between the actual output and the one predicted by means of production function estimations[23].

Under the assumption of Hicks neutral Cobb Douglas technology we obtain the following logarithmic approximation of the production function, for firm *i* , in industry *j*, at time *t*:

[23] Instead of TFP, an alternative measure of performance traditionally used is labour productivity. However as highlighted also by Sachs et al. (1999), given the country's labour regulations, Indian firms often problems of over-staffing and this would bias the performance measure.

$$y_{it}^{j} = \beta_0 + \beta_w lw_{it}^{j} + \beta_b lb_{it}^{j} + \beta_k k_{it}^{j} + \beta_e e_{it}^{j} + \beta_m m_{it}^{j} + \omega_{it}^{j} + \varepsilon_{it}^{j} \qquad (7)$$

where y_{it} is the log of gross output (proxied by sales)[24] , k_{it} is the log of the plant's capital stock, lw_{it} is the log of hours worked by skilled workers (white), lb_{it} is the log of hours worked by unskilled workers (blue), and m_{it} and e_{it} denote log-levels of materials, and energy (which includes consumption of fuel and electricity). The error term has two unobserved components, ω_{it} ,the transmitted productivity components and ε_{it}, the random noise component. The difference between the two is that ω_{it} is a state variable, known by the firm when deciding the amount of input to employ in production[25], while ε_{it} is independent with respect to input choices. The correlation between the error component and inputs leads to the well known simultaneity problem firstly highlighted by Marschak and Andrews (1944). Estimations that ignore this correlation yield biased results. This is the case for OLS that, most commonly, overestimate the labour coefficient and underestimates the capital coefficient.

To overcome this problem we use the Levinshon and Petrin (2003) methodology[26]. This approach builds on the work of Olley and Pakes (1996) that proposed the use of investments as proxy to control for the correlation between the unobserved productivity shock and capital (assuming that labour and materials are freely available inputs). The Olley-Pakes procedure can be applied only to plants reporting non-zero investments and this criteria would require a significant truncation of our sample[27]. For this reason, as suggested by Levinshon and Petrin, we use intermediate input demand as proxy. In particular, we use raw material inputs[28] that become a valid proxy when their demand function is monotonic in firm's productivity for all levels of capital. Appendix A reports the details of the Levinshon-Petrin estimation procedure, its implementation and a description of the variables used in estimations.

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[24] We did also estimated the value added production function, assuming weak separability on materials. The TFP estimations did not differ substantially.

[25] But not by the econometrician.

[26] If the productivity is assumed to be plant specific and time invariant, the simultaneity problem can also be solved including in the regression firm specific effects (fixed-effect panel estimations). However this estimator does not fully exploit the cross-sectional variation which, especially in our case, with a short panel, is a relevant dimension.

[27] In the case of the ICS of India, new investments are reported only for 1999 and 2001 and even in those case there is a high frequency of zero observations.

[28] Alternatively also electricity consumption, possibly in physical quantities, can be a good proxy but we have only data on cost of energy. For a more detailed discussion on the choice of proxies see Appendix A.

The simultaneity bias consistent estimates of the production function's parameters, obtained for each macro sector, have then been used to calculate each firm's Hicks-neutral TFP as residual between actual and predicted output values. In order to make the TFP estimates comparable across industries, the exponential values of TFP were divided by the corresponding year and industry average[29].

Table 5 reports descriptive statistics on the performance variables calculated dividing the sample according to their trade practices. Both the TFP Index and the natural logarithm of TFP show that exporters, importers and firms engaged in international networks are on average more productive than firms that rely on the domestic market as source of inputs and/or destination of output.

Table 5 Relationship with performance

Variable	*Obs*	*Mean*	*Std. Dev*	*Obs*	*Mean*	*Std. Dev*
		Importers			**Non Importers**	
TFP_index	147	1,1736	0,5638	412	1,0384	0,5024
lnTFP	147	1,7392	1,4901	412	0,6662	1,3036
		Exporters			**Non Exporters**	
TFP_index	291	1,1389	0,583	284	1,0047	0,4289
lnTFP	291	1,1807	1,3891	284	0,7174	1,4438
		IE>0			**IE=0**	
TFP_index	119	1,2274	0,5795	440	1,0329	0,4982
lnTFP	119	1,7968	1,3708	440	0,7188	1,3641

5.1.1 Profitability

Before proceeding with the analysis it must be observed that theoretical production functions explain quantities of output trough quantities of inputs. However, in empirical

[29] To mitigate the problem of misreporting and outliers we used as industry-year TFP average the Huber mean truncating the one percent tails of the distributions.

applications, like ours, quantities of output and some inputs are replaced with values. The main reason to use values instead of quantities is that, at the firm level, products are heterogeneous and quantities cannot be directly aggregated or compared. As a result, as Klette and Griliches (1996) have pointed out[30], the estimators from a production function regressions using sales are inconsistent. The problem comes from the fact that the value of output does not depend only on technology but includes both prices and quantities. While quantities can be directly linked to inputs through the production function, prices are the equilibrium outcome resulting from the interaction of supply and demand. Therefore, price times quantity is not reflecting just the production side but it also includes demand and market structure. For this, the above TFP estimates cannot be considered as pure measures of efficiency in production but more as measures of "efficiency in generating value of output"[31]. As a result, measured productivity it is likely to capture *profitability* in a broader sense rather than strict technical efficiency. Keeping this in mind, we can still meaningfully employ in our analysis the TFP measures obtained by means of production function estimates using sales as proxy for output. In fact, the choices on import, export and diversification depend on expected profits. Profits will, on turn, depend both on productive efficiency and on the demand side, therefore using a measure of performance that captures profitability instead of productive efficiency will not bias the results.

5.2 Empirical Strategy and Results

The second step of our analysis consists on the estimations of the relationship between trade practices and productivity. The baseline specification will be

$$TFP_{it} = \alpha_0 + \alpha_1 X_{it} + \alpha_2 Y_{it} + \alpha_3 k_i + \alpha_4 h_t + v_{it} \qquad (8)$$

[30] In their study on returns to scale estimates.

[11] To address this problem few authors (Melitz 2000, and Katayama, Lu and Tybout 2003) have started introducing information about the demand and market structure into the estimation. They show that firms that face a more inelastic demand are able to charge higher prices and they appear to be more productive according to the TFP estimates

Where the dependent variable represents the productivity index[32] for firm *i* at time *t*; X_{it} is our variable of interest that should be correlated with performance; Y is a set of time variant firm's characteristics such as the age of the firm, the ownership status, and size but also other controls introduced in specific estimations that can explain firm performance; *k* are time invariant controls such as industry and location[33], and *h* is the set of year dummies that controls for macroeconomic shocks common to all firms. Our main focus will be the magnitude and the sign of the α_1 coefficient.

The first step is to check for the relationship between productivity and Import and Export intensity variables separately. The results from estimating equation (8) using standard OLS correcting for heteroskedasticity and adjusting standard errors for clustering at the year-sector level[34] are reported in tables 6 a and b.

The first and the second column of both tables show the regressions with the dichotomous variables[35]. In particular, columns (1) are premium-type regressions were the independent variables are all binary controls. The coefficients of the Import dummy is never significant, while the coefficient on the export dummy is significant only if other controls such as ownership status and firm age are not introduced. In contrast, when import and export are introduced as "intensities", columns (3), then both coefficients become positive and significant indicating a positive relationship between the productivity index and the share of inputs imported or the share of output exported even though the results are not robust to the inclusion of additional controls such as technology and innovation proxies.
In columns (4), the hypothesis of non linear (quadratic) relationship in import and export share is tested and rejected.

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32 The production function that we have estimated using sales to proxy for quantities produced could introduce a bias. This is because, the value of output does not depend only on technology but it includes both prices and quantities. Therefore , this measured productivity it is likely to capture *profitability* in a broader sense rather than strict technical efficiency. However, the choice of trade practices is based on expected profits, which on turn will depend both on technical efficiency and on the demand side. For this, the use of "efficiency in generating value of output" as measure of performance does not bias the results.

33 To control for the location of firms, instead of dummies indicating Indian States, we use a dummy that assumes the value 1 if the firm is located in a coastal State, and a variable that quantifies, on a scale from 1 to 4 the investment climate of the State (World Bank and CCI, 2002)

34 introducing any aggregate variables (in this case industry) in micro units OLS regressions leads to an underestimation of the standard errors (Moulton ,1990). For this reason, we correct the standard errors for correlation between the observations belonging to the same industry in a given year.

35 Which take value one if the respective firm's import share or export share are grater than zero, otherwise takes zero value.

Among the additional explanatory variables introduced, import experience (column 5 of Table 6a) is the only one having a significant positive correlation with productivity. This confirms the fact that it takes time to optimally integrate foreign inputs in the production process. Export experience on the other side (column (5), table 6b) does not have a similar impact.

As shown in column (7) in table 6a, there is a positive and significant correlation between import intensity and productivity in the restricted sample of exporting firms. In addition, column (7) in table 6b reports a positive and significant correlation between export intensity and productivity in the sub-sample of importing firms.

Table 6a Relationship between Import and Performance

	Dependent variable : TFP_index						
	(1)	(2)	(3)	(4)	(5)	(6)	(7) exporters
Import Dummy	0.086 [0.094]	0.070 [0.085]					
Import share			0.244 [0.135]*	0.541 [0.557]	0.074 [0.204]	0.349 [0.181]*	0.377 [0.172]**
Age of the firm		0.003 [0.005]	0.003 [0.005]	0.003 [0.005]	0.001 [0.002]	0.002 [0.002]	
Share of public ownership		0.004 [0.002]*	0.004 [0.003]	0.004 [0.002]*	0.029 [0.023]	-0.001 [0.001]	
Share of foreign ownership		1.217 [0.357]***	1.249 [0.377]***	1.253 [0.382]***	2.133 [0.441]***	1.019 [0.289]***	
Import share squared				-0.346 [0.583]			
Age of Machineries						0.002 [0.004]	
R&D_spending						0.000 [0.000]**	
Import experience					0.013 [0.003]***		
Skill Intensity						0.002 [0.005]	
Imported new investments					-0.371 [0.255]		
Constant	0.936 [0.078]***	1.077 [0.083]***	1.068 [0.082]***	1.063 [0.080]***	1.259 [0.143]***	0.705 [0.103]***	0.790 [0.156]***
Observations	558	548	548	548	301	331	280
R-squared	0.05	0.09	0.10	0.10	0.25	0.20	0.08

Notes: Robust standard errors in brackets (clustered at the industry-year level)
* significant at 10%; ** significant at 5%; *** significant at 1% ,
All the estimations include year sector, size and location controls .

Table 6b Relationship between Export and Performance

	Dependent variable : TFP_index						
	(1)	(2)	(3)	(4)	(5)	(6)	(7) importers
Export Dummy	0.085 [0.039]**	0.063 [0.047]					
Export share			0.124 [0.070]*	0.210 [0.385]	0.113 [0.068]	0.158 [0.102]	0.271 [0.147]*
Age of the firm		0.004 [0.004]	0.004 [0.004]	0.004 [0.004]	-0.001 [0.002]	0.001 [0.002]	
Share of public ownership		0.005 [0.002]*	0.005 [0.002]**	0.005 [0.002]**	0,031 [0.024]**	0.002 [0.002]	
Share of foreign ownership		1.206 [0.363]***	1.194 [0.393]***	1.200 [0.407]***	1.205 [0.406]***	0.923 [0.281]***	
Export share squared				-0.090 [0.433]			
Age of Machineries						0.003 [0.004]	
R&D_spending						0.000 [0.000]**	
Export experience					0.004 [0.005]		
Skill Intensity						0.007 [0.004]*	
Imported new investments					-0.306 [0.188]		
Constant	0.940 [0.076]***	1.101 [0.074]***	1.102 [0.079]***	1.105 [0.081]***	1.285 [0.088]***	1.068 [0.120]***	1.133 [0.612]*
Observations	573	563	563	563	359	334	146
R-squared	0.05	0.09	0.09	0.09	0.18	0.19	0.20

Notes: see Table 6a

The findings from this preliminary analysis substantiate further the importance of investigating the combined role of import and export.

This is developed with the estimations reported in Table 7. Here, equation (8) is estimated by substituting to X, first the dummy variable indicating the fact that a firm is both an importer and an exporter, then the IE index as presented in the previous section. As expected, both the interacted dummy and the IE index (5) display positive and significant coefficient. This indicates that firms involved in foreign networks are more productive and the higher is the degree of such involvement, the higher is productivity. This results holds to the inclusion in the regressions of controls such as import and export shares separately, and also variables indicating the export share of firms that do not import their inputs and import share of firms that do not exports (column 5).

One other important and significant control is the share of foreign ownership that, as expected, is positively correlated to the firm's performance.

Yet, identifying the relationship between productivity and trade practices though the variation *across* plants can introduce a bias. In fact the foreign network index could be correlated with omitted plant characteristics that affect productivity. Under the hypothesis that these characteristics are time invariant, it is possible to control for unobserved firm heterogeneity with fixed effect estimates. This estimator identifies the impact of the variable of interest relying on the within-firm time variation. Such estimates are reported in column (6) and (7) where is shown how the coefficient on the IE index remains positive and statistically significant.

To further test the robustness of our findings in column (8) we also introduce among the regressors, the lagged value of TFP index assuming that firm's productivity follows a Markov process. This inclusion introduces however a bias that we correct trough the Arellano-Bond dynamic panel estimator in column (9) (Arellano and Bond, 1991). The coefficient of interest maintains both significance and sign even when import and export shares are introduced as controls (column (10)). This latter estimator has also the advantage of permitting to address more general endogeneity issues. In fact we introduce in the GMM instruments matrix also the lagged values[36] of the IE index to overcome the endogeneity between the level of productivity and the value of the index. However the use of lagged values of the variables to control for endogeneity leads to a significant decline in the number of observations which does not permit to draw very definite conclusions from the analysis. The same happens when using traditional instrumental variables estimators such as the one reported in columns (11) and (12). The first case corresponds to the two stages least squares estimator with first and second lag of the IE index used as instruments. Column (12) instead displays the two-step instrumental variables GMM estimates[37] obtained with the same instruments. Nonetheless, in both cases the IE index shows a positive and statistically significant coefficient and the tests on the validity of the instrument confirm that they are uncorrelated with the error term[38].

[36] Starting from t-2

[37] The efficiency gains of this estimator relative to the traditional instrumental variable two step estimator derive from the use of the optimal weighting matrix that generates efficient estimates of the coefficients as well as consistent estimates of the standard errors in presence of heteroskedasticity.

[38] therefore first and second lags are valid instruments for the IE index.

Table 7 Foreign networks and performance

	Dependent variable : TFP_index											
	(1)[a)]	(2)[a)]	(3)[a)]	(4)[a)]	(5)[a)]	(6)	(7)	(8)[a)]	(9)	(10)	(11)	(12)
IMP*EXP DUMMY	0.129	0.204										
	[0.057]**	[0.081]**										
Export Dummy		0.011										
		[0.056]										
Import Dummy		-0.091										
		[0.114]										
IE			0.429	0.240	0.442	0.716	1.247	0.205	0.749	1.343	0.776	1.980
			[0.108]***	[0.193]*	[0.126]***	[0.284]**	[0.353]***	[0.086]**	[0.384]**	[0.474]***	[0.324]**	[1.201]*
Import share				0.108			-0.553			-0.613		
				[0.174]			[0.180]***			[0.240]**		
Export share				0.077			0.038			-0.006		
				[0.073]			[0.082]			[0.124]		
Imp. Sh. of non exporters					-0.155							
					[0.119]							
Exp. Sh. of non importers					0.063							
					[0.084]							
TFP_index (t-1)								0.632	0.537	0.529		
								[0.123]***	[0.122]***	[0.120]***		
Age of the firm	0.003	0.003	0.003	0.003	0.003			-0.001	0.001	0.001	-0.001	0.015
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]			[0.001]	[0.001]	[0.001]	[0.002]	[0.013]
Share of public ownership	0.004	0.004	0.005	0.004	0.005			-0.020	0.000	0.000	0.002	0.450
	[0.002]	[0.002]	[0.002]**	[0.002]*	[0.002]**			[0.012]	[0.000]	[0.000]	[0.005]	[0.384]
Share of foreign ownership	1.222	1.221	1.239	1.223	1.210			0.862	-0.042	0.040	1.158	3.483
	[0.357]***	[0.355]***	[0.369]***	[0.391]***	[0.381]***			[0.269]***	[0.660]	[0.652]	[0.380]***	[2.073]*
Constant	1.098	1.116	1.090	1.091	1.101	1.015	1.041	0.386	-0.078	-0.065	1.084	0.000
	[0.066]***	[0.056]***	[0.064]***	[0.061]***	[0.063]***	[0.035]***	[0.041]***	[0.149]**	[0.131]	[0.129]	[0.128]***	[0.000]
Obs.	548	548	548	548	548	559	559	414	247	247	281	281
R-squared	0.09	0.10	0.10	0.10	0.10	0.02	0.05	0.51			0.14	
Firm fixed effect						Y	Y					
Arellano Bond									Y	Y		
ARII									-0.07	-0.17		
P-value)									(0.942)	(0.861)		
Hansen- Sargan test									24.01	23.97	2.207	
(P-value)									(0.021)	(0.019)	(0.137)	
Hansen J												1.380
(P-value)												(0.240)

Notes: Robust standard errors in brackets, a)Errors are clustered at the industry-year level.
* significant at 10%; ** significant at 5%; *** significant at 1%
All the estimations include year sector, size and location controls .

6 Does the direction of trade explain the positive effect of vertical specialization?

These findings seem to substantiate the hypothesis that, at the firm level, there is a positive relationship between performance and the involvement in foreign networks. In fact not only exports but also imports have their role with respect to performance. It can be the case that in order to be successful in foreign markets as sellers, firms have to customize their production and use imported inputs. In addition, importing intermediate inputs from abroad firms can benefit from more advanced technology levels and from better quality goods. Furthermore being contemporaneously an importer and an exporter a firm can reduce the fixed costs linked to the gathering of information on foreign markets.

Our data do not allow to explain with more detail the kind of contractual relationship that the firms in the sample have with their foreign counterparts. We only know the share of foreign ownership of these firms and this is a factor that we have controlled for thorough the whole analysis showing that there is a positive relationship with firm's performance[39] but it is not the main factor that explains it. However, a nice feature of the ICS survey is that, for each firm, there are detailed information on the share of import sourced from specific origin and the share of export to specific destination.

We will use this information to shed some light on the kind of international network in which these firms are involved, or at least to have insights on the technological level to which Indian firms are exposed, to better justify this productivity advantage of firm that are both importers and exporters.

Next section will therefore presents some location-specific network indexes which have been related to the performance indexes to identify systematic patterns.

6.1 Direction of trade

The information on the destinations and origin of goods traded refer to three main geographic areas: "North" (which includes North America, Europe), "Asia" (which includes also China and Japan), "South" (Central-Latin America, Africa, Eastern Europe,

[39] In all the estimations the variable "Share of foreign ownership" shows a positive and significant sign.

Russia and Middle East) and finally, as a complement, also "Home" has been considered so not to exclude from the sample the counterfactual.
From this, we construct localization-specific versions of the indexes presented in section 3.2, respectively on import and export practices separately and then on their combination.

For firm *i* at time *t* we have the share of intermediate inputs imported from each origin and the share of export to each destination calculated as,

$$iX_{it} = \left(\frac{\text{Imported Interm.}_{it}}{\text{Mat. Inputs}_{it}}\right) * \left(\text{share of Imports from X}\right)_{it} = \left(\frac{(\text{Imported Interm. from X})_{it}}{\text{Mat. Inputs}_{it}}\right) \quad (9)$$

and

$$eX_{it} = \left(\frac{\text{Exports}_{it}}{\text{Sales}_{it}}\right) * \left(\text{share of Exports to X}\right)_{it} = \left(\frac{(\text{Exports to X})_{it}}{\text{Sales}_{it}}\right) \quad (10)$$

where X represents "North", "South"; "Asia" and "Home".
From this we then construct the localization-specific version of (5), for firm *i* at time *t* , is defined as:

$$I^j E^i_{it} = \left(\frac{\text{Imported Intermediates from j}_{it}}{\text{Material Inputs}_{it}}\right) * \left(\frac{\text{Exports to i}_{it}}{\text{Sales}_{it}}\right) \quad (11)$$

where *j*= "North", "South", "Asia" and "Home" and also *i* = "North", "South", "Asia" and "Home". Therefore, *j* indicates the origin of import, and *i* the destination of sales. This index takes the value zero if the firm does not have contact with any of the two areas considered. While it takes the value one, its upper bound, if a firm imports all of his material inputs from the same area and sells all its output to the same area. Many firms in our sample are not exclusively dealing with one single geographical area and this index accounts for all the trade flows of each firms. If for example a firm buys 30 percent of its inputs from the "North" and 70 percent from "Asia" and then it sells 40 percent of its output domestically and 60 percent to the "North", we have that the "Asia-North" flow has the highest weight. In fact this firm is mostly characterized by having upstream contacts with Asia and downstream contacts with the North. Even though the other flows[40] are not excluded from the analysis but they enter with a lower weight.

From the combinations of the four origin/destinations, sixteen kinds of flows are generated. However for each flow there are too little non-zero observations to perform a parametric analysis. For this reason we choose to group these flows according to different criteria.

Firstly we concentrate on those flows that have the same origin and destination. This is to test the idea that specialization towards a specific market generates the necessary knowledge to overcome information and search costs. Therefore it permits to find the most appropriate inputs and to better know the standards required to satisfy local demand in order increase efficiency.

Thus, we construct an index that groups all the flows for which $j=i$ excluding the domestic cases[41]. Table 8a reports the results from the estimations obtained including these indexes in equation (8). As expected, the index that measures the magnitude of import and export flows to the same area shows a positive sign and it is statistically different from zero. The sign and statistical significance is maintained also when controls such as import share, export share or IE index are introduced. In addition, column (4) displays the coefficient of the ratio between the index referring to the same origin and destination and the IE index. This term gives a measure of the weight of those international activities concentrated on the same areas with respect to all the international activities. Such coefficient is positive and statistically significant indicating that the correlation between performance and concentration persists regardless the amount of international trade the firm is involved in as long as it is spatially concentrated. However when we introduce lagged values of the variables as instruments, to solve the possible endogeneity bias, the number of observations becomes fairly small and the results become weaker (columns (6) to (10)).

40 "Asia-Home", "North-Home" and "North-North".

41 When j=Home and I=Home

Table 8a Direction of trade(j=i)

	Dependent variable : TFP_index									
.	(1)[a]	(2)[a]	(3)[a]	(4)[a]	(5)[a]	(6)	(7)	(8)	(9)	(10)
I^iE^j (i=j)	1.041	0.921	1.013		0.815	0.449	0.470	0.781	3.219	3.017
	[0.310]***	[0.339]**	[0.363]**		[0.426]*	[0.576]	[0.547]	[0.612]	[0.587]***	[0.502]***
(I^iE^j)/IE (i=j)				0.274	0.121			-0.169		
				[0.066]***	[0.101]			[0.109]		
Import share		0.046	0.100				-0.369			
		[0.108]	[0.175]				[0.184]**			
Export share		0.064	0.077				-0.014			
		[0.071]	[0.074]				[0.088]			
IE			-0.157		0.039	-0.143	0.292	-0.170		
			[0.190]		[0.107]	[0.259]	[0.346]	[0.252]		
TFP_index (t-1)						0.770	0.667	0.722		
						[0.145]***	[0.142]***	[0.142]***		
Age of the firm	0.003	0.003	0.003	0.003	0.003	0.001	0.001	0.001	0.001	0.001
	[0.002]*	[0.002]*	[0.002]*	[0.002]	[0.002]*	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]
Sh. of pub. Own.	0.005	0.005	0.005	0.004	0.005	0.000	0.000	0.000		
	[0.002]**	[0.002]*	[0.002]*	[0.003]	[0.002]*	[0.000]	[0.000]	[0.000]		
Sh. of For. Own.	1.207	1.196	1.191	1.167	1.188	-0.001	-0.101	0.088	0.928	0.855
	[0.356]***	[0.376]***	[0.378]***	[0.336]***	[0.345]***	[0.742]	[0.711]	[0.722]	[0.362]**	[0.479]*
Constant	1.284	1.271	1.266	1.237	1.260	-0.021	-0.047	-0.052	1.079	0.000
	[0.178]***	[0.181]***	[0.182]***	[0.165]***	[0.165]***	[0.092]	[0.088]	[0.093]	[0.104]***	[0.000]
Observations	548	548	548	548	548	255	255	255	283	283
R-squared	0.12	0.12	0.12	0.10	0.12					
AB						Y	Y	Y		
IV									Y	
IV-GMM										Y
AR II						-0.84	-0.99	-0.57		
(P-value)						(0.3995)	(0.3233)	(0.5699)		
Hansen- Sargan test						4.95	5.69	5.69	0.206	
(P-value)						(0.4220)	(0.3371)	(0.3371)	(0.6496)	
Hansen J										0.3069
(P-value)										(0.5796)

Notes:
Robust standard errors in brackets;
a) Errors are clustered at the industry-year level.
* significant at 10%; ** significant at 5%; *** significant at 1% ,
All the estimations include year sector, size and location controls.

Alternatively, the other issue of interest is tracing the flows that corresponds to contacts with the “North”. This is to test the idea that those Indian firms that trade with developed countries firms have contacts with the most advanced technology or have to face high competition therefore they should exhibit a better performance level. We group the location-specific indexes according to the fact that “North” is at least one of the destinations or origins of trade flows. Table 8b displays the results from estimations of the relationship between this index and productivity. Surprisingly the coefficients on the variable of interest are in most cases not statistically significant. From table 8 there seemed to be an advantage for those firms that imported inputs from the “North” while there was a negative correlation between the share of output sold to this destination and the level of efficiency. The results from table 10b seem to combine these two outcomes.

Thus, we find no evidence that generic trade contacts with North America or Western Europe are associated with a productivity advantage.

Table 8b Direction of trade: highlighting "North"

	Dependent variable : TFP_index									
	(1)[a)]	(2)[a)]	(3)[a)]	(4)[a)]	(5)[a)]	(6)	(7)	(8)	(9)	(10)
I^iE^j (i=N &/or j=N)	0.162	-0.110	0.076		0.066	-0.123	-0.111	-0.059	0.322	0.278
	[0.043]***	[0.057]*	[0.045]		[0.045]	[0.094]	[0.090]	[0.122]	[0.099]***	[0.158]*
I^iE^j /IE (i=N &/or j=N)				0.001	0.001			-0.001		
				[0.000]***	[0.000]***			[0.002]		
Import share		0.161	0.048				-0.365			
		[0.158]	[0.162]				[0.182]**			
Export share		0.082	0.058				-0.017			
		[0.071]	[0.075]				[0.088]			
IE			0.378		0.534	0.405	0.855	0.224		
			[0.228]		[0.236]**	[0.385]	[0.468]*	[0.440]		
TFP_index (t-1)						0.704	0.614	0.707		
						[0.149]***	[0.145]***	[0.149]***		
Age of the firm	1.291	1.269	1.293	1.331	1.306	-0.007	-0.047	-0.007	1.113	0.000
	[0.198]***	[0.195]***	[0.192]***	[0.199]***	[0.193]***	[0.100]	[0.098]	[0.100]	[0.109]***	[0.000]
Sh. of pub. Own.	0.003	0.003	0.003	0.003	0.003	0.001	0.001	0.001	0.000	0.000
	[0.002]	[0.002]*	[0.002]*	[0.002]	[0.002]*	[0.001]	[0.001]	[0.002]	[0.002]	[0.002]
Sh. of For. Own.	0.004	0.003	0.004	0.005	0.004	0.000	0.000	0.000		
	[0.002]	[0.002]	[0.002]	[0.002]*	[0.002]*	[0.000]	[0.000]	[0.000]		
Constant	1.167	1.168	1.177	1.200	1.196	0.109	0.006	0.198	0.907	0.857
	[0.323]***	[0.356]***	[0.353]***	[0.352]***	[0.342]***	[0.719]	[0.692]	[0.723]	[0.385]**	[0.433]**
Observations	540	540	540	540	540	251	251	251	279	279
R-squared	0.11	0.11	0.12	0.09	0.12					
AB						Y	Y	Y		
IV									Y	
IV-GMM										Y
AR II (no autocorr.)						-0.40	-0.61	-0.33		
(P-value)						(0.6876)	(0.5414)	(0.7398)		
Hansen- Sargan test						5.02	4.68	5.02	3.875	
(P-value)						(0.4139)	(0.4557)	(0.4134)	(0.0491)	
Hansen J										1.259
(P-value)										(0.2618)

Notes:
Robust standard errors in brackets;
a) Errors are clustered at the industry-year level.
* significant at 10%; ** significant at 5%; *** significant at 1% ,
All the estimations include year sector, size and location controls.

Summing up, the higher is the firms' specialization, both as importer and as exporter, towards a particular geographical area, the higher is their level of productivity. The advantages do not seem to stem from the potential of technology transfer associated with trade with developed countries or be generated by the efficiency requirements of these markets, especially when considering downstream linkages.

7. Robustness checks: Semiparametric analysis

The parametric results reported up to here become weaker when we try to control for endogeneity biases. The most interesting results derive from multivariate correlation exercises. We are not able to conclude if trade practices generate productivity advantages or if it is the case that more productive firms chose to export or import. However additional extensions of the analysis are suggested by the fact that recent industrial organization literature has highlighted the importance of heterogeneity of firms within sectors. To investigate this feature we examine whether the participation in trade networks affects the *distribution* of firms' productivity uniformly or not.

The density distribution of the productivity index conditional on the fact that firms participate in foreign networks can be estimated with the following kernel density function:

$$f_h = \frac{1}{n_j h} \sum_{i=1}^{n} K\left(\frac{TFP_i - TFP}{h}\right) I(X = j) \qquad (12)$$

where K() is a kernel function[42], *h* is the bandwidth, I() is an indicator function equal to 1 if the trade index X is equal to j that can be either zero or one, n_j is the number of firms for which the index X is equal to j. Figure 2 shows the kernel density of the productivity index for firms that are both importers and exporters and for firms that are not[43].The distribution of firms that participate in foreign networks shows a good degree of heterogeneity however the probability of having an higher productivity level[44] is greater for firms that are both importer and exporter. In fact, the density distribution of firms for which the IE index is greater that zero lies on the right of the density distribution of firms for which the index is equal to zero. For a more rigorous test, in Appendix B we also report the Stochastic dominance tests on the cumulative distributions.

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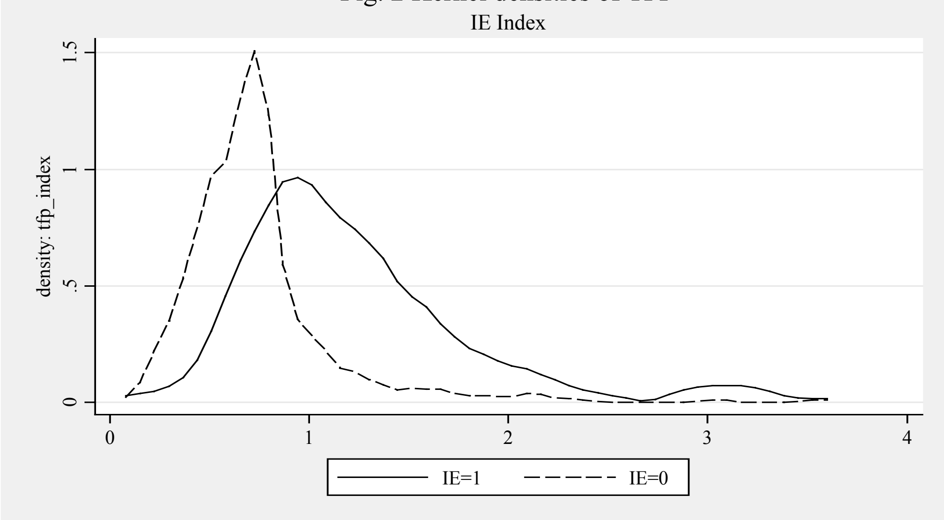
[42] in this application, a Gaussian kernel function will be used.

[43] Whether the IE index (5) is equal to zero or to one.

[44] Above the "mean" which corresponds, for the TFP Index, to the value "1" on the horizontal axis.

Fig. 2 Kernel densities of TFP



On the other hand, these findings can derive from the different, and not observed, characteristics of the firms that belong to the two groups. However, following Di Nardo et al (1996) is possible to construct a counterfactual density distribution of the productivity of firms for which the IE index is equal to zero. This counterfactual density is calculated associating a greater weight to the firms that are not involved in international networks but that have observable characteristics similar to those firms that are involved.

Since the density function of the TFP index conditional to the realization of the IE index is the integral of the cumulative conditional probability function. For the case of firms that are not involved in foreign networks but have the same z_i characteristics of firms that are both importers and exporters we have that:

$$f_{z_i}\left(TFP \mid X=0\right) = \int_z f_{z_i}\left(TFP \mid z, X=0\right) dF(z \mid X=1) = \int_z f_{z_i}\left(TFP \mid z, X=0\right) \frac{dF(z \mid X=1)}{dF(z \mid X=0)} dF(z \mid X=0) \quad (13)$$

Thus, with $\frac{dF(z \mid X=1)}{dF(z \mid X=0)} = \psi_z(z_i)$ as weighting function, we have that the estimated counterfactual kernel density function will be:

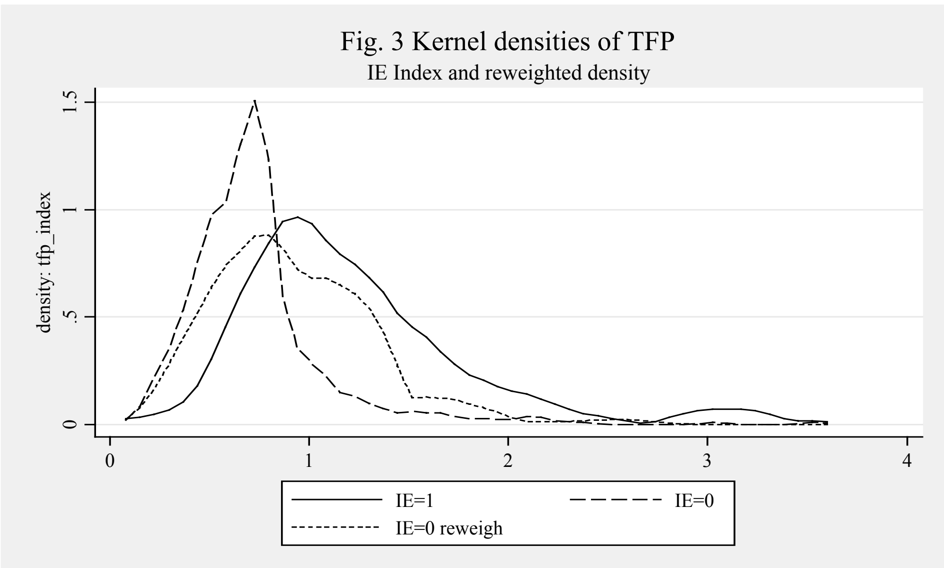
$$f_h = \frac{1}{n_j h} \sum_{i=1}^{n} \hat{\psi}_z * K\left(\frac{TFP_i - TFP}{h}\right) I(X=0) \quad (14)$$

by applying Bayes rule at the numerator and at the denominator, the weighting function can be estimated using the following specification:

$$\psi_z(z_i) = \frac{dF(z \mid X=1)}{dF(z \mid X=0)} = \frac{\Pr(X=1 \mid z=z_i)}{\Pr(X=0 \mid z=z_i)} \frac{\Pr(X=0)}{\Pr(X=1)} \tag{15}$$

Where, Pr(X=0) and Pr(X=1) is the unconditional probability that the IE index is equal to zero or one respectively, while Pr(X=1| $z = z_i$) and Pr(X=0| $z = z_i$) are the prediction obtained from Probit estimates of the probability that X=1 or X=0, with z_i as regressors[45]. Figure 3 displays the estimated counterfactual density for the firms that are not involved in trade networks. This latter density lies between the other two showing how the similarity on firm characteristics affects the distribution of the performance variable, however it is still always on the left of the distribution of productivity of the plants that are engaged in trade both upstream and downstream.

Therefore after controlling for firm characteristics we still find that there is an higher productivity advantage associated with being both an importer and an exporter.



[45] z_i is a vector that includes the same variables used to estimate equation (3)

Similar analyses have then be performed substituting to X, in equations (12) to (15), firstly the index that identifies firms that have both upstream and downstream contacts with the same geographical area, then the index that indicates trade flows with North America and Western Europe. Results are displayed in Figure 4 and 5.

Fig. 4 Kernel densities of TFP

Same Destination and reweighted density

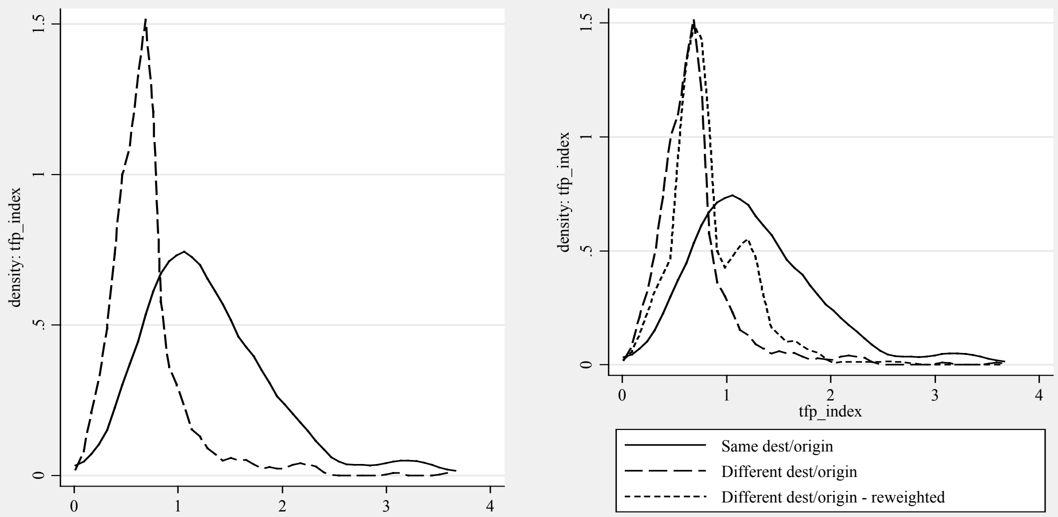
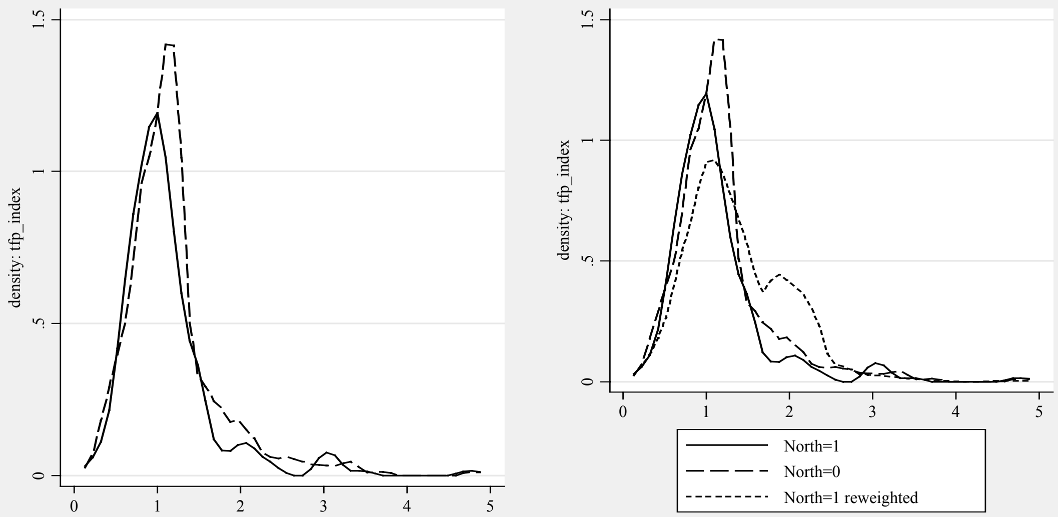


Fig. 5 Kernel densities of TFP

Trade with North and reweighted density



These last two figures (and the stochastic dominance tests reported in Appendix B) confirm the findings of the parametric analysis on the direction of trade. In fact, after controlling for firm characteristics, the density distribution of productivity associated to trade flows that have the same origin and destination always lies on the right of the density distribution of productivity associated to other flows (Fig.4). While in the case of trade flows with the "North" there seem to be no diversification between the density distributions (Fig.5).

Conclusions

Indian exporters and importers have higher productivity than firms that are not engaged in these practices. This replicates similar findings for a number of other countries. Specifically, we find that such positive correlation with performance is stronger and more significant when the share of inputs imported or the share of output exported are introduced substantiating the idea that markets are segmented and it is necessary to specialize both as a "buyer" and as a "seller". Therefore the more a firm is oriented towards foreign markets, the more advantages it can reap given also the fact that there are fixed costs in entering foreign market that need to be compensated. Moreover the most productive firms are those that choose to have both backward and forward linkages with foreign counterparts. In particular, the higher is the magnitude of the combined flows that involve the *same* region the higher is the efficiency advantage. This combined effect of imports and exports within trade networks on firm performance has not being documented before and it deserves further investigation.

Besides, further analysis on the relationship between import and exports can have important trade policy implications. India has moved from an import-substitution industrial policy to more liberalized import and export policies. However the country liberalization process is not yet completed and for this it can be relevant to focus on the import content of export at the firm level.

Finally from the analysis on the origin and destination of trade it has emerged that firms that are exporter-to or importer-from North America and Western Europe do not necessarily have a productivity advantage with respect to the others. This is quite surprising if we interpret the results on the light of previous studies. However this could correspond to the involvement of Indian firms in production networks with Northern firms. Given the possibility of extreme disintegration of production processes we can have that, theoretically, in a low-cost labour country like India, the more labour intensive and lower value added phases of production are performed. This can be one of the reasons why we do not find efficiency advantages. This issue needs however more in depth studies in the future and more specific data sources.

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Appendix A

Production Function Estimations with Levinshon-Petrin Correction

The main benefit of using the Levinshon and Petrin methodology instead of Olley and Pakes is essentially data driven. The use of the investment proxy to control for unobservables so to overcome the endogeneity of labour and inputs in production function estimations (Marschak and Andrews,1944, Griliches and Mairesse, 1998) is valid only when firms report non-zero investments and this would imply a severe truncation of our sample.

The idea suggested by Levinsohn and Petrin (2003), is to use, instead of investments, intermediate inputs to control for producer unobservables. In details, we start from a Cobb-Douglas production function (as equation (7)),

$$y_{it}^{j} = \beta_0 + \beta_w lw_{it}^{j} + \beta_b lb_{it}^{j} + \beta_k k_{it}^{j} + \beta_e e_{it}^{j} + \beta_m m_{it}^{j} + \omega_{it}^{j} + \varepsilon_{it}^{j}$$

where y_{it} is the log of gross output (proxied by sales) for firm i in year t lw_{it} is the log of white (skilled) labor input, lb_{it} is the log of the blue (unskilled) labor input, and e_{it} and m_{it} denote log-levels of materials, and energy (which includes consumption of fuel and electricity).

Here, we consider that the demand for intermediate inputs m_{it} depends on capital, k_{it} , and on the productivity component ω_{it} , that are both firm's state variables.

$$m_{it}= m_{it}(k_i\ ,\ \omega_{it})$$

Inverting this function[46], we have that $\omega_{it}=\omega_{it}(k_{it}\ ,m_{it})$, so the unobservable productivity term becomes a function of observed inputs.

Then, following Olley and Pakes (1996), the final identification restriction relies on the fact that productivity is governed by a first-order Markov process:

$$\omega_{it} = \mathrm{E}[\omega_{it} \mid \omega_{it-1}] + \xi_{it}$$

where ξ_{it} is an innovation in productivity uncorrelated with k_{it} .

Substituting for ω_{it} in the production function, we have that

$$y_{it} = +\beta_w lw_{it} + \beta_b lb_{it} + \beta_e e_{it} + \phi_{it}(k_{it}, m_{it}) + \varepsilon_{it}$$

where $\phi_{it}(k_{it}, m_{it}) = \beta_0 + \beta_k k_{it} + \beta_m m_{it} + \omega_{it}(k_{it}, m_{it})$.

[46] Levinshon and Petrin, 2003 show that under mild assumptions, the input demand function is monotonically increasing in ω_{it}

The estimation of the coefficient on the labour inputs and energy are obtained substituting a third order polynomial approximation in k_{it} and m_{it} to ϕ_{it} and then using OLS. From this first stage of the estimation routine we obtain $\hat{\beta}_w$, $\hat{\beta}_b$, $\hat{\beta}_e$ and $\hat{\phi}_{it} = \hat{y}_{it} - \hat{\beta}_w lw_{it} - \hat{\beta}_b lb_{it} - \hat{\beta}_e e_{it}$.

In the second stage, for any candidate value[47] of β_k* and β_m* it is possible to compute $\hat{\omega}_{it}$ using $\hat{\omega}_{it} = \hat{\phi}_{it} - \beta_k^* k_{it} - \beta_m^* m_{it}$

Subsequently, from the regression

$$\hat{\omega}_{it} = \gamma_0 + \gamma_1 \omega_{t-1} + \gamma_2 \omega_{t-1}^2 + \gamma_3 \omega_{t-1}^3 + \eta_{it}$$

we obtain a consistent (non parametric) approximation of $E[\omega_{it} \mid \omega_{it-1}]$, $\hat{E}[\omega_{it} | \omega_{it-1}]$ that is used to compute the sample residual for the production function (as a function of β_k* and β_m*)

$$\hat{\varepsilon}_{it}(\beta_k^*, \beta_m^*) + \hat{\xi}_{it} = y_{it} - \beta_w lw_{it} - \beta_b lb_{it} - \beta_e e_{it} - \beta_k^* k_{it} - \beta_m^* m_{it} - \hat{E}$$

To identify both β_k and β_m separately we need two moment conditions. The first will be (as in Olley and Pakes) that the capital does not respond to shocks to this period's innovation in productivity ξ_{it}, providing the population moment:

$$E[\xi_{it} + \varepsilon_{it} \mid k_{it}]=0$$

The second condition, needed to identify β_m , uses the fact that last period's material choices should be uncorrelated with the innovation in productivity in this period.

$$E[\xi_{it} + \varepsilon_{it} \mid m_{it-1}]=0$$

Finally, with $Z_{it}=(k_{it} ,m_{it-1})$, $\hat{\beta}_m$ and $\hat{\beta}_k$ are obtained minimizing the GMM criterion function,

$$Q(\beta^*) = \min_{\beta^*} \sum_i \left[\sum_t (\xi_{it} + \varepsilon_{it}) Z_{it} \right]^2$$

With respect to inference, given the fact that this is a multi stage estimation procedure, the covariance matrix of the final parameters must account for variance and covariance of every estimator that enters the routine. This problem is solved by bootstrapping standard errors.

[47] good starting values might be the OLS estimates from the production function.

Implementation

The procedures has been implemented on the Indian data set using the Stata 8 "levpet" command (Levinshon, Petrin and Poi, 2003).

One important issue for this estimation procedure is the choice of proxies. In fact any intermediate material can be potentially used as a valid proxy. In our case we could use both intermediate material inputs and energy consumption.

Often energy (and in particular electricity consumption) is considered the best proxy. In fact, since it cannot be stored, its use should be highly correlated with the year to year productivity term.

However, one of the basic estimation assumption is that the input demand function is such that for any capital level and productivity shock, the firm is really able to obtain $m_t(w_t,k_t)$. In the case of energy, we have that many of the firms in the sample have reported pessimistic evaluation of the supply reliability. For example the mean number of power outages or surges declared per month is about 9,3 and when asked to rate the quality of power on a 1 to 10 scale, 40 percent of the firms in the sample judged it less than 5. therefore unreliability of supply might lead, in our case, to the observed energy usage that is different from the true demand. For this reason, we choose to rely on material inputs as proxy variable. Furthermore, on the basis of some information reported in the data, the "number of days of inventory kept for the most important product"[48] is on average 30, therefore we have grounds to consider intermediates as not heavily stored.

The estimation were then performed on each macro sector identified so no assumption of common production technologies and common return to factors among sectors had to be made. Outliers were identified by means of the Hadi method. In particular, we dropped the one percent tails at both ends of the joint distribution of all the variables used in the production function estimation.

Table A1 displays the coefficient from the production function estimations with the Levinshon-Petrin methodology and with ordinary least squares. The variation between the two estimates is close enough to expectations. In fact, in case of simultaneity bias OLS tends to overestimate the labour coefficient and underestimates the capital coefficient. Therefore the Levinshon-Petrin procedure, solving the bias, should give lower labour coefficient and higher capital coefficient.

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[48] One of the question of the IC-survey.

Table A1. Comparison of coefficient of production function estimations LP vs. OLS.

	Drugs & Pharma	Electronic & Electrical Goods	Garm. & Tex.
Coeff from LP regressions			
Lw	0.159***	0.104	0.042***
Lb	0.063*	0.074	0.036**
Lk	0.034	0.013	0.050
Lm	0.487**	0.968***	0.761***
Le	0.080**	0.047	0.108***
Coeff from OLS regressions			
Lw	0.163***	0.132***	0.051*
Lb	0.068***	0.038	0.036**
Lk	0.024	0.013	0.032**
Lm	0.671***	0.852***	0.761***
Le	0.092***	0.082**	0.109***
Change in lw coeff	-	-	-
Change in lb coeff	-	+	0
Change in lk coeff	+	0	+
Change in lm coeff	-	+	+
Change in le coeff	-	-	-
Observations	195	118	372

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%

Variables used in estimations

Production Function	
Output	deflated sales from the balance sheet
Labour	"White" and "Blue", for each category it represents the average hours worked in one year by each employees then multiplied by the number of employees belonging to each cathegory. In particular "white" collar workers (skilled) represents manager and professionals and "blue" collar workers identify the production and the non production, unskilled workers.
Capital	net book value from balance sheet
Material	deflated cost of material inputs excluding fuel, from balance sheet.
Energy	deflated cost for energy consumption (including electricity and fuel) from balance sheet.
Deflators	Wholesale Price Index (Source office of the Economic Adviser, Ministry of Commerce & Industry)
Tab.3	
Capital Intensity	Net book value of capital /number of employees
Sh. of Sk. Workers	Number of white collar workers/blue collar workers
Age of mach	Average age of machineries
Employment	Number of employees
Average Wage	Total wage bill/ number of employees

Appendix 3.B

Kolmogorov-Smirnov test.

To test for differences in all moments of the conditional distributions (showed in fig B1 and B2) we can use the Kolmogrov-Smirnov test of first order stochastic dominance. For this we refer to the two conditional cumulative distribution functions of productivity, *F* and *G*. *F* corresponds to the of firms engaged in the international activity we are interested, for example firms that both import and export ,and *G* the comparison group, firms the exhibit an IE Index equal to zero. First-order stochastic dominance of *F* with respect to *G* is defined as: $F(z)-G(z)\leq 0$ uniformly in $z\in\Re$ with strict inequality for some *z*.
Therefore to perform the full test, we first refer to the two-sided Kolmogorov-Smirnov statistics to reject the hypothesis that both distributions are identical.
In this case the null and the alternative hypotheses are:
H_0: $F(z)-G(z)=0 \quad \forall \; z\in\Re$ versus H_1: $F(z)-G(z)\neq 0$ for some $z\in\Re$ (A)
Then subsequently , the one-sided test of stochastic dominance of *F(z)* with respect to *G(z)* will be:
H_0: $F(z)-G(z)\leq 0 \quad \forall \; z\in\Re$ versus H_1: $F(z)-G(z)>0$ for some $z\in\Re$ (B)

Rejection of the null hypothesis in (A) and not rejection of the null in (B) imply that the distribution of *F* lies to the right of *G*. In this case, *F* is said to stochastically dominate *G*.

Table B1 displays the values of the KS statistics and the corresponding probability levels[49]. We can see that in the first two cases, the distributions F(IE=1) and F(SAME=1) are stochastically dominating the distributions G(IE=0) and G(SAME=0) respectively as it also appear from the figures B1 and B2a. In the case of the F(NORTH=1) and G(NORTH=0) we cannot reject the hypothesis of equality of distributions.

[49] We are aware that limiting distribution of the Kolmogorov-Smirnov statistics is only known under independence of observations (see Girma, Kneller and Pisu 2003). But instead of performing the analysis year by year, we choose to test the stochastic dominance on the distribution of the firm level averages productivity index conditional on the respective average values of the trade indexes.

Table B1 Kolmogorov-Smirnov tests on the distribution of the productivity index

	Obs	(A) KS statistic (p-value)	(B) Hip	(B) KS statistic (p-value)
IE[a)]=1	305	0.2515*** (0.000)	G(IE=0)>F(IE=1)	-0.0145 (0.961)
vs IE=0	635		G(IE=0)<F(IE=1)	0.2515*** (0.000)
SAME[b)]=1	195	0.2946*** (0.000)	G(SAME=0)>F(SAME=1)	-0.0235 (0.929)
vs SAME=0	720		G(SAME=0)<F(SAME=1)	0.2946*** (0.000)
NORTH[c)]=1	240	0.0959 (0.164)	G(NORD=0)>F(NORD=1)	-0.0293 (0.803)
vs NORTH=0	675		G(NORD=0)<F(NORD=1)	0.0959 (0.196)

Notes :

a) Indicator variable that takes the value of 1 if the IE Index is greater than zero and the value zero otherwise
b) Indicator variable that takes the value of 1 if the I^iE^j (i=j) index is greater than zero and the value zero otherwise.
c) Indicator variable that takes the value of 1 if the I^iE^j (i=N &/or j=N) index is greater than zero and the value zero otherwise.

Figure B1. Cumulative conditional distributions (IE Index)

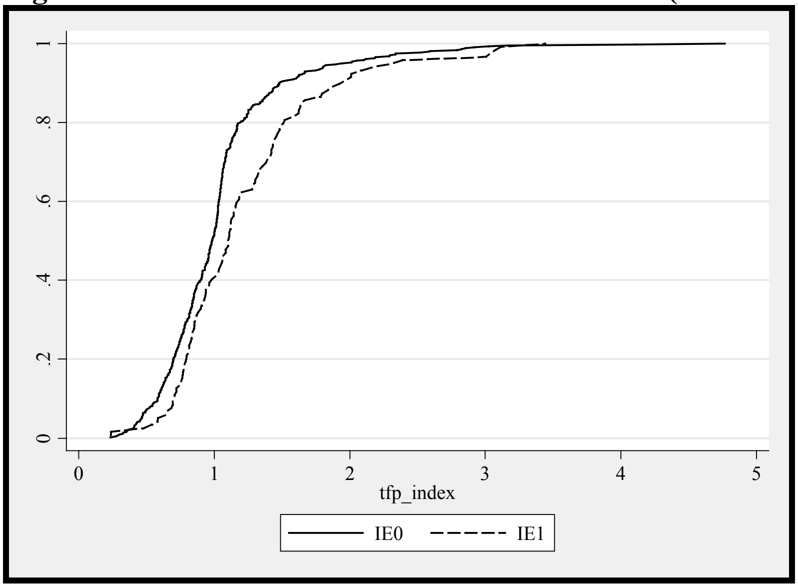

Figure B2. Cumulative conditional distributions (IE Index)