Journal of Evolutionary Economics
https://doi.org/10.1007/s00191-020-00718-z

REGULAR ARTICLE

Making one's own way: jumping ahead in the capability space and exporting among Indian firms

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Accepted: 26 December 2020Published online: 06 February 2021

Abstract

This paper provides large scale evidence on the determinants of international competitiveness of Indian manufacturing firms, focusing in particular on the role of technology, costs and imported intermediate inputs. Our evidence suggests that innovation, in particular R&D investment, is positively related to both firms' probability to export and firms' export volumes. We also find that imported intermediate inputs, incorporating foreign technology is strongly associated with expanding export activities of firms. Finally, and in contrast to much of previous evidence on developed economies, we find that higher productivity or lower unit labour costs are not systematically associated with the probability to enter export markets, but they are positively related to higher export volumes. Overall our results point to the existence of a pattern of involvement in international trade for firms in developing countries that is not relying as a main driver on cost competitiveness.

Keywords Innovation · Firms' capabilities · Imported inputs · Productivity sorting · Trade policy · India

JEL Classification D22 · F13 · F14 · L25 · O33

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1 Introduction

A rich stream of literature, mostly focused on developed countries, and including, among others, Soete (1981, 1987), Wakelin (1998), Cimoli et al. (2009), Bustos (2011), and Dosi et al. (2015), has highlighted the distinct role of technology and cost-related variables in determining export performance at the country, country-sector and, finally, at the firm-level. There is some evidence that cost-variables, as proxied by unit labour costs, do matter for export performance of developing countries (for a country-sector analysis of South Africa, see Edwards and Golub 2004); and the same is true for the role of technology.[1] However, there is still a lack of evidence regarding the role of costs *vis à vis* technology in determining export performance of firms. This is even more true for developing countries, where a lower labour cost is often regarded as one of the main determinants of export participation and much less attention is generally paid to the role of innovation. In such a context, we will resort to comprehensive firm-level data for India to shed light on this issue.

A closely related body of empirical and theoretical evidence documents widespread and persistent differences in efficiency between exporters and non-exporters. The evidence, which is mainly based on productivity measures as proxies of efficiency, comes from several countries, including the United States (Bernard and Jensen 1999), Germany (Bernard and Wagner 1997), Colombia, Mexico and Morocco (Clerides et al. 1998), Spain (Delgado et al. 2002), Italy (Castellani 2002), the United Kingdom (Girma et al. 2004), Sweden (Nan and Hansson 2004) and Slovenia (Damijan and Kostevc 2006).[2] Most of these studies confirm the evidence that high productivity precedes entry into the export market, a finding that hints at the presence of sunk entry costs, which only the most productive firms can afford to pay.

In addition, when focusing on the relation between firm performance and openness to trade in the case of a developing country, one has to bear in mind that these economies have traditionally relied heavily on foreign technology, for instance in the form of import of intermediate inputs (see, for instance, Goldberg et al. 2010). Indeed, if access to foreign intermediate goods allows firms to reduce their marginal costs, or provides access to new foreign inputs, it is reasonable to expect a positive effect also on their export performance; this effect is likely to be relevant for developing countries if, as generally assumed, they depend more on foreign technology than developed countries. Despite the growing body of literature addressing this issue, no evidence has been provided, to our knowledge, for the existence of this relationship in the case of India.[3]

Further note that if firm heterogeneity is in general pervasive and persistent, this is even more true in a developing country like India, where firms differ a lot, in terms

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[1] Chadha (2009) analyzes, within a neo-technology framework, the impact of technology, proxied by patents, on Indian pharmaceutical firms' exports, and finds a positive relationship between the two variables. Fafchamps (2009) finds that, for Moroccan manufacturing firms, technology and product quality are positively associated with exports.

[2] See Bernard et al. (2012) for a recent survey of this literature.

[3] A related work by Topalova and Khandelwal (2011) focuses on the relation between imported intermediate inputs and firm productivity in India, without tackling the role of technology for export market participation.

of their degree of development and their capabilities. In their seminal work, Cirera and Maloney (2017) observe, in what they refer to as the innovation paradox, that despite high returns from R&D investment in more advanced economies, developing countries do much less innovation, instead of following the track of developed countries.

The explanation put forth by the authors is that firms in developing countries might lack the necessary capabilities to fully benefit out of such R&D investment. We argue here that a similar mechanism could be at work in the context of international trade: the lack of skills might prevent firms from harvesting opportunities in foreign countries. The intuition behind is related to Cirera and Maloney (2017)'s concept of "capability escalator", where the basic idea is that firms build on their accumulated capabilities, moving, at each step of the capability ladder, to more and more sophisticated investments over time.[4] While the lower steps of the capability ladder involve building capabilities like basic infrastructure facilities, at a higher level, firms are involved in technology adoption and imitation of foreign technology. During their lifetime, firms might get to a point in which they actually export, but if they have not previously developed the necessary capabilities for such activity, they are likely not to benefit from it, even if they show up as exporters in the data. For instance, to benefit from exporting activity (which according to Cirera and Maloney (2017) comes within the second stage of the capability escalator), the firm should have built on other capabilities in addition to basic infrastructure, such as managerial capabilities, a distribution network abroad, etc.

In the Indian case, in order to promote exports, the government has been steadily providing export incentives to enterprises, in various forms, like import replenishment, tax concessions, export commitments, etc. See Kumar and Siddharthan (1994). Perhaps such policies could attract firms that are in the lower stage of the capability escalator with less capabilities to undertake exporting. Now, the question arises as to whether these firms would be able to reap benefits from exporting or not. In fact, this concept also makes it challenging to have a presumption on which firms enter the export market in the first place. This is indeed one of the research questions we explore in this work.

Our work contributes to the following streams of research. *First,* building upon (Dosi et al. 2015), we contribute to the "technology gap" literature in the context of a developing country. In particular, we investigate the role of investments, R&D expenditures, productivity and unit labour costs in affecting export market participation and export performance. We refer to the first two variables as "innovation" variables and to the last two variables as "efficiency" variables. Interestingly, and at odds with most of the existing empirical literature, we do not find robust evidence in favor of the so-called self-selection hypothesis, according to which there should be a clear sorting of firms into the export market according to their productivity. Yet we do find that efficiency plays an important role in determining how much firms export, once

[4] It is important to emphasize that any advancement in the capability space does come at a cost and it is not to be taken for granted. On this, Coad et al. (2020) rephrase the term "capabilities escalator" to "capabilities ladder", since as they point out, there is no automatic upward tendency for capabilities over time.

they already started exporting. Process innovation and product innovation are positively related to the probability to be an exporter and to the levels of export. On the contrary, cost competitiveness, measured by unit labour costs, does not appear to be associated with the probability of firms to enter the export market, but it does have an impact on export volumes.

Second, we look at the relationship between firms' export decisions and the availability of imported intermediate goods, possibly spurred by input trade liberalization in India. In this respect India is an interesting case, since in the post-reform era policy makers have shown interest both in export-led growth, through various export promotion policies, and in input tariff liberalization (Banga and Das 2012; Naranpanawa and Arora 2014). In fact, India's foreign trade policy over the period 2009-2014 aimed at expanding its overall share in international trade in order to promote massive employment creation through export growth.[5] However, India's growth in manufacturing and particularly in exporting has been slower than that of other developing countries, notably China (Rajan et al. 2002). In this respect our results find that the import of inputs is related to the export performance of firms, suggesting a positive and significant role of imported foreign technology in the process of firm's internationalization.

The rest of the paper is organised as follows. Section 2 reviews the existing literature on technological and cost-related determinants of firm export behaviour and provides a brief outline of the trade reforms that have taken place in India. Section 3 describes the data used in the study, and Section 4 presents the results from the empirical analysis. Section 5 concludes.

2 Conceptual framework and related literature

A long-standing tradition in economic literature posits that trade performance of countries is determined to a large extent by their relative technological position. This perspective, shared both by technology-gap theories of trade and product-cycle views (see, among others, Posner 1961; Vernon 1966; Cimoli 1988; Dosi et al. 1990), sees trade flows as mainly driven by sector-specific absolute advantages, which in turn are related to the capabilities of some countries to produce innovative goods or to adopt process innovations more quickly.

A central theme of this literature, following the question originally posed by Kaldor (1978), is to what extent technological factors are important for trade performance vis-à-vis other factors, like unit labour costs. The technology-gap literature has provided a robust set of results on the dominant role of the former. However, most of the evidence to date is at the aggregate country or sector-country level (see Fagerberg 1988; Dosi et al. 1990; Amendola et al. 1993, and the review in Dosi et al. 2015) and the evidence from developing countries, while existing, is still scarce (among

[5] See Foreign Trade Policy 2009 (27th August 2009-31st March 2014), Government of India, Ministry of Commerce and Industry, accessible at (http://dgft.delhi.nic.in) for more details on India's export targets and trade policy of export promotion.

the exceptions, we refer to the theoretical model and historical perspective in Cimoli et al. 2019).

The recent literature on firms in international trade (Bernard et al. 2007) emphasizes the presence of sunk entry costs which restrict the access to foreign markets to most productive firms. Such prediction of self-selection of more productive firms into the export market (Melitz 2003) has been confirmed by several empirical studies (see Introduction for a brief review) and is now a widely accepted empirical regularity. Also much relevant for our study, several contributions point towards the impact of innovation on exporting behaviour at the firm-level. Some studies that have investigated the impact of product and process innovation for exporting behaviour of firms include Wakelin (1998), Haidar (2012), and Dosi et al. (2015). A positive relation between R&D and exports has emerged from firm-level micro-econometric studies (Kumar and Siddharthan 1994; Fagerberg 1996; Wakelin 1998; Bernard and Wagner 1997; Lefebvre et al. 1998; Sterlacchini 1999; Hasan and Raturi 2003; Yang et al. 2004; Filippetti et al. 2011; Ghazalian 2012). Costantini and Melitz (2008), Lileeva and Trefler (2010), and Bustos (2011) have explored the linkages between investments in innovation and the decision to export in the context of the liberalization of trade regimes. Few studies have investigated the role of cost competition in firms' export performance including, among others, Wakelin (1998), Basile (2001) and Dosi et al. (2015). While Wakelin (1998) and Dosi et al. (2015) have found no evidence for the effect of unit labour costs on export performance, Basile (2001) have found a negative and significant effect of labour costs.[6] In line with the above mentioned studies, we examine the relationship between cost and technology factors and exporting behaviour of firms.

The analysis of international trade in a developing country has an additional and distinctive feature that must be accounted for: the sourcing of inputs abroad might be related to acquiring technology that is not available in the home country. This aspect is especially relevant for India, which undertook a gradual process of import tariff liberalization during the period under investigation (more on this in Section 2.1).

Previous literature, both theoretical and empirical, has emphasized economic gains from importing intermediate goods. Theoretical models (Ethier 1979; Grossman and Helpman 1991b; 1991a; Markusen 1989; Rivera-Batiz and Romer 1991; Eaton and Kortum 2002) and empirical work using country-level data (Coe and Helpman 1995; Keller 2002) have highlighted a positive relationship between importing foreign intermediate goods and economic growth. Empirical work using firm-level data has shown that imported intermediate inputs increase firm productivity, even if the magnitude and the significance of the effect depend heavily on the choice of the country of analysis. Using semi-parametric estimation of total factor productivity, Halpern et al. (2015) for Hungary, Kasahara and Rodrigue (2008) for Chile, Amiti and Konings (2007) for Indonesia, and Van Biesebroeck (2008) for Zimbabwe find large positive effects of importing intermediate inputs on firm productivity. Smeets and Warzynski (2013) using a firm-product level dataset from Denmark, show that imported inputs of different origins (OECD countries and low-wage countries) improve firm TFP. On

[6] See Dosi et al. (2015) for a complete review of firm-level empirical studies.

the other hand, Muendler (2004) focusing on manufacturing plants in Brazil, finds no significant effect of imported inputs on firm productivity growth. Finally, the literature on two-way traders (see among the others, Muûls and Pisu 2009; Castellani et al. 2010) has shown that greater availability of imported inputs should increase firm productivity and this, in turn, might affect export propensity.[7]

There are several explanations to the positive relation between foreign intermediate goods and firm performance. Let us start to consider the increase in product variety. Importing new intermediate inputs, not previously available on the domestic market, allows firms to expand the set of inputs (Goldberg et al. 2010; Klenow and Rodriguez-Clare 1997), which, in turn, impacts on variety expansion (Broda et al. 2006). Goldberg et al. (2010) using firm-level data for India, disentangle the price and variety channels and find that an expansion in firms' product scope is driven more by increased access to new imported varieties of inputs that were previously unavailable than by lower import prices. Similarly, Halpern et al. (2015) using firm-level data for Hungary, show that most of the positive effect of importing intermediate goods on firm productivity comes from greater imported input variety.

Another explanation is related to quality upgrading, i.e, higher quality of imported inputs with respect to domestic intermediate inputs. Kugler and Verhoogen (2009) using firm-product level data from Columbia, show that importers use more distinct categories of inputs in their production and pay higher prices for imported inputs than for domestic inputs in the same product category.

If imported intermediates increase input mix variety, provide access to inputs not available on the domestic market, and allow firms to produce high-quality products, then it is reasonable to assume that they would have positive effects on firms' export performance as well. A related literature has indeed examined the direct effect of imported input on export performance of firms (see among the others, Bas 2012; Aristei et al. 2013; Turco and Maggioni 2013; Damijan et al. 2014).

2.1 Details on India's trade policy reforms

Until the beginning of the 1990s, trade policy in India has mainly been based on an import substitution strategy with the goal of supporting the domestic producers, especially those in the upstream level of the global value chain (see, for instance, Bruton 1998). In 1990, following a balance of payment crisis, India undertook structural reforms which paved the way to the liberalization of the economy. India's trade regime was complex, characterized by severe quantitative restrictions on imports and exports and extraordinarily high tariffs on imports (Krishna and Mitra 1998). The trade reforms included the removal of licensing and other non-tariff barriers on most of the imports of intermediate and capital goods and significant reductions in tariffs on all imports. Still, the reforms exempted few intermediate inputs and capital goods from the removal of import licensing on them. In addition, some consumer goods, accounting for approximately 30 percent of tariff lines, remained under licensing. Only a decade later, such barriers were finally removed. Nonetheless, India was still

[7] In addition to foster productivity, the availability of new imported inputs is also positively related to the probability to expand the export portfolio (Castellani and Fassio 2019).

far less open to international trade than many other developing economies. For example, by the mid-1990s, the import-weighted tariff rate in India was 33% as compared to 9% in Korea, 10% in Indonesia, 10% in Mexico and 14% in Brazil (see Ahluwalia et al. 1996).

Today, with the exception of a few goods whose trade is not allowed on environmental or health and safety grounds, and a few (including fertilizer, cereals, edible oils, and petroleum products) that can be imported only by the government, all goods may be imported without a license or other restrictions.

Following steps towards a liberalized trade regime, India's simple average tariff rate decreased significantly from 120% in 1989-90 to about 33% in 1997-98 (Goldar and Saleem 1992; Nouroz 2001), whereas trade-weighted tariffs declined from 87% in 1991 to around 30% by 2000 (Goldar 2002). For manufacturing, there was a decline in the average rate of tariff from about 120% in 1989-90 to about 33% in 1997-98 (Goldar and Saleem 1992; Nouroz 2001). India has been able to gradually increase its share in global merchandise exports from 0.44% in 1980 to 0.69% in 1999 and to 1.5% in 2010 (Government of India 2011). Figure 2 in Appendix A shows the trend of input tariffs in the manufacturing sector.

3 Data and descriptive analysis

In this study, we employ firm-level data from the Prowess database, provided by the CMIE (Centre For Monitoring Indian Economy Pvt. Ltd.). The database includes both publicly listed and unlisted firms from a wide cross-section of manufacturing, services, utilities, and financial industries. In this paper, we focus only on the manufacturing sector and the time span is from 1995 to 2011. The companies covered account for around 70 percent of industrial production.

Table 1 reports, for each year, the total number of firms, exporters, importers and two-way traders in the dataset. While the overall share of exporters has remained more or less constant over time, the share of importers and two-way traders shows an increasing trend, especially during the years 1995-2001, with a marked jump in the year 1999.[8] Note that, as our trade data (both on import and export) are collected at the customs, it is possible to identify only direct importers (exporters), and not firms that indirectly source their imported inputs from an intermediary.[9]

Table 2 shows the distribution of firms across different manufacturing sectors for the years 1995 and 2010. The columns report the number of firms in each sector (I); the distribution of firms and sales across sectors (II)-(III); the percentage of exporting firms within each sector (IV), and the distribution of export volumes across sectors (V). While the food and textile sectors accounted for around 30% of firms in

[8] As this could also be due to issues related to data coverage in the initial years, in the empirical analysis we remove the years 1995-1998 when analyzing the role of import intensity as determinant of export performance (see Section 4.3).

[9] This is a very well known issue in the trade literature and depends on the data collection procedure. See, among the others, Bernard et al. (2015) and Grazzi and Tomasi (2016) for an assessment of the role of intermediaries in international trade.

Table 1 Number and Share of exporters, importers, and two-way traders in different years

Year	All firms	Exporters	Exporters(%)	Importers	Importers(%)	Two-way traders	Two-way traders(%)
1995	3485	1720	50.65	109	3.13	65	1.87
1996	3464	1696	51.04	111	3.20	62	1.79
1997	3469	1679	51.60	163	4.70	85	2.45
1998	3566	1726	51.60	249	6.98	149	4.18
1999	3531	1660	52.99	1141	32.31	730	20.67
2000	3610	1691	53.16	1358	37.62	893	24.74
2001	3631	1679	53.76	1459	40.18	953	26.25
2002	3791	1660	56.21	1496	39.46	1002	26.43
2003	3944	1653	58.09	1619	41.05	1085	27.51
2004	3994	1674	58.09	1641	41.09	1093	27.37
2005	4008	1653	58.76	1649	41.14	1130	28.19
2006	3942	1624	58.80	1684	42.72	1156	29.33
2007	4011	1623	59.54	1707	42.56	1185	29.54
2008	4029	1639	59.32	1711	42.47	1205	29.91
2009	3962	1693	57.27	1685	42.53	1169	29.51
2010	3860	1731	55.16	1540	39.90	1089	28.21
2011	2699	1186	56.06	1042	38.61	774	28.68

Note. Exporters (importers) are defined as firms with strictly positive exports (imports). Two-way traders are firms which are both exporters and importers

1995 (slightly declining in 2010), the most important sectors in terms of sales were coke and petroleum, chemicals, basic metals and transport equipment, which together accounted for around 60% of total manufacturing sales.

The export propensity was above 40% in almost all sectors, with the exceptions of the food and wood sectors (around 30%); it is also, with few exceptions, increasing through time. Notably, the trend in the coke and petroleum sector between 1995 and 2010 witnessed both an increase in the export propensity (from 38.89% to 56.41%) and a substantial increase in its share of export volume with respect to total manufacturing, from around 7.5% in 1995 to 44.37% in 2010.[10]

In our analysis of export performance, we consider among independent variables total factor productivity, TFP,[11] unit labour costs, R&D activity (measured by a dummy), investment intensity, and import intensity. The definition of variables is provided in Appendix B; Table 3 reports some descriptive statistics on the variables of interest. Exporters are, on average, larger (in terms of sales) and more productive

[10]Since the coke and petroleum sector only contains 36 firms, we do not expect our firm-level analysis to be heavily affected by the inclusion of this sector. However, we also perform a robustness check by excluding this sector and the results did not change.

[11]A well known issue of CMIE is the lack of data on the number of employees which only allows us to employ TFP as an efficiency measure, instead of labour productivity.

Table 2 Descriptive statistics for exporters and non-exporters by sector of economic activity, for selected years

Sector	1995					2010				
	(I)	(II)	(III)	(IV)	(V)	(I)	(II)	(III)	(IV)	(V)
Food, beverages, tobacco	489	14.03	7.65	34.15	10.44	476	12.33	6.78	33.40	5.29
Textiles, wearing, leather	539	15.47	6.66	61.60	24.47	530	13.73	3.92	61.70	7.53
Wood, paper, printing	148	4.25	1.93	30.41	0.96	180	4.66	0.98	31.11	0.37
Coke & petroleum	36	1.03	21.98	38.89	7.57	39	1.01	38.76	56.41	44.37
Chemicals	455	13.06	14.48	57.14	12.14	517	13.39	6.81	54.35	5.91
Pharmaceuticals	263	7.55	3.36	57.79	6.50	289	7.49	3.49	60.55	8.68
Rubber & plastics	226	6.48	4.15	45.58	4.84	256	6.63	2.93	58.59	2.75
Non-metallic minerals	156	4.48	4.40	46.15	2.95	142	3.68	3.13	52.11	1.02
Basic metals	357	10.24	14.01	44.26	14.58	420	10.88	13.31	51.43	11.45
Fabricated metal	98	2.81	0.91	41.84	1.43	133	3.45	0.88	57.89	0.80
Computer & electronic	136	3.90	2.09	54.41	1.68	141	3.65	1.34	58.16	0.97
Electrical equipment	171	4.91	3.61	51.46	2.12	202	5.23	2.54	58.42	1.70
Machinery	203	5.82	5.87	68.97	3.85	251	6.50	4.80	74.50	2.15
Transport equipment	204	5.85	8.90	57.84	6.47	278	7.20	10.34	73.02	7.01
Furniture	4	0.11	0.01	25.00	0.00	6	0.16	0.01	33.33	0.00
Total	3,485	100.00	100.00		100.00	3,860	100.00	100.00		100.00

Note. (I) Number of firms; (II) distribution of number of firms (%); (III) distribution of sales (%); (IV) percentage of exporting firms within each sector (%); (V) distribution of export volumes (%)

while the average unit labour cost is almost identical for the two categories of firms. The higher mean for the R&D dummy also suggests that exporters are more likely to undertake R&D activities. The value of investment intensity and import intensity is higher for non-exporters. The correlation matrix for the variables used is presented in Table 10 in Appendix B.

The difference in size between exporters and non-exporters is apparent also at visual inspection when considering the whole distribution of sales, as in Fig. 1a and b. As for the other continuous variables, a comparison of the respective distributions reveals less clear-cut differences between exporters and non-exporters. The distributions of TFP and investments for exporters are only slightly to the right with respect to the non-exporters (see Fig. 1c–f). On the other hand, the distribution of unit labour cost for exporters seems to be more concentrated around the modal value than the one of non-exporters.

In order to have a more precise assessment of the differences in the distributions of the variables of interest for exporters and non-exporters, we also perform a non-parametric test. Table 4 reports the results for the Fligner-Policello (F-P) test[12] which

[12]Fligner-Policello is a non-parametric test for the statistical equality of two distributions, the null hypothesis being that the median in the two groups (samples) is the same. For details, refer to Fligner and Policello (1981).

Table 3 Descriptive statistics of selected variables in 2010, for the whole sample and by export status

Variable	Mean	Median	Std.Dev.
ALL FIRMS			
Sales	4703.53	606.00	53040.68
Total factor productivity	128.41	8.61	1440.62
Unit labour cost	0.22	0.17	0.17
Import Intensity	0.27	0.18	0.27
R&D dummy	0.28	0.00	0.45
Investment intensity	0.22	0.12	2.01
EXPORTERS			
Sales	6036.49	837.00	62477.30
Total factor productivity	155.90	9.48	1668.26
Unit labour cost	0.21	0.17	0.15
Import Intensity	0.29	0.20	0.27
R&D dummy	0.40	0.00	0.49
Investment intensity	0.18	0.13	0.20
NON EXPORTERS			
Sales	1440.10	274.80	11383.01
Total factor productivity	66.81	7.58	696.20
Unit labour cost	0.22	0.16	0.19
Import Intensity	0.24	0.12	0.28
R&D dummy	0.09	0.00	0.29
Investment intensity	0.19	0.10	0.54

Note. All variables are defined as in Appendix B. Sales are in rupee million

compares the distributions of sales, TFP, unit labour cost, and investment intensity, for the two different groups of exporters and non-exporters. From the statistics reported in Table 4, it is possible to conclude that some of the variables display a rather clear sorting between the groups of domestic and exporting firms. This is the case, for instance, of sales: exporters are systematically larger than non-exporters. Statistical significance is more nuanced, but still present for investment intensity, while for TFP and ULC the test statistics do not always show a clear ranking between the two distributions.

To conclude the exploratory analysis concerning the characteristic of exporting firms, we investigate the persistence in the export status and the probability to switch from one status to the other by employing a transition probabilities matrix. This result is indeed much related to the existence of what is generally referred to as sunk cost. Values on the main diagonal of Table 5, which display the probabilities of remaining in a given status from t to $t+1$, are rather high, thus suggesting persistence in the export as well as in the non-export status. This persistent behaviour is consistent with the presence of sunk costs to export and with evidence from other countries (see,

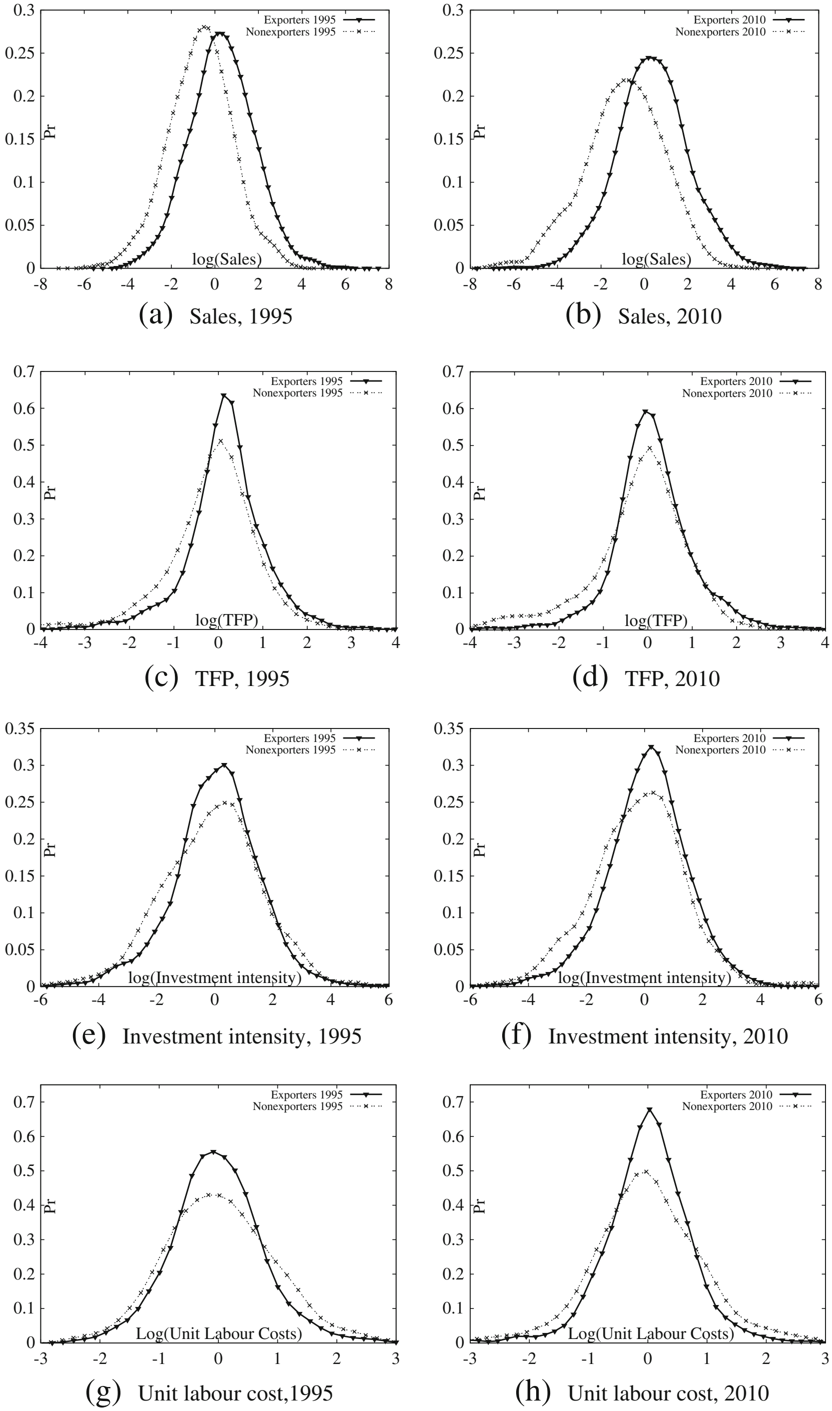

Fig. 1 Kernel density estimation of main variables, exporters vs non-exporters

Table 4 Exporters vs Non-exporters: Fligner-Policello statistics

Year	Sales	TFP	ULC	Investment intensity
1995	12.37	1.81	1.86	2.09
	(0.00)	(0.06)	(0.06)	(0.03)
2000	18.34	5.11	1.08	3.63
	(0.00)	(0.00)	(0.27)	(0.00)
2005	16.61	3.96	2.54	3.19
	(0.52)	(0.00)	(0.01)	(0.00)
2010	16.90	4.70	3.93	3.16
	(0.01)	(0.00)	(0.69)	(0.00)

Note. p-value in parentheses. Before pooling observations from different sectors, all variables have been taken as log deviation from their sectoral mean

among other, Roberts and Tybout 1997 for Colombia, Bernard and Jensen 2004 for US, and Grazzi 2012 for Italy).

4 Productivity, cost and technological competitiveness: extensive and intensive margin

In the following section, we turn to a more standard regression framework to investigate the firm-level determinants of export behaviour focusing both on the probability of a firm being an exporter (the so-called extensive margin), and also on what determines the export volumes of firms, once they are already in the export market (intensive margin).

4.1 Export market participation

Following the conceptual framework outlined in Section 2, we analyze the determinants of export market participation, focusing in particular on productivity, costs and technology-related variables. We estimate the following equation:

$$P(D_{EXP_{it}}=1)=\phi(\beta_1\, D_{EXP_{it-1}}+\beta_2\, PROD_{it-1}+\beta_3\, ULC_{it-1}+\beta_4\, R\&D_{it-1}+ \\ +\beta_5\, INV_{it-1}+\beta_6\, SIZE_{it-1}+e_{it}) \qquad (1)$$

Table 5 Transition matrix in and out of exporting over the whole time period (1995-2011)

t	t+1		
	0	1	Total
0	20,745	2,985	23,730
	(87.42)	(12.58)	(100.00)
1	3,045	28,730	31,775
	(9.58)	(90.42)	(100.00)
Total	23,790	31,715	55,505
	(42.86)	(57.14)	(100.00)

Note. Absolute and relative (in brackets) frequencies. 0 and 1 represent the status of non-exporter and exporter where, $D_{EXP_{it}}$ is a binary variable which takes value one if a firm exports and zero otherwise; $PROD$ is the (log) total factor productivity estimated using the Levinsohn-Petrin method; ULC is the (log) unit labour cost, which is equal to firms' total compensation to employees divided by value added of the firm; $R\&D$ is a dummy which takes value one if the firm invests in $R\&D$ and zero otherwise; $SIZE$ denotes firm's dimension and is proxied by (log) total domestic sales;

INV denotes (log) firms' investment intensity, which is equal to firms' total investment divided by total sales.

Econometric literature discusses several estimation problems in discrete-choice models with fixed effects. First, a fixed effects Probit model is theoretically not possible (Cameron and Trivedi 2005). Further, discrete-choice models (logit or tobit) allow to adjust for firm-specific effects, though the coefficients would be severely biased with small T-periods and a high number of individuals (Nickell 1981; Greene 2004; Fernández-Val 2009), as in our case. Additionally, computing linear models controlling for fixed effects with binary dependent variables is also problematic, especially when the dependent variable is rather persistent (Creusen and Lejour 2011). As a result, we estimate (1) using a pooled Probit specification. We also use a Probit model with Random Effects as a robustness check; the results are reported in Table 6.

Table 6 Determinants of export market participation

	(1) PROBIT RE	(2) PROBIT RE	(3) PROBIT	(4) PROBIT
Productivity	0.003	0.001	0.015***	0.000
	(0.005)	(0.005)	(0.005)	(0.004)
Unit Labour Cost	0.003	–0.002	0.003	–0.002
	(0.005)	(0.004)	(0.006)	(0.004)
R&D Dummy	0.099***	0.098***	0.174***	0.087***
	(0.010)	(0.008)	(0.010)	(0.008)
Investment Intensity	0.006**	0.010***	0.020***	0.010***
	(0.002)	(0.003)	(0.003)	(0.002)
Domestic Sales	0.040***	0.027***	0.031***	0.023***
	(0.004)	(0.003)	(0.004)	(0.002)
Lag. Exp. Dummy		0.551***		0.608***
		(0.013)		(0.011)
Sector Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Observations	17902	17902	17902	17902
Pseudo R^2			0.129	0.396
Number of firms	4353	4353	4353	4353

Note. Robust standard errors (in brackets) are clustered at the firm-level. Columns (1)-(2) report the results from the Probit Random Effects estimation. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Columns (1)-(2) and columns (3)-(4) report results from a Probit Random Effects and a pooled Probit estimation, respectively. We report the marginal effects of the independent variables on the probability of a firm exporting. We observe that both the decision to undertake R&D, i.e, our proxy for product innovation, and investment intensity, i.e, our proxy for process innovation, are strongly associated with export participation of firms.[13] The coefficient on the lagged export dummy is positive and significant, suggesting a considerable role of sunk costs in exporting. In line with earlier literature, we find that bigger firms are more likely to enter the export market. Surprisingly, both productivity and unit labour cost are not significant, suggesting that, contrary to most previous findings, there is no compelling evidence in favor of self-selection of firms into exporting based on their relative efficiency.

Table 11 in Appendix C presents the results for selection, that is, the estimate of the probability of being an exporter, using a Probit model performed separately for each two-digit manufacturing sector. Similar to the results observed in whole manufacturing, the lagged export dummy is positive and significant in all the sectors. R&D is also positive and significant in most of the sectors. In few sectors, namely, food and beverages, coke and petroleum, rubber and plastics, non-metallic minerals and computer and electronics sector, the coefficient is not significant. Investment intensity is significant only in a few sectors, namely, textiles, chemicals and pharmaceuticals, where the sign of the coefficient is positive. Productivity is not significant in any of the sectors, thus suggesting that the result of the single specification in the aggregate regression (Table 6, column 3) where productivity shows up as significant is, most likely, a statistical "artefact" due to the high number of observations.

4.2 Levels of exports

We now turn our attention to the impact of firm characteristics on how much firms export. The following equation presents our empirical model:

$$\begin{aligned} EXPORTS_{it} &= \alpha + \beta_1\, PROD_{it-1} + \beta_2\, ULC_{it-1} \beta_3\, R\&D_{it-1} \\ &\quad + \beta_4\, INV_{it-1} + \beta_5\, SIZE_{it-1} + e_{it} \end{aligned} \tag{2}$$

where $EXPORTS_{it}$ is log values of export of firm i at time t.

We begin by performing an OLS and fixed effects estimation to analyze the determinants of trade volumes for manufacturing firms. Notice that Eq. 2 is estimated only on the sample of exporting firms. This may introduce a bias in the estimated coefficients if the decision to export is correlated with the levels of export. Following previous studies, such as Greenaway et al. (2004) and Kneller and Pisu (2007), we also employ a Heckman sample selection model (Heckman 1979) that introduces a correction term accounting for the correlation between the extensive margin and the intensive margin. However, the Heckman approach can seriously inflate standard errors due to collinearity between the correction term and the included regressors,

[13] In the tradition of studies on innovation and international trade, we assume that the effect of technology on cost reduction, that we refer to as process innovation, is mostly due to investments, whether R&D is mostly related to product innovation, which tend to be associated to creating new products, hence to an increase in sales or exports.

Table 7 Determinants of levels of exports

	(1) OLS	(2) FE	(3) Heckman
Productivity	0.2951***	0.0986***	0.2777***
	(0.0391)	(0.0243)	(0.0378)
Unit Labour Cost	–0.2126***	–0.0906**	–0.2218***
	(0.0407)	(0.0384)	(0.0398)
R&D Dummy	0.7197***	0.1700***	0.4893***
	(0.0687)	(0.0550)	(0.0693)
Investment Intensity	0.0869***	0.0506***	0.0619***
	(0.0174)	(0.0108)	(0.0172)
Domestic Sales	0.3843***	0.3111***	0.3501***
	(0.0265)	(0.0391)	(0.0249)
Sector Dummies	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes
Observations	13670	13670	13670
R^2	0.299	0.253	
Number of firms	3284	3284	3284

Note. Robust standard errors clustered at the firm-level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

in particular in the absence of exclusion restrictions (Moffitt 1999; Stolzenberg and Relles 1990).

The exclusion variable we use, i.e. the variable that affects the selection process, but not the quantity exported, is the lagged export dummy. As previously shown (Table 5), exporting behaviour of firms is highly persistent, around 90% of the firms that export at time $t - 1$ also export at time t, therefore the lagged export dummy is very well suited to predict selection into the export market.

We estimate (2) using, respectively, OLS, fixed-effects and Heckman selection for all manufacturing firms. Table 7 reports the results.[14] Notice that, as might be expected, point estimates for the fixed effects specification are smaller than those of OLS. This is due to the fact that some variables are very persistent over time, such as the R&D status, which indeed registers the largest drop in the coefficient value, and also to the relevance of the unobserved fixed effects which is not accounted for in the OLS specification.

We observe that both R&D and investment intensity, our proxies for product and process innovation, are strongly associated with an increase in export volumes. We also find that bigger firms are more likely to export more. Interestingly, both productivity and unit labour cost are significant in explaining how much firms export: a 1% increase in total factor productivity or a 1% decrease in unit labour cost increase exports by around 0.2% (OLS specification).

[14] In order to check for multicollinearity among the independent variables, we compute the variance inflation factor after the standard OLS regression. The observed values for productivity, unit labour cost, R&D Dummy, investment intensity and domestic sales are 1.43, 1.29, 1.30, 1.11 and 1.90 respectively. These values are well below the standard threshold value used to detect potentially harmful multicollinearity, i.e. 10 (see Hair et al. 1998).

Table 12 in Appendix C reports the results for levels of exports using a Heckman selection framework for 2-digit manufacturing sectors. The picture on the volumes of export at the sector level is more mixed than that for export participation. Out of 14 sectors, in 6 sectors the coefficient of productivity is positive and significant.[15]

Concerning R&D, the variable is significant and positive in 8 out of 14 sectors.[16] Investment intensity is positive and significant in 7 sectors.[17]

Overall, the investigation of the determinants of export status and export volumes offers a rather interesting and peculiar account on Indian firms. Contrary to most evidence to date, it appears that there is almost no relationship between productivity and the probability to be an exporter. In this respect, the more detailed account at the sector level is even more compelling as productivity never appears to be significant in explaining the probability to be an exporter. In addition, also the coefficient of unit labour cost is not significant, i.e, firms with a cost advantage do not appear to be more more likely to export. These results, together with the evidence from Mathew (2017), who finds no relation between exporting and firm growth, show that the effects and determinants of export market participation is much more complex in the Indian case than one might assume given previous evidence from other countries. However, once in the export status, productivity and unit labour cost become relevant factors: more efficient firms export more.

4.3 Input tariff, imported inputs and export performance

As detailed in Section 2, access to imported inputs can improve export performance of firms through different channels: increased input variety (Klenow and Rodriguez-Clare 1997) leading to increased product variety (Broda et al. 2006), expansion in firms' product scope (Goldberg et al. 2010), quality upgrading (Kugler and Verhoogen 2009). The role of foreign intermediate inputs is very relevant in the case of India for at least two reasons. First, as a developing country, it relies heavily on imported technology (Goldberg et al. 2010). Second, India experienced a gradual, but continuous decline in the average tariff over the '90s (see Section 2.1): Fig. 2 in Appendix A displays the evolution of weighted average tariffs on imports over the years of analysis.

In this section, we investigate the relationship between import of inputs and firms' export market performance, both in terms of participation and in boosting export values. We carry out this analysis for a subset of the whole sample, i.e, over the period 1999-2011, since the data on imports during the initial years 1995-1998 is very scant (see Section 3). We augment the selection and level equations (Eqs. 1 and 2) with our input intensity measure. The estimation techniques are the same as those we introduced in the previous section.

[15]The sectors include coke & petroleum, chemicals, pharmaceuticals, rubber & plastics, non-metallic minerals and fabricated metal. In few sectors, like computer and electronic, the coefficient is negative and significant.

[16]Sectors include food, beverages and tobacco, textiles, wearing and leather, chemicals, pharmaceuticals, rubber & plastics, non-metallic minerals, basic metals and electrical equipment.

[17]The sectors are wood, paper and printing, chemicals, pharmaceuticals, rubber & plastics, non-metallic minerals, basic metals and computer and electronics.

Tables 8 and 9 report the results from the relation between the use of imported inputs and export market participation and exporting levels respectively. In Table 8, columns 1 and 2 present the results with import intensity as one of the independent variables, while columns 3 and 4 present the results without import intensity, but for the reduced sample. Concerning the extensive margin (Table 8), the coefficient on the use of imported inputs is positive and significant with a Probit estimation, as reported in column (2). Regarding the role of imported inputs for export volumes, we find a strong and positive relationship between the use of imported inputs and the level of exports as reported in Table 9. In the Table, columns 1 and 2 present the results with import intensity, while columns 3 and 4 show the results without import intensity, but for the reduced sample with the shorter time frame, 1999-2011. In all the specifications, we find that the coefficient on the use of imported inputs is positive and significant at 1% level, highlighting the strong relationship between the use of imported foreign inputs by firms and their export performance.

As for the other variables, the results for export participation are slightly different with respect to Table 6. In particular, productivity is now negatively and significantly related to the probability of exporting (with a Probit estimation), whereas investment intensity is not significant when the equation is estimated using Probit random effects. Concerning exporting levels, the results are in line with the baseline model (see Table 7).

Overall, our findings suggest that the use of imported inputs by firms is strongly associated with the export performance, both in increasing export values, and the

Table 8 Import intensity of inputs and export market participation: 1999-2011

	(1) Probit RE	(2) Probit	(3) Probit RE	(4) Probit
Productivity	–0.000	–0.009**	0.000	–0.002
	(0.000)	(0.004)	(0.002)	(0.004)
Unit Labour Cost	0.000*	0.009**	0.003	0.006
	(0.000)	(0.004)	(0.002)	(0.004)
R&D Dummy	0.002***	0.055***	0.025***	0.069***
	(0.001)	(0.006)	(0.005)	(0.007)
Investment Intensity	–0.000	0.006***	0.000	0.010***
	(0.000)	(0.002)	(0.001)	(0.002)
Domestic Sales	0.000***	0.013***	0.016***	0.021***
	(0.000)	(0.002)	(0.002)	(0.002)
Lag. Exp. Dum.	–0.000	0.453***	0.031***	0.568***
	(0.000)	(0.014)	(0.008)	(0.009)
Import Intensity	0.000	0.026**		
	(0.000)	(0.012)		
Sector Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Observations	11586	11586	16988	16988
Pseudo R^2		0.276		0.378
firm clusters	1857	1857	2741	2741

Note. Reported coefficients are marginal effects.

Robust standard errors clustered at the firm-level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9 Import intensity of inputs and levels of exports: 1999-2011

	(1) OLS	(2) Heckman	(3) OLS	(4) Heckman
Productivity	0.1718**	0.1942***	0.2101***	0.2137***
	(0.0705)	(0.0702)	(0.0613)	(0.0731)
Unit Labour Cost	–0.1780**	–0.2014***	–0.2056***	–0.2234***
	(0.0796)	(0.0770)	(0.0631)	(0.0780)
R&D Dummy	0.6622***	0.3981***	0.7211***	0.4248***
	(0.1110)	(0.1137)	(0.0994)	(0.1132)
Investment Intensity	0.0483*	0.0350	0.0685***	0.0328
	(0.0277)	(0.0278)	(0.0246)	(0.0279)
Domestic Sales	0.5767***	0.5188***	0.5155***	0.5043***
	(0.0456)	(0.0432)	(0.0402)	(0.0435)
Import Intensity	1.1050***	1.0191***		
	(0.2449)	(0.2434)		
Sector Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Observations	10076	12693	13580	12693
R^2	0.367		0.330	

Note. Robust standard errors clustered at the firm-level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

probability to export. Let us recall our results on exporting-productivity linkage, where we could not find evidence of more efficient firms self-selecting into export, while we found evidence for more efficient firms exporting higher volumes. This combined evidence indicates that, while the probability of entering the export market is mainly related to technology (R&D, investment) and imported inputs, efficient firms perform consistently better in the export market. While we do not intend to make any causal claim here, the evidence just recalled is reminding of the "capability ladder" discussion outlined in Section 1: unless firms have made all the required progress in the capability space, they might not be able to fully reap benefits associated to international trade.

Finally, notice that although we are not providing a casual interpretation to our findings, we have performed some robustness checks employing alternative specifications to ensure that our results are not heavily biased, for instance by reverse causality. In this respect, we have run regressions, both on the export status and volumes, on specific sub-samples. Focusing, for instance, on first time exporters, allows to get rid of the potential productivity effect that characterizes firms with a previous export experience, the so-called "learning by exporting" mechanism, according to which exposure to a more stimulating environment might foster productivity and, in turn, boost exports. Similarly, we have replicated the analysis for exporters that have not imported in previous years. Obviously, this specification does not suffer from a potential causal relation going from imported inputs to productivity and export. All such robustness checks, which in the interest of space are not reported here, further confirm our findings.

5 Conclusions

This paper contributes to the analysis of the determinants of the export behaviour of firms in two main ways. *First*, it examines the importance of cost and technological competitiveness in firms' exporting behaviour. Our evidence points out that technology, as proxied by R&D, is strongly associated with the export market performance of firms, both in increasing probability to export and in boosting export volumes. Instead, efficiency and cost-competitiveness are associated only with the levels of exports, and we could not find evidence for any such relationship with the probability of firms' entering the export market. In other words, higher productivity is not systematically associated with a higher probability of being an exporter, but it does matter, to some extent, in explaining the performance of exporting firms, once they are in the export market. Note that this piece of evidence already suggests the existence of an alternative pattern of inclusion into international trade for developing economies. In particular, a pattern which is not relying on cost competitiveness (such as a lower cost of labor) as the main determinant of success in foreign markets.

Second, the lack of self-selection is consistent with the conjecture of learning-by-exporting, according to which firms become more efficient after they start to engage in foreign trade as a result of exposure to better managerial practices, technologies or also, as shown here, different inputs. For example, as Trofimenko (2008) points out, the productivity gains from export could depend on the destination markets: exporting to less developed countries should not generate as much productivity growth as exporting to advanced countries given the differences in technological capabilities and product quality requirements. Note that such evidence could also be driven by the fact that India, as many developing countries, engage in export promotion policies. If such policies manage to effectively target firms with initial low productivity but a high potential for export success, one would not be able to distinguish *ex-ante* exporting and non-exporting firms based on their productivity.

From the perspective of the notion of capability escalator, the empirical evidence would suggest that firms, being attracted by export promotion policies, might skip some steps (or some part of a step) of the capability escalator, so that while they start exporting, they are not able to fully benefits from such activity.

In addition, the fact that less efficient firms might be jumping the escalator could be one reason why we do not find evidence of self-selection into export. However, at higher levels of the capability ladder, there could also be feed-backs between capabilities accumulation. That is, entering export markets leads to increased exposure to competition, which could enhance innovation and organizational capabilities, thereby helping in improved performance of exporters in terms of export values. Unfortunately, we cannot directly test this conjecture on our data, even though this could be interesting future work.

Finally, our work provides evidence on the effect of trade policy on firms' export activities by showing that trade liberalization on the import side might significantly contribute to boosting the export performance of domestic firms. This further suggests that trade restriction policies, as those supported by the infant industry argument, should be very carefully targeted. Indeed, if tariff protection reduces import in a given sector, the detrimental effects on export might instead span to all other sectors that source their inputs from the protected sector. And, *ça va sans dire*, this is even more true in a world characterized by a well connected global value chain.

Appendix A: input tariff in Indian manufacturing sector over time

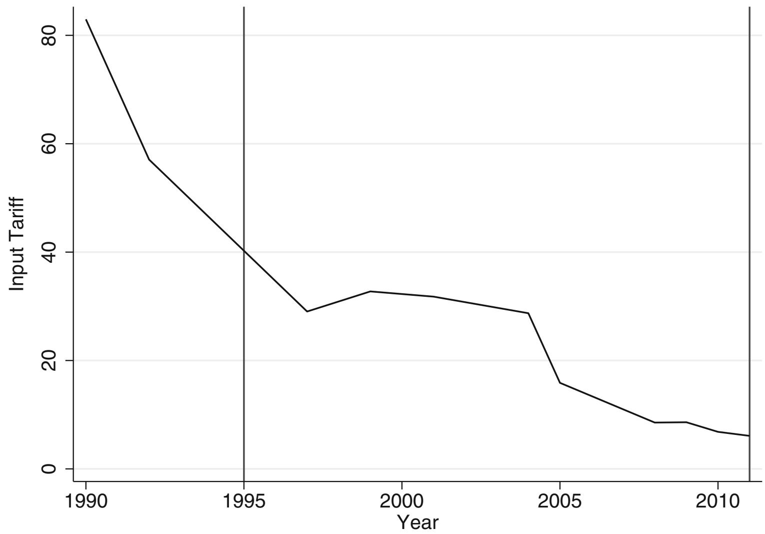

Fig. 2 The evolution of weighted average tariffs in manufacturing sector in India. The vertical lines correspond to the time period of our analysis

Appendix B: variable definition

Definitions of variables used in the regression analysis, equations (1) and (2).

Export dummy (D_{EXP}) takes value 1 if the firm exports and 0 if it does not export.

Export value $(EXPORTS)$ is the revenue from exports of goods outside India.

Productivity $(PROD)$ is total factor productivity (TFP) calculated as in Levinsohn and Petrin (2003) with energy as proxy for unobservable productivity shocks. TFP estimates employ inflation-adjusted (2-digit sector-specific price indices) values of total revenue, wage bills, raw material inputs, fixed assets and energy expenses.

Domestic sales $(SIZE)$ are revenues from sales of industrial goods and providing non-financial services in India.

R&D dummy $(R\&D)$ takes value 1 if the firm has positive spending on R&D.

Investment (INV) is the investment intensity defined as investments over sales. Investment is computed as Net fixed assets$_{it}$ - Net fixed assets$_{it-1}$

Unit Labour Cost (ULC_{it}) is defined as total wages paid over value added.

Import Tariff Rate $(TARIFF)$: The tariff data, reported at the six-digit HS (HS6) level, are provided by the World Bank and available from the WITS database. We use the matching done by Pierce and Schott (2012) to match the tariff data of products to 4-digit industries using those products as inputs. The tariff for industry j in year t is thus the weighted average rate across all 6-digit HS products within each NIC 4-digit industry, using India's average import value from all destinations (averaging across destinations) as weights.

Table 10 Correlations table

	D_{EXP}	*EXPORTS*	*SALES*	*WAGES*	*CAPITAL*	*TFP*	*ULC*	$D_{R\&D}$	*INVESTMENT INTENSITY*	*IMPORT INTENSITY*
D_{EXP}	1.0000									
	(62996)									
EXP	.	1.0000								
	(35009)	(35009)								
$SALES$	0.3183*	0.5900*	1.0000							
	(44607)	(31368)	(44607)							
$WAGES$	0.4095*	0.5165*	0.8234*	1.0000						
	(53144)	(34941)	(44583)	(53144)						
$CAPITAL$	0.3028*	0.4405*	0.7067*	0.6495*	1.0000					
	(54199)	(34962)	(44583)	(52950)	(54199)					
TFP	0.1220*	0.1664*	0.3990*	0.2651*	0.2908*	1.0000				
	(49094)	(33676)	(44306)	(49094)	(49085)	(49094)				
ULC	0.0005	-0.1747*	-0.3233*	0.1115*	-0.1288*	-0.2499*	1.0000			
	(44316)	(31302)	(44068)	(44316)	(44292)	(44060)	(44316)			
R&D	0.3347*	0.2547*	0.4056*	0.4967*	0.3669*	0.2463*	0.0572*	1.0000		
	(44501)	(27631)	(36653)	(43167)	(44015)	(40152)	(36423)	(44501)		
$INV/SALES$	0.1170*	0.0661*	0.0442*	0.0888*	0.2524*	-0.0107	0.0254*	0.0830*	1.0000	
	(27412)	(19762)	(27194)	(27401)	(27400)	(27225)	(27103)	(23238)	(27412)	
IMPORT INTENSITY	0.0137*	0.0942*	0.1170*	0.1551*	0.0219*	0.0851*	-0.0587*	0.0208*	-0.0089	1.000
	(26688)	(21967)	(28882)	(32551)	(31125)	(31182)	(29198)	(27159)	(17601)	(31598)

Note. * denotes significance at 1%. Observations in parentheses. All variables are in log with the exception of export dummy, R&D dummy

Import intensity ($IMPORT\ INTENSITY$) is defined as total imported inputs over total inputs used by the firm.

Definitions of other variables used to compute the main ones and for descriptive purposes.

Sales includes income from sale of industrial goods and providing non-financial services.

Net fixed assets ($CAPITAL$ *in Table 10*) are tangible fixed assets, adjusted for depreciation. This include both movable and immovable assets. This is the proxy for capital used in the production function equation.

Salaries and wages ($WAGES$ *in Table 10*) include total expenses incurred by an enterprise on all employees, including the management. Besides salaries and wages, items such as payment of bonus, contribution to an employee's provident fund and staff welfare expenses are also included.

Raw material expenses include cost of purchase of commodities by an enterprise in the process of manufacturing or rendering services or transformation into a product. Also, all the costs incidental to the purchase of raw material are included. Some of the incidental expenses like transportation of raw material (known as freight inward), handling expenses, purchase tax, coolie and cartage form a part of the raw material cost.

Power and fuel expenses includes the cost of power and fuel.

Appendix C: sector-wise results for selection and levels of exports

Table 11 Sectorwise results for selection into export markets: Probit estimation

Sector	Exp	Prod	ULC	R&D	Inv	Size	Obs.	Firms
Food, beverages, tobacco	0.705***	–0.016	–0.001	–0.020	0.002	0.043**	1848	271
	(0.042)	(0.029)	(0.034)	(0.073)	(0.019)	(0.018)		
Textiles, wearing, leather	0.572***	–0.013	–0.009	0.099***	0.008	0.013***	2561	429
	(0.042)	(0.009)	(0.010)	(0.016)	(0.005)	(0.005)		
Wood, paper, printing	0.564***	–0.026	0.003	0.152**	0.016	0.053**	776	150
	(0.058)	(0.053)	(0.039)	(0.062)	(0.017)	(0.025)		
Coke & petroleoum	0.728***	–0.096	0.009	–0.063	0.020	0.084	270	34
	(0.085)	(0.076)	(0.027)	(0.084)	(0.027)	(0.055)		
Chemicals	0.586***	0.018	–0.011	0.075***	0.014**	0.013	3291	412
	(0.039)	(0.022)	(0.013)	(0.021)	(0.006)	(0.012)		
Pharmaceuticals	0.637***	0.024	0.045*	0.075**	0.041***	0.015	484	101
	(0.071)	(0.030)	(0.025)	(0.037)	(0.012)	(0.017)		
Rubber & plastics	0.588***	0.019	0.018	0.004	0.013	0.021	1479	209
	(0.060)	(0.020)	(0.020)	(0.027)	(0.012)	(0.014)		
Non-metallic minerals	0.666***	–0.010	0.055*	0.046	–0.017	0.039*	1132	158
	(0.063)	(0.033)	(0.033)	(0.044)	(0.013)	(0.021)		

Table 11 (continued)

Sector	Exp	Prod	ULC	R&D	Inv	Size	Obs.	Firms
Basic metals	0.561***	0.011	0.023	0.142***	0.002	0.025***	2744	385
	(0.040)	(0.024)	(0.015)	(0.032)	(0.009)	(0.009)		
Fabricated metal	0.751***	–0.151	–0.051	0.000***	0.020	0.077***	628	102
	(0.065)	(0.093)	(0.047)	(0.000)	(0.021)	(0.028)		
Computer & electronic	0.566***	–0.018	–0.011	–0.024	0.007	0.020***	694	123
	(0.084)	(0.033)	(0.019)	(0.024)	(0.007)	(0.007)		
Electrical equipment	0.488***	–0.012	0.024	0.061**	0.004	0.022***	1795	191
	(0.059)	(0.015)	(0.016)	(0.025)	(0.008)	(0.007)		
Machinery	0.354***	–0.003	0.003	0.033*	0.011	0.011**	2335	233
	(0.063)	(0.020)	(0.016)	(0.018)	(0.007)	(0.005)		
Transport equipment	0.418***	0.011	-0.023	0.094***	0.005	0.001	1564	238
	(0.068)	(0.008)	(0.015)	(0.021)	(0.008)	(0.006)		

Table 12 Sectorwise results for levels of exports: Heckman estimation

Sector	Prod	ULC	R&D	Inv	Size	Obs.	Firms
Food, beverages, tobacco	0.021	–0.583***	0.807***	–0.069	0.092	1781	526
	(0.193)	(0.137)	(0.296)	(0.073)	(0.074)		
Textiles, wearing, leather	–0.129*	–0.210***	0.517***	0.023	0.149***	2495	612
	(0.076)	(0.071)	(0.179)	(0.036)	(0.035)		
Wood, paper, printing	–0.287	–0.033	0.019	0.229***	0.699***	670	181
	(0.262)	(0.248)	(0.413)	(0.082)	(0.153)		
Coke & petroleoum	3.119***	0.647	0.358	0.000	–1.162**	190	40
	(0.768)	(0.446)	(0.627)	(0.122)	(0.532)		
Chemicals	1.336***	0.071	0.302*	0.078*	–0.334***	2657	620
	(0.195)	(0.123)	(0.176)	(0.041)	(0.103)		
Pharmaceuticals	1.814***	–0.238*	0.414**	0.246***	–0.387***	1294	311
	(0.303)	(0.135)	(0.166)	(0.052)	(0.147)		
Rubber & plastics	1.107***	–0.116	0.643**	0.116**	–0.208	1270	293
	(0.324)	(0.163)	(0.262)	(0.058)	(0.177)		
Non-metallic minerals	1.113***	0.036	0.568*	0.108*	0.233	819	181
	(0.347)	(0.230)	(0.291)	(0.061)	(0.175)		
Basic metals	–0.312*	–0.252**	0.551**	0.101**	0.619***	1745	458
	(0.172)	(0.117)	(0.231)	(0.050)	(0.075)		
Fabricated metal	0.507***	0.295	0.209	0.014	0.537***	562	141
	(0.181)	(0.206)	(0.366)	(0.109)	(0.160)		
Computer & electronic	–1.003***	–0.479*	0.394	0.343***	0.429***	606	158
	(0.353)	(0.249)	(0.304)	(0.096)	(0.105)		

Table 12 (continued)

Sector	Prod	ULC	R&D	Inv	Size	Obs.	Firms
Electrical equipment	–0.373**	–0.125	0.611**	0.084	0.641***	916	221
	(0.169)	(0.139)	(0.248)	(0.081)	(0.092)		
Machinery	–0.023	–0.071	0.009	0.062	0.687***	1386	282
	(0.220)	(0.164)	(0.199)	(0.064)	(0.070)		
Transport equipment	–0.045	0.032	0.253	–0.039	0.676***	1514	331
	(0.098)	(0.168)	(0.193)	(0.070)	(0.081)		

Acknowledgments We thank Antonio Andreoni, Alex Coad, Giovanni Dosi, Davide Fiaschi, Michiko Iizuka, Andrea Mina, Mun Heng Toh and two anonymous referees for insightful comments and suggestions. We thank participants to the conference "Micro-macro determinants of growth in emerging economies" in UCL, London (2016), the ISS Conference, Montreal (2016), the Globelics Conference in National Technical University, Athens (2017), the ETSG annual conference, Florence (2017), the Workshop Empirical Research on Productivity and Innovation, Tokyo (2018). An earlier draft of this work circulated with title "Efficiency, innovation, and imported inputs: determinants of export performance among Indian manufacturing firms". The usual disclaimer applies.

Funding Open Access funding provided by Universit Cattolica del Sacro Cuore. Nanditha Mathew gratefully acknowledges financial support from IBIMET-CNR, grant CrisisLab-ProCoPe. Daniele Moschella received financial support by the Italian Ministry of Education and Research under the SIR Programme (Project code RBSI14JAFW) and the PRIN-2017 Programme (project code 201799ZJSN).

Declarations

Conflict of Interests The authors declare that they have no conflict of interest.

References

Ahluwalia IJ, Mohan R, Goswami O (1996) Policy reform in India, Development Centre of Organisation and Development

Amendola G, Dosi G, Papagni E (1993) The dynamics of international competitiveness. Review of World Economics (Weltwirtschaftliches Archiv) 129:451–471

Amiti M, Konings J (2007) Trade liberalization, intermediate inputs, and productivity: evidence from Indonesia. Am Econ Rev 97:1611–1638

Aristei D, Castellani D, Franco C (2013) Firms' exporting and importing activities: is there a two-way relationship? Rev World Econ 149:55–84

Banga R, Das A (2012) Twenty years of India's liberalization: experiences and lessons. United Nations Publications

Bas M (2012) Input-trade liberalization and firm export decisions: evidence from Argentina. J Dev Econ 97:481–493
Basile R (2001) Export behavior of Italian manufacturing firms over the nineties: the role of innovation. Res Policy 30:1185–1201
Bernard A, Wagner J (1997) Exports and success in German manufacturing. Review of World Economics (Weltwirtschaftliches Archiv) 133:134–157
Bernard AB, Grazzi M, Tomasi C (2015) Intermediaries in international trade: products and destinations. Rev Econ Stat 97:916–920
Bernard AB, Jensen BJ (1999) Exceptional exporter performance: cause, effect, or both? J Int Econ 47:1–25
Bernard AB, Jensen JB (2004) Why some firms export? Rev Econ Stat 86:561–569
Bernard AB, Jensen JB, Redding SJ, Schott PK (2007) Firms in international trade. J Econ Perspect 21:105–130
Bernard AB, Jensen JB, Redding SJ, Schott PK (2012) The empirics of firm heterogeneity and international trade. Ann Rev Econ 4:283–313
Broda C, Greenfield J, Weinstein D (2006) From groundnuts to globalization: a structural estimate of trade and growth. Working Paper 12512, NBER
Bruton HJ (1998) A reconsideration of import substitution. J Econ Literature 36:903–936
Bustos P (2011) Trade liberalization, exports, and technology upgrading: evidence on the impact of MERCOSUR on Argentinian firms. Am Econ Rev 101:304–340
Cameron AC, Trivedi PK (2005) Microeconometrics: methods and applications. Cambridge University Press, Cambridge
Castellani D (2002) Export behavior and productivity growth: evidence from Italian manufacturing firms. Review of World Economics (Weltwirtschaftliches Archiv) 138:605–628
Castellani D, Fassio C (2019) From new imported inputs to new exported products. Firm-level evidence from Sweden. Res Polic 48:322–338
Castellani D, Serti F, Tomasi C (2010) Firms in international trade: importers' and exporters' heterogeneity in italian manufacturing industry. World Econ 33:424–457
Chadha A (2009) Product cycles, innovation, and exports: a study of Indian pharmaceuticals. World Development 37:1478–1483
Cimoli M (1988) Technological gaps and institutional asymmetries in a North-South model with a continuum of goods. Metroeconomica 39:245–274
Cimoli M, Dosi G, Stiglitz JE (eds) (2009) Industrial policy and development: the political economy of capabilities accumulation. Oxford University Press, New York
Cimoli M, Pereima JB, Porcile G (2019) A technology gap interpretation of growth paths in Asia and Latin America. Res Polic 48:125–136
Cirera X, Maloney WF (2017) The innovation paradox: Developing-country capabilities and the unrealized promise of technological catch-up. The World Bank
Clerides SK, Lach S, Tybout JR (1998) Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico and Morocco. Quart J Econ 113:903–947
Coad A, Mathew N, Pugliese E (2020) What's good for the goose ain't good for the gander: heterogeneous innovation capabilities and the performance effects of R&D. Ind Corp Chang 29:621–644
Coe DT, Helpman E (1995) International R&D spillovers. Eur Econ Rev 39:859–887
Costantini J, Melitz M (2008) The dynamics of firm-level adjustment to trade liberalization. Org Firms Global Econ 4:107–141
Creusen H, Lejour A (2011) Uncertainty and the export decisions of Dutch firms, Tech. Rep. 69, FIW Working Paper
Damijan JP, Konings J, Polanec S (2014) Import churning and export performance of multi-product firms. World Econ 37:1483–1506
Damijan JP, Kostevc Č (2006) Learning-by-exporting: continuous productivity improvements or capacity utilization effects? Evidence from Slovenian firms. Rev World Econ 142:599–614
Delgado MA, Farina JC, Ruano S (2002) Firm Productivity and export market: a non-parametric approach. J Int Econ 57:397–422
Dosi G, Grazzi M, Moschella D (2015) Technology and costs in international competitiveness: from countries and sectors to firms. Res Policy 44:1795–1814
Dosi G, Pavitt K, Soete L (1990) The economics of technical change and international trade. New York University Press, New York

Eaton J, Kortum S (2002) Technology, geography, and trade. Econometrica 70:1741–1779
Edwards L, Golub SS (2004) South Africa's international cost competitiveness and exports in manufacturing. World Development 32:1323–1339
Ethier W (1979) Internationally decreasing costs and world trade. J Int Econ 9:1–24
Fafchamps M (2009) Human capital, exports, and earnings. Econ Dev Cult Chang 58:111–141
Fagerberg J (1988) International competitiveness. Econ J 98:355–374
Fagerberg J (1996) Technology and competitiveness. Oxf Rev Econ Policy 12:39–51
Fernández-Val I (2009) Fixed effects estimation of structural parameters and marginal effects in panel probit models. J Econ 150:71–85
Filippetti A, Frenz M, Ietto-Gillies G (2011) Are innovation and internationalization related? An analysis of European countries. Indus Innov 18:437–459
Fligner MA, Policello GE (1981) Robust rank procedures for the Behrens-Fisher problem. J Am Stat Assoc 76:141–206
Ghazalian PL (2012) Assessing the effects of international trade on private R&D expenditures in the food processing sector. Indus Innov 19:349–369
Girma S, Greenaway D, Kneller R (2004) Does exporting increase productivity? a microeconometric analysis of matched firms. Rev Int Econ 12:855–866
Goldar B (2002) Trade liberalization and manufacturing employment: the case of India. International labour office (ILO)
Goldar B, Saleem HN (1992) India's tariff structure: effective rates of protection of Indian Industries, Studies in Industrial Development. Paper no. 5
Goldberg PK, Khandelwal AK, Pavcnik N, Topalova P (2010) Imported intermediate inputs and domestic product growth: evidence from India. Quart J Econ 125:1727–1767
Government of India (2011) Economic Survey, Ministry of Finance
Grazzi M (2012) Export and firm performance: evidence on productivity and profitability of Italian companies. J Indus Competition Trade 12:413–444
Grazzi M, Tomasi C (2016) Indirect exporters and importers. Review of World Economics (Weltwirtschaftliches Archiv) 152:251–281
Greenaway D, Sousa N, Wakelin K (2004) Do domestic firms learn to export from multinationals? Eur J Polit Econ 20:1027–1043
Greene W (2004) The behaviour of the maximum likelihood estimator of limited dependent variable models in the presence of fixed effects. Econ J 7:98–119
Grossman GM, Helpman E (1991a) Innovation and growth in the global economy. M.I.T. Press, Cambridge
Grossman GM, Helpman E (1991b) Quality ladders in the theory of growth. Rev Econ Stud 58:43–61
Haidar JI (2012) Trade and productivity: self-selection or learning-by-exporting in India. Econ Model 29:1766–1773
Hair JF, Black WC, Babin BJ, Anderson RE, Tatham RL et al (1998) Multivariate data analysis, vol 5,3. Prentice Hall, Upper Saddle River
Halpern L, Koren M, Szeidl A (2015) Imported Inputs and Productivity. American Economic Review 105:3660–3703
Hasan R, Raturi M (2003) Does investing in technology affect exports? Evidence from Indian firms. Rev Dev Econ 7:279–293
Heckman JJ (1979) Sample selection bias as a specification error. Econometrica, 153–161
Kaldor N (1978) The effect of devaluations on trade in manufactures, in Further essays on applied economics. Duckworth, London, pp 99–118
Kasahara H, Rodrigue J (2008) Does the use of imported intermediates increase productivity? Plant-level evidence. J Dev Econ 87:106–118
Keller W (2002) Trade and the transmission of technology. J Econ Growth 7:5–24
Klenow PJ, Rodriguez-Clare A (1997) Quantifying variety gains from trade liberalization unpublished. Graduate School of Business, University of Chicago
Kneller R, Pisu M (2007) Industrial linkages and export spillovers from FDI. World Econ 30:105–134
Krishna P, Mitra D (1998) Trade liberalization, market discipline and productivity growth: new evidence from India. J Dev Econ 56:447–462
Kugler M, Verhoogen E (2009) Plants and imported inputs: new facts and an interpretation. Am Econ Rev 99:501–507
Kumar N, Siddharthan N (1994) Technology, firm size and export behaviour in developing countries: the case of Indian enterprises. J Develop Stud 31:289–309

Lefebvre E, Lefebvre LA, Bourgault M (1998) R&D-related capabilities as determinants of export performance. Small Bus Econ 10:365–377
Levinsohn J, Petrin A (2003) Estimating production functions using inputs to control for unobservables. Rev Econ Stud 70:317–41
Lileeva A, Trefler D (2010) Improved access to foreign markets raises plant-level productivity... for some plants. Quart J Econ 125:1051–1099
Markusen JR (1989) Trade in producer services and in other specialized intermediate inputs. Am Econ Rev 79:85–95
Mathew N (2017) Drivers of firm growth: micro-evidence from Indian manufacturing. J Evol Econ 27:585–611
Melitz MJ (2003) The impact of trade on intra-industry reallocations and aggregate industry productivity. Econometrica 71:1695–1725
Moffitt RA (1999) New developments in econometric methods for labor market analysis. Handbook Labor Econ 3:1367–1397
Muendler M-A (2004) Trade, technology and productivity: a study of brazilian manufacturers 1986-1998, Tech. rep., CESifo Working Paper Series
Muûls M, Pisu M (2009) Imports and exports at the level of the firm: evidence from Belgium. World Econ 32:692–734
Nan LN, Hansson P (2004) Exports as an indicator on or promoter of successful swedish manufacturing firms in the 1990s. Rev World Econ 140:415–445
Naranpanawa A, Arora R (2014) Does trade liberalization promote regional disparities? Evidence from a multiregional CGE model of India. World Dev 64:339–349
Nickell S (1981) Biases in dynamic models with fixed effects. Econometr: J Econometr Soc 49:1417–1426
Nouroz H (2001) Protection in Indian manufacturing: an empirical study. MacMillan India Ltd., Delhi
Pierce JR, Schott PK (2012) A concordance between ten-digit US harmonized system codes and SIC/NAICS product classes and industries. J Econ Soc Meas 37:61–96
Posner MV (1961) International trade and technical change. Oxford Econ Papers 13:323–341
Rajan RS, Sen R et al (2002) A decade of trade reforms in India. World Econ 3:87–100
Rivera-Batiz LA, Romer PM (1991) International trade with endogenous technological change. Eur Econ Rev 35:971–1001
Roberts MJ, Tybout JR (1997) The decision to export in Colombia: an empirical model of entry with sunk costs. Am Econ Rev 87:545–64
Smeets V, Warzynski F (2013) Estimating productivity with multi-product firms, pricing heterogeneity and the role of international trade. J Int Econ 90:237–244
Soete L (1981) A general test of technological gap trade theory. Weltwirtschaftliches Arch 117:638–660
Soete L (1987) The impact of technological innovation on international trade patterns: the evidence reconsidered. Res Policy 16:101–130
Sterlacchini A (1999) Do innovative activities matter to small firms in non-R&D-intensive industries? An application to export performance. Res Policy 28:819–832
Stolzenberg RM, Relles DA (1990) Theory testing in a world of constrained research design the significance of Heckman's censored sampling bias correction for nonexperimental research. Sociol Methods Res 18:395–415
Topalova P, Khandelwal A (2011) Trade liberalization and firm productivity: the case of India. Rev Econ Stat 93:995–1009
Trofimenko N (2008) Learning by exporting: does it matter where one learns? Evidence from Colombian manufacturing firms. Econ Dev Cult Chang 56:871–894
Turco AL, Maggioni D (2013) On the role of imports in enhancing manufacturing exports. World Econ 36:93–120
Van Biesebroeck J (2008) The sensitivity of productivity estimates: revisiting three important debates. J Business Econ Stat 26:311–328
Vernon R (1966) International investment and international trade in the product cycle. Quart J Econ 80:190–207
Wakelin K (1998) Innovation and export behaviour at the firm level. Res Polic 26:829–841
Yang C-H, Chen J-R, Chuang W-B (2004) Technology and export decision. Small Bus Econ 22:349–364