Chapter 2

Source of Learning-by-Exporting Effects: Does Exporting Promote Innovation?

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CHAPTER 2

Sources of Learning-by-Exporting Effects: Does Exporting Promote Innovation?

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This paper examines whether first-time exporters achieve productivity improvements through learning-by-exporting effects. The results suggest that starting exporting to North America/Europe has a strong positive effect on sales and employment growth, R&D activity, and productivity growth. On the other hand, starting exporting to Asia does not have any strong productivity enhancing effects, although it does tend to raise the growth rates of sales and employment and be associated with an increase in R&D expenditure. However, even for these variables, the positive impact of starting exporting to North America/Europe is much larger. Further analysis shows that export starters to North America/Europe are larger, more productive, more R&D intensive, and more capital intensive than export starters to Asia even before they start exporting, suggesting that the former are potentially better performers than the latter. In other words, the former have greater absorptive capacity, and this absorptive capacity itself may be a source of the larger positive learning-by-exporting effects. Moreover, export starters to North America/Europe become more innovative than export starters to Asia after starting exporting. The results obtained imply that potentially innovative non-exporters should be supported through an export promotion policy. Firms that have the potential to be sufficiently innovative to export to developed regions are likely to benefit from doing so through the positive interaction between exporting and innovation.

Keywords: Exports, Innovation, R&D, Productivity, Learning by exporting, Export destination, Propensity score matching

JEL Classification: D22, D24, L1, L6, O31, F14

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1. Introduction

Globalization clearly affects firms' behavior and performance in various ways, and how to design effective policies to promote economic growth in a globalized economic environment has become a priority subject for many countries around the world. A large body of literature has already investigated the various relationships between globalization and the performance of firms and industries, utilizing a variety of macro- and/or micro-level databases. While a considerable number of empirical studies suggest that firms engaged in international trade and investment perform better than firms not engaged in such activities, the evidence has been less clear-cut on the "learning-by-exporting" hypothesis that exporting firms experience an improvement in productivity by gaining access to technical expertise from export markets.

That being said, there are some studies that do provide evidence of a positive learning-by-exporting effect. One of these is the study by De Loecker (2007), who, moreover, finds that the productivity gains are higher for firms exporting towards high income regions, although he does not provide a detailed discussion of the reasons why learning-by-exporting effects differ depending on the destination of exports. Positive learning-by-exporting effects have also been shown in a number of other empirical studies, but to date, the mechanisms and sources of learning-by-exporting effects have not been adequately investigated, and there is still a long way to go until we have a good understanding of learning-by-exporting effects and can derive appropriate policy recommendations to enhance firms' growth in the globalized economy.

Against this background, this study, utilizing a large-scale firm-level panel dataset on Japanese manufacturing firms, examines the existence of learning-by-exporting effects and investigates how exporting improves the productivity of firms, i.e., it investigates the mechanisms or sources of learning-by-exporting effects. In the case of Japan, several previous studies have already found that firms engaged in international trade and investment outperform non-internationalized firms and that the gap in performance between both types of firms has been widening.[1] Yet, although engaging in international trade and investment has generally raised the performance of individual

[1] See, e.g., Fukao and Kwon (2006), Kimura and Kiyota (2006), Wakasugi *et al*. (2008), and Ito and Lechevalier (2009).

firms, industry-level productivity in Japan has stagnated in many industries and productivity growth at the macro level has remained low during Japan's so-called "Two Lost Decades." This pattern suggests that the majority of Japanese firms have not benefited from globalization and that only a small fraction of firms have enjoyed efficiency gains and growth through international activities. On the other hand, Ito and Lechevalier (2010) found that, compared with European countries, there were a relatively large number of firms in Japan that conducted R&D activities but did not export.[2] In addition, the study found that, in Japan, R&D firms were more likely to see an improvement in productivity by starting to export than non-R&D firms.

These studies indicate that to raise the country's overall economic growth rate, a top priority for the government should be to devise policy schemes to help non-internationalized firms to take advantage of the globalized economy. However, to devise such policy schemes, it is necessary to understand the mechanisms underlying the learning-by-exporting effect, which studies to date have not adequately explored.

Against this background, this paper focuses on the behavior and performance of first-time exporters and investigates how first-time exporters evolve through learning-by-exporting, by exploring the sources of learning from exporting. Specifically, this paper tries to answer to the following questions: (1) Does exporting further promote R&D activities, resulting in further improvements in productivity? (2) Does exporting increase the volume of demand for a firm's products which then raises the firm's productivity through scale effects? And (3) does the learning-by-exporting effect differ across export destinations?

The organization of this paper is as follows. Section 2 provides an overview of related research, while Section 3 describes the dataset used in this paper and explains how first-time exporters are defined. Section 4 then explains the framework of the econometric analysis and presents the results. Finally, Section 5 discusses the policy

[2] While this comparison is not based on a rigorous analysis that takes account of differences in the coverage of databases, sizes of domestic economies, industry compositions, barriers to trade, etc., the pattern it suggests is consistent with the results obtained by Nishikawa and Ohashi (2010), who, analyzing the results of the second *National Innovation Survey* conducted by the Japanese government in 2009, find that despite the fact that Japanese firms actively conduct innovative activities in collaboration with R&D organizations within and/or outside the firm, the share of firms which collaborate with overseas organizations or which sell their products in overseas markets is extremely low compared with European firms. Their findings also imply that Japanese firms tend to be less internationalized than firms in European countries.

implications and concludes.

2. Related Literature

Over the last decade, many empirical studies have found evidence in favor of self-selection of more productive firms into exporting, supporting a theoretical prediction by Melitz (2003) and others that heterogeneity in firm productivity affects firms' decision to start exporting. On the other hand, the evidence has been mixed on the "learning-by-exporting" hypothesis that exporting firms experience an improvement in productivity by gaining access to technical expertise from export markets. A few studies, such as Girma *et al*. (2004), De Loecker (2007), and Hahn and Park (2009), have found positive learning-by-exporting effects. However, both the theoretical and the empirical literature say little about the mechanisms involved: the theoretical model on the self-selection effect simply assumes that firms' productivity levels are drawn randomly from a probability distribution without explaining the origin of productivity differences, while the empirical studies do not explore the mechanisms underlying the learning-by-exporting effects.

In recent years, an increasing number of empirical studies have tried to identify the missing link between innovation, performance, and exporting, being aware of the importance of firms' innovative activities for their technological progress and productivity growth, as suggested by theories of firms' growth and endogenous growth theory (Romer 1990, etc.). Particularly in European countries, the interactions between exporting and innovation have been a research topic of major interest. Several studies, using firm-level data, have investigated the innovation-productivity-export link, and some found a positive impact of innovation on productivity and exporting.[3]

[3] For instance, Griffith *et al*. (2006) found that process innovation rather than product innovation positively affects productivity growth. For Spanish firms, Cassiman and Golovko (2007) found evidence of a positive link between innovation and productivity. Moreover, again focusing on Spanish firms, Cassiman *et al*. (2010) found that product innovation, rather than process innovation, was a driver of exports. Similar results were obtained by Becker and Egger (2007) and Bocquet and Musso (2010) for German and French firms, respectively. As for Belgian firms, van Beveren and Vandenbussche (2009) suggest that the combination of product and process innovation, rather than either of the two in isolation, increases a firm's probability to start exporting. On the other hand,

On the other hand, there are at best only a handful of studies that have found evidence in favor of a causal link in the opposite direction, that is, a link from exporting to innovation and productivity. Examples include Damijan *et al*. (2010), who investigated this reverse link using Slovenian firm-level data and found that past exporting status does increase the probability that medium and large firms will become process innovators, but past exporting status does not affect product innovation. Hahn (2010), on the other hand, focusing on the case of Korea, found that exporting has the effect of facilitating new product introduction by those plants that export. Moreover, Hahn's (2010) results suggest that not only exporting activity *per se* but also the absorptive capacity of plants matter in this process. For Japan, Ito and Lechevalier (2010) examined the effects of exporting and R&D activities on productivity growth and found that only firms which have accumulated internal knowledge through R&D activities experience an improvement in productivity after starting to export. Firms without *ex ante* R&D activities did not experience significantly higher productivity growth by starting to export than firms that did not start to export.

These empirical studies provide evidence on the existence of learning-by-exporting. However, the sources of learning-by-exporting have not yet been adequately explored. Damijan *et al*. (2010), for example, concluded that the mechanism underlying learning-by-exporting effects was that it enhanced firms' technical efficiency through process innovation and not that it promoted the introduction of new products. On the other hand, Hahn (2010) suggested that exporting promotes new product introduction, while Ito and Lechevalier (2010) argued that firms' absorptive capacity is important for the realization of learning-by-exporting effects. Finally, Yashiro and Hirano (2009) found that exporting firms realized much faster productivity growth than non-exporting firms during the export boom Japan experienced in 2002-2007. However, they concluded that only large exporting firms showed a higher productivity growth rate while small exporting firms did not show any significant productivity premium vis-à-vis small non-exporting firms.

Therefore, to date, the mechanisms of learning-by-exporting are not yet very clear.

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although they find a positive relationship between innovation and exporters' productivity, Bellone *et al*.(2010) conclude that the contribution of innovative capabilities to exporters' productivity premium is small.

Identifying these mechanisms certainly is not without challenges, given the fact that firms' size, absorptive capacity, product innovation, and process innovation are all endogenous.[4] However, attempting to address these challenges is important in order to gain a better understanding of the mechanisms and dynamics that allow firms to benefit from globalization, and to design effective policies that help firms to do so.

3. Data Description

3.1. Data

The data used for this study is the firm-level panel data underlying the *Basic Survey on Business Structure and Activities (BSBSA)*, collected annually by the Ministry of Economy, Trade and Industry, for the period 1994-2006.[5] The survey covers all firms with at least 50 employees or 30 million yen of paid-in capital in the Japanese manufacturing, mining, and commerce sectors and several other service sectors. The survey contains detailed information on firm-level business activities such as the 3-digit industry in which the firm operates, its number of employees (including a breakdown of the number of employees by firm division), sales, purchases, exports, and imports (including a breakdown of the destination of sales and exports and the origin of purchases and imports),[6] R&D and patents, the number of domestic and overseas subsidiaries, and various other financial data such as costs, profits, investment, and assets. Here, observations for the manufacturing sector are used because the focus of the study is the interaction between R&D and exporting.[7]

[4] An increasing number of empirical studies on innovation and exporting, including works listed in this literature review, employ propensity score matching to address endogeneity between various firm strategies. Details of propensity score matching are provided in Section 4.

[5] The compilation of the firm-level panel data underlying the *BSBSA* was conducted as part of the project "Japan's Productivity and Economic Growth" at the Research Institute of Economy, Trade and Industry (RIETI).

[6] The survey asks for the amount as well as the destination or origin of exports and imports broken down into seven regions (Asia, Middle East, Europe, North America, Latin America, Africa, and Oceania). Unfortunately, more detailed information on the destination of exports and origin of imports is not available.

[7] Although the survey also asks non-manufacturing firms for information on exports and imports, they are required to provide the amount of trade in goods only. The survey does not cover international transactions in services.

Because firm-level information on product and process innovation is not available, the analysis mainly relies on information on R&D expenditure in the *BSBSA*.[8] Although patent-related information is also used as a proxy for a firm's innovative capabilities for supplementary analyses, a substantial number of firms do not report such information in the *BSBSA*. However, the advantage of the *BSBSA* data is that they are panel-data with more than 10-year time-series observations and that information on the destination of exports and the origin of imports is available.

After cleaning the data, the panel dataset contains approximately 11,000 manufacturing firms each year.[9] Table 1 shows the number of firms by size and by activity. In Table 1, R&D firms are defined as firms that have positive R&D expenditure (the sum of expenditure for in-house R&D and contract R&D) while firms with zero R&D expenditure are defined as non-R&D firms. Similarly, exporting firms are defined as firms that have a positive export value while firms with a zero export value are defined as non-exporting firms.[10] As shown in Table 1, nearly half of the firms do not export and report zero R&D expenditure. However, depending on firm size, between one-quarter and one-third of firms do have positive R&D expenditure but do not export. Especially among small and medium enterprises (SMEs), there are a large number of firms that do have some expenditure on R&D activities but do not export. As for large firms, nearly half are engaged in both exporting and R&D activities. The figures in Table 1 suggest that there is some kind of complementarily between R&D and

[8] The National Institute of Science and Technology Policy (NISTEP) conducted a *National Innovation Survey* in 2003 and 2009 which asked for various types of information related to product and process innovation. According to Kwon *et al*. (2008), the firm-level information taken from the 2003 survey can be linked with the firm-level data in the *BSBSA* for 1,745 manufacturing firms. Although only 15 percent of firms surveyed in the *BSBSA* provide information on innovative activities in the *National Innovation Survey*, such data would be potentially very useful for a future study on innovation and firm performance. Unfortunately, however, gaining access to the data involves extremely time-consuming red tape. Due to time constraints, I would therefore like to leave the analysis utilizing the *National Innovation Survey* for a future study.

[9] Firms for which data on sales, the number of employees, total wages, tangible fixed assets, depreciation, or intermediate inputs are not positive or are missing for at least one year were dropped from the dataset. The list of manufacturing industries analyzed in this paper and the number of firms by industry are shown in Appendix Table 1.

[10] The survey asks for the amount of direct exports and sales by firms' overseas affiliates. There is no information on indirect exports through trading companies and wholesalers. As far as the author knows, all the official surveys in Japan clearly ask for the amount of direct exports only and request not to include indirect exports. Although the fact that only direct exports are included in the data may create some bias in the results, it seems plausible to assume that direct contact to export markets is much more important for learning by exporting than indirect exporting.

exporting. This, in turn, may be a key factor which determines the growth of firms.

Table 1. Distribution of Japanese Manufacturing Firms Engaged in R&D and Export Activities

	No R&D No EXP	R&D only	EXP only	R&D & EXP	Total
All mfg. firms					
1994	4,935	3,502	595	2,308	11,340
	(44%)	(31%)	(5%)	(20%)	(100%)
2006	4,804	2,658	1,009	2,796	11,267
	(43%)	(24%)	(9%)	(25%)	(100%)
SMEs (with 300 or fewer employees)					
1994	4,404	2,502	472	1,068	8,446
	(52%)	(30%)	(6%)	(13%)	(100%)
2006	4,295	1,934	830	1,476	8,535
	(50%)	(23%)	(10%)	(17%)	(100%)
Large firms (with more than 300 employees)					
1994	531	1,000	123	1,240	2,894
	(18%)	(35%)	(4%)	(43%)	(100%)
2006	509	724	179	1,320	2,732
	(19%)	(27%)	(7%)	(48%)	(100%)

Note: The table shows the number of firms in each category. Figures in parentheses are the share of each category in the total. Figures in parentheses are shares of the number of firms for each category.

3.2. First-time Exporters

In order to investigate the mechanisms underlying learning-by-exporting effects, this study focuses on first-time exporters. As the survey does not provide information on the date or year firms first started to export, it is necessary to define first-time exporters based on certain rules. How first-time exporters are indentified is illustrated in Figure 1, which shows hypothetical examples five different patterns of data for exports. Examples 1 and 2 show firms which never exported before the reference year and are therefore defined as export starters in the reference year. On the other hand, if a firm, as shown in Example 3, has a positive export value for the year when it first enters the dataset, it is impossible to indentify whether the firm is an export starter or not. Consequently, export starters cannot be identified for the year 1994 which is the first

year of the dataset, because the export status in the previous year is not available. Moreover, it should be noted that there is a greater likelihood of misidentification of export starters for early years in the dataset. Next, export quitters are similarly defined as firms which stopped exporting and subsequently did not start exporting again (Examples 1 and 3). If a firm has a positive export value for the last year in which it appears in the dataset, it is impossible to indentify whether the firm is an export quitter or not (Example 2). The definition of export quitters here also means that export quitters cannot be identified for the year 2006, which is the last year of the dataset. It should also be noted that there is a greater likelihood of misidentification of export quitters for later years in the dataset. Moreover, some firms can be both export starters and quitters (Example 1). Firms which have a positive export value for all years for which observations for them are available in the dataset are defined as firms which always export (Example 4), while firms which have a zero export value for all years for which observations for them are available in the dataset are defined as firms which never export (Example 5).

Figure 1. Examples for Export Starters and Quitters

	Exports (ex.1)		Exports (ex.2)		Exports (ex.3)		Exports (ex.4)		Exports (ex.5)	
1994	0				1		n.a.		n.a.	
1995	0				0		n.a.		n.a.	
1996	0				0		1	ALWAYS	n.a.	
1997	1	STARTER			1		1		0	NEVER
1998	0				0		1		0	
1999	1		0		1		1		0	
2000	0		0		0		1		0	
2001	1		0		1	QUITTER	1		0	
2002	1	QUITTER	1	STARTER	0		1		0	
2003	0		1		0		1		0	
2004	0		1		n.a.		1		0	
2005	0		n.a.		n.a.		1		n.a.	
2006	0		n.a.		n.a.		1		n.a.	

Notes: 1: A positive export value; 0: A zero export value; n.a.: No observation in the dataset.

Table 2 summarizes the number of firms by export status over the period 1995-2005 by industry. The table shows that of the firms in the dataset, 2,408 newly entered export markets during the period 1995-2005. At the same time, a significant number of firms (1,636 firms) stopped exporting and did not start exporting again. In fact, 787 starter

firms are also defined as quitters, suggesting that a significant number of export starters quit exporting later.

Table 2. Number of Firms by Industry and by Export Status

		STARTER		QUITTER		ALWAYS		NEVER		Industry total	
		No.	%	No.	%	No.	%	No.	%	No.	%
1	Food products and beverages	159	(6.6)	153	(9.4)	88	(2.5)	2,243	(17.4)	2,601	(12.8)
2	Textiles	116	(4.8)	87	(5.3)	87	(2.4)	950	(7.3)	1,207	(6.0)
3	Lumber and wood products	41	(1.7)	34	(2.1)	22	(0.6)	505	(3.9)	589	(2.9)
4	Pulp, paper and paper products	66	(2.7)	43	(2.6)	29	(0.8)	500	(3.9)	623	(3.1)
5	Printing	43	(1.8)	31	(1.9)	25	(0.7)	804	(6.2)	890	(4.4)
6	Chemicals and chemical fibers	80	(3.3)	45	(2.8)	150	(4.2)	235	(1.8)	509	(2.5)
7	Paint, coating, and grease	30	(1.2)	33	(2.0)	60	(1.7)	75	(0.6)	196	(1.0)
8	Pharmaceutical products	35	(1.5)	29	(1.8)	84	(2.3)	139	(1.1)	291	(1.4)
9	Miscellaneous chemical products	68	(2.8)	49	(3.0)	145	(4.0)	133	(1.0)	391	(1.9)
10	Petroleum and coal products	12	(0.5)	10	(0.6)	20	(0.6)	35	(0.3)	75	(0.4)
11	Plastic products	154	(6.4)	89	(5.4)	137	(3.8)	664	(5.1)	1,023	(5.0)
12	Rubber products	24	(1.0)	18	(1.1)	56	(1.6)	115	(0.9)	213	(1.1)
13	Ceramic, stone and clay products	69	(2.9)	56	(3.4)	107	(3.0)	713	(5.5)	935	(4.6)
14	Iron and steel	89	(3.7)	81	(5.0)	60	(1.7)	411	(3.2)	605	(3.0)
15	Non-ferrous metals	79	(3.3)	52	(3.2)	103	(2.9)	232	(1.8)	460	(2.3)
16	Fabricated metal products	179	(7.4)	114	(7.0)	185	(5.2)	1,002	(7.8)	1,452	(7.2)
17	Metal processing machinery	59	(2.5)	46	(2.8)	137	(3.8)	140	(1.1)	376	(1.9)
18	Special industry machinery	78	(3.2)	58	(3.5)	208	(5.8)	252	(1.9)	612	(3.0)
19	Office and service industry machines	44	(1.8)	26	(1.6)	52	(1.5)	137	(1.1)	251	(1.2)
20	Miscellaneous machinery	179	(7.4)	120	(7.3)	335	(9.3)	479	(3.7)	1,104	(5.4)
21	Electrical machinery and apparatus	84	(3.5)	47	(2.9)	114	(3.2)	355	(2.7)	598	(2.9)
22	Household electric appliances	37	(1.5)	22	(1.3)	63	(1.8)	181	(1.4)	293	(1.4)
23	Communication equipment	52	(2.2)	44	(2.7)	98	(2.7)	225	(1.7)	409	(2.0)
24	Computer and electronic equipment	52	(2.2)	27	(1.7)	101	(2.8)	152	(1.2)	328	(1.6)
25	Electronic parts and devices	160	(6.6)	77	(4.7)	286	(8.0)	529	(4.1)	1,049	(5.2)
26	Miscellaneous electrical machinery	40	(1.7)	22	(1.3)	109	(3.0)	153	(1.2)	324	(1.6)
27	Motor vehicles and parts	211	(8.8)	93	(5.7)	217	(6.1)	795	(6.2)	1,286	(6.3)
28	Other transportation equipment	32	(1.3)	27	(1.7)	73	(2.0)	212	(1.6)	343	(1.7)
29	Precision machinery	75	(3.1)	46	(2.8)	257	(7.2)	191	(1.5)	581	(2.9)
30	Miscellaneous mfg. industries	61	(2.5)	57	(3.5)	175	(4.9)	369	(2.9)	659	(3.3)
1-30	Manufacturing Total	2,408	(100.0)	1,636	(100.0)	3,583	(100.0)	12,926	(100.0)	20,273	(100.0)

Notes: Firms are classified based on the industry reported for the first observation of each firm during the observation period. ALWAYS denotes firms which always exported throughout the sample period while NEVER denotes firms which never exported throughout

Table 3 shows a breakdown of export starters by firm characteristics.[11] It indicates that 74 percent of the 2,408 export starters are SMEs (firms with 300 or fewer employees). This share more or less corresponds to the share of SMEs in the total

[11] The number of export starters by year and the number of export quitters by year are shown in Appendix Table 2.

number of firms in the dataset overall, which is 76 percent. Moreover, as expected, the major export destination for both SMEs and larger firms is Asia.

Table 3. Number of Export Starters by Characteristics (Period Total)

		Total		SMEs		Large firms	
Export Starters		2,408	(100%)	1,780	(74%)	628	(26%)
Breakdown by Export Destination							
Destinations Total		3,142	(100%)	2174	(100%)	968	(100%)
	Asia	1,952	(62%)	1446	(67%)	506	(52%)
	Middle East	64	(2%)	33	(2%)	31	(3%)
	Europe	256	(8%)	165	(8%)	91	(9%)
	North America	617	(20%)	395	(18%)	222	(23%)
	Latin America	85	(3%)	50	(2%)	35	(4%)
	Africa	47	(1%)	23	(1%)	24	(2%)
	Oceania	121	(4%)	62	(3%)	59	(6%)

4. Econometric Analysis

4.1. Propensity Score Matching and DID Estimator

This section explains the econometric strategy employed to investigate the effects of starting to export. Taking account of endogeneity among firms' various strategies and outcomes, propensity score matching is used to examine various outcomes of starting exporting.

First, using logit estimation, the probability of initiating exporting for firms is estimated and then a "propensity score" for each firm calculated. The propensity score is defined as the conditional probability of initiating exporting given a firm's characteristics prior to exporting:

$$P(x) \equiv Pr\{z = 1|x\} = E\{z|x\} \quad (1)$$

where $z=\{0,1\}$ indicates whether the firm started exporting in year *t*, and *x* is a vector of observed firm characteristics in year *t-1*, i.e., the year prior to starting to export. For *x*, the productivity level, firm size (proxied by the number of employees), R&D intensity

(R&D expenditure divided by sales), age, the debt-asset ratio, the import-sales ratio, and the FDI ratio (foreign investment divided by assets) are considered.[12] The main productivity measure used here is total factor productivity (TFP) estimated using the Olley-Pakes method. The production function is estimated by industry and the estimated production function coefficients are shown in Appendix Table 3.[13]

Second, after estimating the logit model, firms which did not start exporting in year *t* are matched with firms that had the closest propensity score and that actually did initiate exporting. The matching is conducted separately for each year and industry.

Finally, the causal effect of initiating exporting on various performance variables is examined. As shown in Rosenbaum and Rubin (1983), if the recipient of the treatment (*z* in equation 1) is randomly chosen within cells defined by *x* in equation 1, it is also randomly chosen within cells defined by the values of the single-index variable *P(x)*. Therefore, the Average effect of Treatment on the Treated (ATT) can be estimated as the average difference between the outcome of recipients and non-recipients of the treatment for which propensity scores *P(x)* are identical. In this case, the treatment is the start of exporting. The propensity score matching technique should identify matched firms that satisfy the assumption that, conditional on observables, the non-treated outcomes are independent of the treatment status. Nonetheless, the propensity score is conditional only on a limited number of observable characteristics, implying that unobservable, time-invariant, firm-specific effects may not be fully removed after propensity score matching. Therefore, the growth rate of the performance variables of exporting firms, which is called the difference-in-differences (DID) estimator, is compared between treated and non-treated firms. In this manner, these unobservable effects can be reduced and more robust estimates can be obtained. The DID estimator can be calculated as follows:

$$\widehat{\propto}_{\mathrm{ATT-DID}} = \frac{1}{n}\sum_{1}^{n}(y_{t+s}^{1} - y_{t-1}^{1}) - \frac{1}{n}\sum_{1}^{n}(y_{t+s}^{0} - y_{t-1}^{0}) \qquad (2)$$

[12] Foreign investment here is defined as the amount of investment and/or lending to related firms (either subsidiaries and affiliates of the firm or those of the parent firm) located abroad.

[13] The estimated coefficient of capital input was negative or insignificant in some cases. Therefore, the production function was estimated at a more aggregated industry level. However, there are still some cases where the coefficient of capital input was not statistically significant.

where n denotes the number of observations and y denotes performance variables. For y, productivity (TFP), demand (firm sales), R&D intensity, R&D volume (R&D expenditure and employees in R&D divisions), firm size (employment and capital stock), and skill intensity (R&D employment share) are considered. It is then examined how and whether exporting changes these performance measures.

4.2. Matching Results

In order to examine the determinants of export initiation, observations of firms which did not export before and started exporting for the first time during the sample period are used. Observations of firms which exported throughout and firms which exported but quit exporting before the reference year are excluded. The result of the logit estimation is shown in column (1) of Table 4 and indicates that larger (in terms of employment), more R&D intensive, older, and financially healthier firms are more likely to become exporters. Moreover, the significantly positive coefficients for the import and FDI ratios suggest that having some sort of link with international markets is a key determinant of starting to export. However, the coefficient on productivity is not statistically significant, suggesting that the productivity level is not a relevant determinant of starting to export.[14] Based on the logit estimation, firms are matched separately for each year and industry using the one-to-one nearest neighbor matching method.[15] The balancing property test results are shown in Panel (a) of Appendix Table 4.[16] Table 5 shows the estimated effects of starting to export, with s denoting the year after the treatment (s in equation 2 above). Table 5 suggests that firms that started exporting show significantly higher sales and employment growth rates than firms that did not start exporting (rows (d) and (l)). Moreover, starting to export promotes R&D activities and increases the R&D intensity and R&D volume (rows (e) to (j) and rows

[14] This result is not consistent with the theoretical prediction by Melitz (2003) and others that export starters should be more productive in order to cover the fixed costs involved in starting to export. However, results by Todo (2009) for Japan suggest that productivity has a positive impact on the export decision, although the impact is economically negligible in size. The insignificant coefficient on TFP in Table 4 seems consistent with Todo's results.

[15] The matching procedure is implemented in Stata11 using a modified version of the procedure provided by Leuven and Sianesi (2003).

[16] The balancing property is not adequately satisfied for some cases in Appendix Table 4, though the specification provided the best results in terms of the balancing property tests out of the several specifications tried.

(o) and (p)). The positive effects of exporting on R&D activities continue even four years after the firm started exporting. However, exporting does not have a significantly positive effect on productivity in most cases (rows (a) and (b)). It should be noted that actually a significant number of treated and control firms are dropped from the sample in later years and only surviving firms are included in the ATT and DID analyses. Moreover, a substantial number of treated firms stopped exporting after they started exporting. For some cases, treated firms are retained in the sample while the matched control firms are dropped from the sample, or vice versa, in later years. As can be seen in Table 5, the numbers of treated firms and control firms are not balanced in later years. Because firms which are dropped from the sample or whose export status switches may create some bias in the results, they are excluded when estimating the effects of starting to export.[17] The results are shown in Table 6 and are mostly consistent with those in Table 5. For the estimation shown in Table 6, only treated firms which continued exporting and whose control firms were not dropped from the sample are included. However, as before (Table 5), starting to export has no (or at best a weakly significant) positive effect on productivity.

Table 4. Determinants of Export Initiation

	Logit	Multinomial logit		
	(1)	(2)	(3)	(4)
	STARTER=1	NAEUR=3	ASIA=2	OTHERS=1
lnTFP (OP)	-0.0472	0.2313	-0.1567	-0.6203
	(0.1325)	(0.2318)	(0.1606)	(0.6843)
ln(employment)	0.3879***	0.5366***	0.3152***	0.3056**
	(0.0263)	(0.0422)	(0.0331)	(0.1284)
R&D intensity	10.7083***	14.1406***	8.0768***	10.1582**
	(1.0193)	(1.3279)	(1.3527)	(4.0193)
Age	0.0026***	0.0023*	0.0027***	0.0025
	(0.0007)	(0.0014)	(0.0008)	(0.0048)
Debt-asset ratio	-0.1744*	-0.2806*	-0.1134	-0.5149
	(0.0892)	(0.1608)	(0.1056)	(0.4708)
Import ratio	1.8835***	1.5279***	1.9775***	2.5612***
	(0.1705)	(0.3218)	(0.1937)	(0.6432)

[17] Specifically, a pair of firms is excluded when one of the pair is dropped from the sample or when the treated firm stopped exporting.

Table 4 (continued). Determinants of Export Initiation

	Logit	Multinomial logit		
	(1)	(2)	(3)	(4)
	STARTER=1	NAEUR=3	ASIA=2	OTHERS=1
FDI ratio	8.6690***	8.4402***	8.8450***	6.6518**
	(0.6541)	(1.0077)	(0.7229)	(2.6418)
No. of observations	69,912		69,912	
Chi-squared	1735.51		1997.66	
Pseudo R^2	0.0931		0.0916	
Log likelihood	-8450.0695		-9901.9601	

Note: Standard errors are in parentheses, with ***, **, and * indicating significance at the 1%, 5%, and 10% levels, respectively. The constant term is not reported. All equations include three-digit industry dummy variables and year dummy variables.

Table 5. Estimated Effects of Starting to Export

S	0	1	2	3	4
No. of observations	4,136	3,528	3,165	2,792	2,448
Treated	2,068	1,748	1,581	1,413	1,243
Control	2,068	1,780	1,584	1,379	1,205
Outcome					
(a) Productivity level (lnTFP_OP)					
	-0.0059	0.0011	-0.0069	-0.0022	0.0047
	(0.0120)	(0.0104)	(0.0128)	(0.0114)	(0.0124)
(b) Productivity growth rate: pre-export level (s=-1)					
	0.0032	0.0109 *	0.0038	0.0062	0.0067
	(0.0052)	(0.0059)	(0.0064)	(0.0076)	(0.0083)
(c) Sales (lnY)					
	-0.0512	-0.0234	-0.0302	-0.0207	-0.0278
	(0.0401)	(0.0393)	(0.0488)	(0.0517)	(0.0487)
(d) Sales growth rate: pre-export level (s=-1)					
	0.0245 ***	0.0365 ***	0.0388 ***	0.0403 ***	0.0494 ***
	(0.0073)	(0.0091)	(0.0119)	(0.0142)	(0.0177)
(e) R&D intensity					
	0.0010	0.0021 ***	0.0031 ***	0.0034 ***	0.0032 ***
	(0.0007)	(0.0008)	(0.0008)	(0.0009)	(0.0010)

Table 5 (continued). Estimated Effects of Starting to Export

S	0		1		2		3		4	
(f) Difference in R&D intensity: pre-export level (s=-1)										
	0.0002		0.0015	***	0.0022	***	0.0026	***	0.0019	**
	(0.0006)		(0.0005)		(0.0007)		(0.0007)		(0.0008)	
(g) R&D expenditure (lnR&D exp)										
	1.7512	***	1.9901	***	2.2229	***	2.0099	***	2.1944	***
	(0.3155)		(0.2983)		(0.3805)		(0.3740)		(0.3577)	
(h) R&D expenditure growth rate: pre-export level (s=-1)										
	0.4626	***	0.4845	**	0.7079	***	0.6213	**	0.7254	**
	(0.1689)		(0.2184)		(0.2328)		(0.2736)		(0.3075)	
(i) R&D employment (lnR&D emp)										
	0.2383	***	0.2548	***	0.2819	***	0.3128	***	0.2978	***
	(0.0488)		(0.0549)		(0.0571)		(0.0673)		(0.0587)	
(j) R&D employment growth rate: pre-export level (s=-1)										
	0.0883	***	0.0844	***	0.1026	***	0.1299	***	0.1358	**
	(0.0245)		(0.0283)		(0.0370)		(0.0388)		(0.0536)	
(k) Employment (ln employment)										
	-0.1104	***	-0.0915	**	-0.0910	***	-0.0830	**	-0.0932	**
	(0.0247)		(0.0335)		(0.0321)		(0.0362)		(0.0372)	
(l) Employment growth rate: pre-export level (s=-1)										
	0.0201	***	0.0275	***	0.0337	***	0.0368	***	0.0317	***
	(0.0043)		(0.0057)		(0.0072)		(0.0093)		(0.0106)	
(m) Capital stock (ln K)										
	-0.0606		-0.0365		-0.0018		0.0042		-0.0083	
	(0.0514)		(0.0429)		(0.0521)		(0.0554)		(0.0562)	
(n) Capital stock growth rate: pre-export level (s=-1)										
	0.0190	*	0.0202		0.0386	***	0.0438	**	0.0675	***
	(0.0111)		(0.0125)		(0.0139)		(0.0190)		(0.0234)	
(o) R&D employment share										
	0.0113	***	0.0131	***	0.0134	***	0.0165	***	0.0145	***
	(0.0025)		(0.0024)		(0.0026)		(0.0026)		(0.0033)	
(p) Difference in R&D employment share: pre-export level (s=-1)										
	0.0021		0.0030	*	0.0030		0.0058	***	0.0047	**
	(0.0015)		(0.0018)		(0.0018)		(0.0021)		(0.0024)	

Notes: Bootstrapped standard errors are in parentheses (100 repetitions). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 6. Estimated Effects of Starting to Export (Excluding Switchers and Quitters)

s	0		1		2		3		4	
No. of observations	4,136		2,260		1,732		1,370		1,136	
Treated	2,068		1,130		866		685		568	
Control	2,068		1,130		866		685		568	
Outcome										
(a) Productivity level (lnTFP_OP)										
	-0.0059		0.0006		-0.0036		-0.0029		0.0001	
	(0.0120)		(0.0149)		(0.0155)		(0.0178)		(0.0177)	
(b) Productivity growth rate: pre-export level (s=-1)										
	0.0032		0.0131	*	0.0166	*	0.0097		0.0095	
	(0.0058)		(0.0071)		(0.0089)		(0.0096)		(0.0101)	
(c) Sales (lnY)										
	-0.0512		-0.0504		-0.0817		-0.0242		-0.0608	
	(0.0355)		(0.0506)		(0.0622)		(0.0691)		(0.0847)	
(d) Sales growth rate: pre-export level (s=-1)										
	0.0245	***	0.0562	***	0.0604	***	0.0746	***	0.0886	***
	(0.0054)		(0.0123)		(0.0151)		(0.0199)		(0.0227)	
(e) R&D intensity										
	0.0010	*	0.0029	***	0.0032	***	0.0033	**	0.0029	
	(0.0006)		(0.0010)		(0.0012)		(0.0016)		(0.0018)	
(f) Difference in R&D intensity: pre-export level (s=-1)										
	0.0002		0.0016	***	0.0022	**	0.0032	***	0.0023	**
	(0.0006)		(0.0006)		(0.0009)		(0.0012)		(0.0011)	
(g) R&D expenditure (lnR&D exp)										
	1.7512	***	2.1893	***	2.1225	***	2.0370	***	1.9617	***
	(0.2893)		(0.3680)		(0.4995)		(0.5369)		(0.5313)	
(h) R&D expenditure growth rate: pre-export level (s=-1)										
	0.4626	**	0.8856	***	0.8358	***	0.9463	**	0.9984	**
	(0.1821)		(0.2737)		(0.3205)		(0.3713)		(0.3856)	
(i) R&D employment (lnR&D emp)										
	0.2383	***	0.2343	***	0.2631	***	0.3624	***	0.3081	***
	(0.0551)		(0.0612)		(0.0841)		(0.0996)		(0.1072)	
(j) R&D employment growth rate: pre-export level (s=-1)										
	0.0883	***	0.0950	**	0.1850	***	0.2741	***	0.1805	**
	(0.0243)		(0.0436)		(0.0538)		(0.0621)		(0.0766)	
(k) Employment (ln employment)										
	-0.1104	***	-0.1024	**	-0.1047	**	-0.0731		-0.0978	*
	(0.0247)		(0.0404)		(0.0407)		(0.0502)		(0.0568)	

Table 6 (continued). Estimated Effects of Starting to Export (Excluding Switchers and Quitters)

s	0		1		2		3		4	
(l) Employment growth rate: pre-export level (s=-1)										
	0.0201	***	0.0340	***	0.0412	***	0.0573	***	0.0573	***
	(0.0043)		(0.0078)		(0.0107)		(0.0130)		(0.0172)	
(m) Capital stock (ln K)										
	-0.0606		-0.0655		-0.0952		-0.0304		-0.0968	
	(0.0514)		(0.0720)		(0.0732)		(0.0812)		(0.0844)	
(n) Capital stock growth rate: pre-export level (s=-1)										
	0.0190	*	0.0156		0.0290		0.0068		0.0447	
	(0.0111)		(0.0171)		(0.0212)		(0.0272)		(0.0300)	
(o) R&D employment share										
	0.0113	***	0.0125	***	0.0135	***	0.0174	***	0.0141	***
	(0.0025)		(0.0038)		(0.0043)		(0.0042)		(0.0051)	
(p) Difference in R&D employment share: pre-export level (s=-1)										
	0.0021		0.0025		0.0056	**	0.0098	***	0.0038	
	(0.0015)		(0.0023)		(0.0026)		(0.0030)		(0.0038)	

Notes: Bootstrapped standard errors are in parentheses (100 repetitions). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

4.3. Learning-by-Exporting Effects by Export Destination

In order to further investigate the mechanism of learning-by-exporting, the sample is split according to the destination market and the effect of exporting is estimated separately for firms exporting to high-income regions and low-income regions. Conducting such estimations by region, it is then examined whether the effects of exporting differ across export destinations. Because the survey only asks respondents to name the export region, such as Asia, North America, and Europe, the following four cases are distinguished: (1) firms which do not export; (2) firms which do not export to Asia, North America, or Europe, but do export to other regions; (3) firms which do not export to North America or Europe, but do export to Asia (and other regions); and (4) firms exporting to North America or Europe (and Asia and/or other regions). That is, for example, if a firm exports to both North America and Asia in the initial year of exporting, the firm is classified as falling into the fourth category. Similarly, if a firm exports to both Asia and Oceania in the initial year of exporting, the firm is classified as falling into the third category. And if a firm exports to Europe only, the firm is

classified as falling into the fourth category.[18] In order to estimate the determinants of exporting for each category of firms, equation (1) is modified into a multinomial logit model. The indicator of initiating exporting in year *t*, *z*, now takes a value of 0, 1, 2, or 3, corresponding to the four cases. The multinomial logit estimation results are shown in columns (2) to (4) of Table 4.[19] Based on the multinomial logit estimation, firms are matched separately for each year and industry using the one-to-one nearest neighbor matching method. The balancing property test results are shown in Panels (b) to (d) of Appendix Table 4.

Tables 7 to 9 show the estimated effects of starting to export. The results in Table 7 suggest that starting to export to North America or Europe has a strong positive effect on sales and employment growth and R&D activities. Moreover, exporting to these regions improves the productivity growth rate significantly. However, starting to export to Asia does not have any productivity enhancing effects, although it tends to raise the growth rate of sales and increase R&D expenditure (Table 8). Starting to export to other regions has almost no significant effect, though the results may be due to the small sample size (Table 9).

Table 7. Estimated Effects of Starting to Export to North America or Europe

S	0	1	2	3	4
No. of observations	1,260	1,096	967	859	764
Treated	630	551	498	445	389
Control	630	545	469	414	375
Outcome					
(a) Productivity level (lnTFP_OP)					
	0.0116	0.0275	0.0002	-0.0008	0.0066
	(0.0205)	(0.0215)	(0.0187)	(0.0233)	(0.0255)
(b) Productivity growth rate: pre-export level (s=-1)					
	0.0163 **	0.0293 ***	0.0183	0.0182	0.0153
	(0.0079)	(0.0104)	(0.0127)	(0.0134)	(0.0149)

[18] The number of firms for each category is shown in Appendix Table 5.

[19] The results in columns (2) to (4) of Table 4 are similar to that in column (1). However, size (as measured by employment) and R&D intensity have a larger impact on the decision to export to North America/Europe than on decision to export to Asia and other regions. As for the productivity level, although the estimated coefficients are not statistically significant, a positive coefficient is estimated only in the case of the decision to export to North America/Europe, suggesting that productivity is a more important determinant for export starters to developed regions than for those to developing regions.

Table 7 (continued). Estimated Effects of Starting to Export to North America or Europe

S	0		1		2		3		4	
(c) Sales (lnY)										
	0.0735		0.0895		0.0818		0.0997		0.1299	
	(0.0787)		(0.0704)		(0.0854)		(0.0874)		(0.0946)	
(d) Sales growth rate: pre-export level (s=-1)										
	0.0672	***	0.0791	***	0.0893	***	0.0787	**	0.0924	***
	(0.0140)		(0.0162)		(0.0214)		(0.0239)		(0.0323)	
(e) R&D intensity										
	0.0026		0.0041	**	0.0057	***	0.0069	***	0.0070	***
	(0.0019)		(0.0020)		(0.0018)		(0.0024)		(0.0022)	
(f) Difference in R&D intensity: pre-export level (s=-1)										
	-0.0007		0.0012		0.0021		0.0034	**	0.0020	
	(0.0012)		(0.0012)		(0.0015)		(0.0016)		(0.0014)	
(g) R&D expenditure (lnR&D exp)										
	3.4182	***	3.4800	***	3.7098	***	3.8470	***	3.9876	***
	(0.4810)		(0.5550)		(0.6499)		(0.6505)		(0.6974)	
(h) R&D expenditure growth rate: pre-export level (s=-1)										
	0.6047	*	0.5624		0.8818	*	1.2263	**	1.0353	*
	(0.3437)		(0.4300)		(0.5251)		(0.5752)		(0.5609)	
(i) R&D employment (lnR&D emp)										
	0.3489	***	0.3903	***	0.4981	***	0.5052	***	0.4992	***
	(0.0903)		(0.1113)		(0.1187)		(0.1138)		(0.1204)	
(j) R&D employment growth rate: pre-export level (s=-1)										
	0.0478		0.0588		0.1934	***	0.2272	***	0.1882	*
	(0.0542)		(0.0661)		(0.0726)		(0.0810)		(0.0992)	
(k) Employment (ln employment)										
	-0.0250		-0.0121		-0.0348		-0.0131		0.0000	
	(0.0567)		(0.0641)		(0.0618)		(0.0717)		(0.0813)	
(l) Employment growth rate: pre-export level (s=-1)										
	0.0364	***	0.0528	***	0.0470	***	0.0517	***	0.0458	**
	(0.0087)		(0.0116)		(0.0158)		(0.0184)		(0.0210)	
(m) Capital stock (ln K)										
	0.1298		0.1178		0.0884		0.1190		0.1391	
	(0.0794)		(0.0851)		(0.1033)		(0.1162)		(0.1140)	
(n) Capital stock growth rate: pre-export level (s=-1)										
	0.0393		0.0351		0.0399		0.0508		0.0997	**
	(0.0257)		(0.0228)		(0.0367)		(0.0398)		(0.0449)	
(o) R&D employment share										
	0.0177	***	0.0178	***	0.0210	***	0.0218	***	0.0219	***
	(0.0052)		(0.0057)		(0.0051)		(0.0057)		(0.0071)	

Table 7 (continued). Estimated Effects of Starting to Export to North America or Europe

S	0	1	2	3	4
(p) Difference in R&D employment share: pre-export level (s=-1)					
	0.0005	-0.0001	0.0035	0.0062	0.0046
	(0.0030)	(0.0032)	(0.0037)	(0.0046)	(0.0053)

Notes: Bootstrapped standard errors are in parentheses (100 repetitions). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 8. Estimated Effects of Starting to Export to Asia

s	0	1	2	3	4
No. of observations	2,714	2,283	2,049	1,787	1,565
Treated	1,357	1,129	1,019	909	798
Control	1,357	1,154	1,030	878	767
Outcome					
(a) Productivity level (lnTFP_OP)					
	-0.0076	-0.0062	-0.0050	-0.0111	-0.0055
	(0.0130)	(0.0141)	(0.0143)	(0.0154)	(0.0169)
(b) Productivity growth rate: pre-export level (s=-1)					
	-0.0058	-0.0018	-0.0057	-0.0124	-0.0116
	(0.0060)	(0.0081)	(0.0085)	(0.0089)	(0.0101)
(c) Sales (lnY)					
	-0.0840 **	-0.0831	-0.1021 *	-0.0798	-0.1001 *
	(0.0403)	(0.0507)	(0.0536)	(0.0530)	(0.0553)
(d) Sales growth rate: pre-export level (s=-1)					
	0.0101	0.0165	0.0215	0.0214	0.0146
	(0.0072)	(0.0106)	(0.0140)	(0.0164)	(0.0208)
(e) R&D intensity					
	-0.0001	0.0010	0.0018 **	0.0018 **	0.0020 **
	(0.0007)	(0.0008)	(0.0009)	(0.0009)	(0.0010)
(f) Difference in R&D intensity: pre-export level (s=-1)					
	0.0010 **	0.0020 ***	0.0028 ***	0.0027 ***	0.0029 ***
	(0.0005)	(0.0005)	(0.0006)	(0.0007)	(0.0008)
(g) R&D expenditure (lnR&D exp)					
	0.8434 **	1.0986 ***	1.3299 ***	0.9912 ***	1.6074 ***
	(0.3728)	(0.3999)	(0.4311)	(0.3591)	(0.4775)
(h) R&D expenditure growth rate: pre-export level (s=-1)					
	0.2539	0.2348	0.6511 **	0.3137	0.7421 **
	(0.2316)	(0.2913)	(0.2992)	(0.3488)	(0.3660)

Table 8 (continued). Estimated Effects of Starting to Export to Asia

s	0		1		2		3		4	
(i) R&D employment (lnR&D emp)										
	0.0883		0.1212	*	0.1376	**	0.1334	*	0.1574	*
	(0.0595)		(0.0681)		(0.0569)		(0.0700)		(0.0893)	
(j) R&D employment growth rate: pre-export level (s=-1)										
	0.0414		0.0567	*	0.1041	**	0.0808		0.0924	*
	(0.0336)		(0.0321)		(0.0436)		(0.0561)		(0.0552)	
(k) Employment (ln employment)										
	-0.1389	***	-0.1446	***	-0.1327	***	-0.1398	***	-0.1484	***
	(0.0320)		(0.0355)		(0.0361)		(0.0404)		(0.0439)	
(l) Employment growth rate: pre-export level (s=-1)										
	0.0113	**	0.0094		0.0210	**	0.0127		0.0050	
	(0.0051)		(0.0066)		(0.0095)		(0.0125)		(0.0159)	
(m) Capital stock (ln K)										
	-0.1244	**	-0.1105	*	-0.1102	**	-0.0819		-0.0892	
	(0.0525)		(0.0640)		(0.0518)		(0.0641)		(0.0756)	
(n) Capital stock growth rate: pre-export level (s=-1)										
	0.0113		0.0079		0.0273		0.0350		0.0495	*
	(0.0125)		(0.0146)		(0.0184)		(0.0216)		(0.0272)	
(o) R&D employment share										
	0.0072	***	0.0072	***	0.0088	***	0.0101	***	0.0097	***
	(0.0022)		(0.0027)		(0.0028)		(0.0030)		(0.0033)	
(p) Difference in R&D employment share: pre-export level (s=-1)										
	0.0014		0.0006		0.0030		0.0029		0.0030	
	(0.0015)		(0.0022)		(0.0022)		(0.0027)		(0.0026)	

Notes: Bootstrapped standard errors are in parentheses (100 repetitions). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 9. Estimated Effects of Starting to Export to Other Regions

s	0	1	2	3	4
No. of observations	162	139	126	116	108
Treated	81	68	64	59	56
Control	81	71	62	57	52
Outcome					
(a) Productivity level (lnTFP_OP)					
	0.0012	-0.0034	-0.0592	-0.0399	-0.0133
	(0.0629)	(0.0599)	(0.0627)	(0.0646)	(0.0639)
(b) Productivity growth rate: pre-export level (s=-1)					
	-0.0016	0.0109	-0.0037	0.0063	0.0181
	(0.0288)	(0.0261)	(0.0283)	(0.0324)	(0.0308)

Table 9 (continued). Estimated Effects of Starting to Export to Other Regions

s	0	1	2	3	4
(c) Sales (lnY)					
	-0.1661	-0.1221	-0.2292	-0.1309	-0.2771
	(0.2107)	(0.2405)	(0.2271)	(0.2733)	(0.2617)
(d) Sales growth rate: pre-export level (s=-1)					
	0.0235	0.0211	0.0220	0.0460	0.0439
	(0.0257)	(0.0455)	(0.0472)	(0.0738)	(0.0854)
(e) R&D intensity					
	-0.0022	-0.0003	0.0004	-0.0014	0.0004
	(0.0024)	(0.0036)	(0.0023)	(0.0034)	(0.0042)
(f) Difference in R&D intensity: pre-export level (s=-1)					
	-0.0035 **	0.0001	-0.0017	-0.0038	-0.0026
	(0.0017)	(0.0026)	(0.0020)	(0.0032)	(0.0027)
(g) R&D expenditure (lnR&D exp)					
	0.9664	-0.1326	1.5564	0.1427	-0.0091
	(1.2480)	(1.6405)	(1.8298)	(1.7239)	(1.7060)
(h) R&D expenditure growth rate: pre-export level (s=-1)					
	0.1393	-0.9247	-0.4689	-2.5038 **	-2.4948 **
	(0.7628)	(0.8846)	(1.1400)	(1.3289)	(1.1326)
(i) R&D employment (lnR&D emp)					
	-0.1133	-0.4866 *	-0.1372	-0.0372	-0.1834
	(0.2434)	(0.2795)	(0.2609)	(0.3065)	(0.3284)
(j) R&D employment growth rate: pre-export level (s=-1)					
	0.2290 *	-0.1179	0.1023	0.0965	-0.0437
	(0.1364)	(0.1875)	(0.1954)	(0.2267)	(0.1722)
(k) Employment (ln employment)					
	-0.2544	-0.2602	-0.3662 **	-0.2869	-0.4188 **
	(0.1639)	(0.2021)	(0.1821)	(0.1776)	(0.2014)
(l) Employment growth rate: pre-export level (s=-1)					
	0.0076	0.0011	0.0036	0.0035	-0.0174
	(0.0173)	(0.0238)	(0.0317)	(0.0511)	(0.0512)
(m) Capital stock (ln K)					
	-0.1134	-0.0802	-0.1415	-0.0394	-0.1564
	(0.2431)	(0.2354)	(0.3030)	(0.2880)	(0.3167)
(n) Capital stock growth rate: pre-export level (s=-1)					
	-0.0400	-0.0811	-0.0343	0.0515	0.0572
	(0.0459)	(0.0710)	(0.0859)	(0.0937)	(0.0952)
(o) R&D employment share					
	0.0051	0.0001	0.0065	0.0167	0.0054
	(0.0089)	(0.0129)	(0.0103)	(0.0158)	(0.0115)
(p) Difference in R&D employment share: pre-export level (s=-1)					
	0.0051	0.0015	0.0005 *	0.0110	-0.0032
	(0.0057)	(0.0106)	(0.0084)	(0.0155)	(0.0065)

Notes: Bootstrapped standard errors are in parentheses (100 repetitions). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

The results in Tables 7 to 9 are based on observations of firms that survived *s* years after the treatment year regardless of whether the export status of the treated firm changed and of whether one of the pair was dropped from the sample. Therefore, similar to Table 6, Tables 10 to 12 show estimates when these firms are excluded and only treated firms which continued exporting and whose control firms were not dropped from the sample are included. The results are mostly consistent with those in Tables 7 to 9. However, the magnitude of the positive impact is much larger in Tables 10 to 12 than in Tables 7 to 9. The results in Tables 10 to 12 pick up the effects for firms which were able to stay and survive in the export market, and these firms are likely to have enjoyed greater learning effects. That is, the results in Tables 10 to 12 may include a selection effect (better performing firms were able to stay in the export market).

Table 10. Estimated Effects of Starting to Export to North America or Europe (Excluding Switchers and Quitters)

s	0		1		2		3		4	
No. of observations	1,260		802		600		494		410	
Treated	630		401		300		247		205	
Control	630		401		300		247		205	
Outcome										
(a) Productivity level (lnTFP_OP)										
	0.0116		0.0211		0.0217		0.0138		0.0325	
	(0.0209)		(0.0223)		(0.0260)		(0.0265)		(0.0330)	
(b) Productivity growth rate: pre-export level (s=-1)										
	0.0163	*	0.0243	**	0.0384	***	0.0304		0.0414	*
	(0.0095)		(0.0119)		(0.0136)		(0.0195)		(0.0232)	
(c) Sales (lnY)										
	0.0735		0.1216		0.0970		0.1951	*	0.2185	*
	(0.0819)		(0.0975)		(0.1086)		(0.1154)		(0.1180)	
(d) Sales growth rate: pre-export level (s=-1)										
	0.0672	***	0.0966	***	0.1149	***	0.1051	***	0.1223	***
	(0.0128)		(0.0203)		(0.0236)		(0.0329)		(0.0396)	
(e) R&D intensity										
	0.0026		0.0051	**	0.0043	*	0.0033		0.0043	
	(0.0018)		(0.0025)		(0.0024)		(0.0030)		(0.0029)	
(f) Difference in R&D intensity: pre-export level (s=-1)										
	-0.0007		0.0014		0.0023		0.0037		0.0040	**
	(0.0012)		(0.0013)		(0.0019)		(0.0023)		(0.0020)	

Table 10 (continued). Estimated Effects of Starting to Export to North America or Europe (Excluding Switchers and Quitters)

s	0		1		2		3		4	
(g) R&D expenditure (lnR&D exp)										
	3.4182	***	3.8709	***	3.7914	***	3.7351	***	4.2656	***
	(0.5000)		(0.6523)		(0.6731)		(0.8356)		(0.9044)	
(h) R&D expenditure growth rate: pre-export level (s=-1)										
	0.6047	*	0.7230	*	0.9719		1.3370	**	1.3970	*
	(0.3268)		(0.4258)		(0.5905)		(0.6193)		(0.7834)	
(i) R&D employment (lnR&D emp)										
	0.3489	***	0.5129	***	0.5793	***	0.5916	***	0.5461	***
	(0.0809)		(0.1135)		(0.1527)		(0.1698)		(0.1569)	
(j) R&D employment growth rate: pre-export level (s=-1)										
	0.0478		0.1231		0.3092	***	0.3813	***	0.2527	*
	(0.0556)		(0.0852)		(0.1077)		(0.1018)		(0.1320)	
(k) Employment (ln employment)										
	-0.0250		0.0093		-0.0102		0.0529		0.0547	
	(0.0567)		(0.0747)		(0.0809)		(0.0811)		(0.0979)	
(l) Employment growth rate: pre-export level (s=-1)										
	0.0364	***	0.0608	***	0.0574	***	0.0761	***	0.0759	***
	(0.0087)		(0.0127)		(0.0204)		(0.0274)		(0.0280)	
(m) Capital stock (ln K)										
	0.1298		0.0702		0.0335		0.1621		0.1644	
	(0.0794)		(0.1193)		(0.1172)		(0.1206)		(0.1564)	
(n) Capital stock growth rate: pre-export level (s=-1)										
	0.0393		0.0245		0.0530		0.0569		0.0528	
	(0.0257)		(0.0311)		(0.0340)		(0.0399)		(0.0444)	
(o) R&D employment share										
	0.0177	***	0.0227	***	0.0210	***	0.0202	**	0.0163	
	(0.0052)		(0.0073)		(0.0078)		(0.0083)		(0.0107)	
(p) Difference in R&D employment share: pre-export level (s=-1)										
	0.0005		0.0014		0.0043		0.0111	*	0.0026	
	(0.0030)		(0.0038)		(0.0053)		(0.0058)		(0.0068)	

Notes: Bootstrapped standard errors are in parentheses (100 repetitions). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 11. Estimated Effects of Starting to Export to Asia (Excluding Switchers and Quitters)

s	0	1	2	3	4
No. of observations	2,714	1,426	1,068	804	688
Treated	1,357	713	534	402	344
Control	1,357	713	534	402	344
Outcome					
(a) Productivity level (lnTFP_OP)					
	-0.0076	-0.0052	-0.0091	-0.0065	-0.0126
	(0.0128)	(0.0195)	(0.0184)	(0.0243)	(0.0268)
(b) Productivity growth rate: pre-export level (s=-1)					
	-0.0058	-0.0052	-0.0145	-0.0166	-0.0104
	(0.0065)	(0.0105)	(0.0111)	(0.0136)	(0.0139)
(c) Sales (lnY)					
	-0.0840 *	-0.0705	-0.0642	-0.0524	-0.1845 **
	(0.0441)	(0.0679)	(0.0715)	(0.0848)	(0.0934)
(d) Sales growth rate: pre-export level (s=-1)					
	0.0101	0.0316 **	0.0480 **	0.0645 **	0.0746 ***
	(0.0068)	(0.0129)	(0.0188)	(0.0258)	(0.0277)
(e) R&D intensity					
	-0.0001	0.0009	0.0020 *	0.0017	0.0008
	(0.0008)	(0.0011)	(0.0012)	(0.0017)	(0.0016)
(f) Difference in R&D intensity: pre-export level (s=-1)					
	0.0010 *	0.0020 ***	0.0033 ***	0.0035 ***	0.0038 ***
	(0.0005)	(0.0007)	(0.0010)	(0.0011)	(0.0012)
(g) R&D expenditure (lnR&D exp)					
	0.8434 ***	0.8088 *	1.3798 **	1.0851 *	0.9615
	(0.3230)	(0.4490)	(0.5966)	(0.6432)	(0.6581)
(h) R&D expenditure growth rate: pre-export level (s=-1)					
	0.2539	0.4137	0.8632 **	0.7703	1.3218 **
	(0.2365)	(0.3374)	(0.3770)	(0.4711)	(0.5192)
(i) R&D employment (lnR&D emp)					
	0.0883	0.0742	0.1203	0.1439	-0.0008
	(0.0591)	(0.0771)	(0.1028)	(0.1193)	(0.1182)
(j) R&D employment growth rate: pre-export level (s=-1)					
	0.0414	0.0500	0.1736 ***	0.1561 *	0.1251
	(0.0266)	(0.0479)	(0.0562)	(0.0852)	(0.0958)
(k) Employment (ln employment)					
	-0.1389 ***	-0.1202 **	-0.1030 *	-0.1070	-0.2081 ***
	(0.0320)	(0.0505)	(0.0603)	(0.0670)	(0.0694)

Table 11 (continued). Estimated Effects of Starting to Export to Asia (Excluding Switchers and Quitters)

s	0		1		2		3		4	
(l) Employment growth rate: pre-export level (s=-1)										
	0.0113	**	0.0185	**	0.0270	**	0.0425	**	0.0235	
	(0.0051)		(0.0080)		(0.0127)		(0.0184)		(0.0231)	
(m) Capital stock (ln K)										
	-0.1244	**	-0.0754		-0.0978		-0.0314		-0.1963	*
	(0.0525)		(0.0776)		(0.0843)		(0.0876)		(0.1069)	
(n) Capital stock growth rate: pre-export level (s=-1)										
	0.0113		0.0329	*	0.0394	*	0.0370		0.0607	
	(0.0125)		(0.0185)		(0.0236)		(0.0289)		(0.0398)	
(o) R&D employment share										
	0.0072	***	0.0051		0.0081	*	0.0091	*	0.0034	
	(0.0022)		(0.0036)		(0.0047)		(0.0054)		(0.0059)	
(p) Difference in R&D employment share: pre-export level (s=-1)										
	0.0014		-0.0011		0.0070	**	0.0050		0.0014	
	(0.0015)		(0.0025)		(0.0031)		(0.0042)		(0.0037)	

Notes: Bootstrapped standard errors are in parentheses (100 repetitions). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 12. Estimated Effects of Starting to Export to Other Regions (Excluding Switchers and Quitters)

s	0	1	2	3	4	
No. of observations	162	46	34	46	38	
Treated	81	23	17	23	19	
Control	81	23	17	23	19	
Outcome						
(a) Productivity level (lnTFP_OP)						
	0.0012	0.0163	-0.0272	0.0232	0.0211	
	(0.0594)	(0.1139)	(0.1055)	(0.0935)	(0.0786)	
(b) Productivity growth rate: pre-export level (s=-1)						
	-0.0016	0.0135	0.0021	0.0374	0.0053	
	(0.0329)	(0.0489)	(0.0466)	(0.0297)	(0.0460)	
(c) Sales (lnY)						
	-0.1661	-0.3473	-0.1230	0.0050	-0.2152	
	(0.1977)	(0.4122)	(0.4522)	(0.4389)	(0.4567)	
(d) Sales growth rate: pre-export level (s=-1)						
	0.0235	-0.0252	0.0810	0.2824 **	0.2364	*
	(0.0242)	(0.0577)	(0.0763)	(0.1275)	(0.1349)	

Table 12 (continued). Estimated Effects of Starting to Export to Other Regions (Excluding Switchers and Quitters)

s	0	1	2	3	4
(e) R&D intensity					
	-0.0022	0.0054	-0.0009	-0.0041	0.0086
	(0.0025)	(0.0086)	(0.0041)	(0.0072)	(0.0082)
(f) Difference in R&D intensity: pre-export level (s=-1)					
	-0.0035 *	0.0035	-0.0027	-0.0080	-0.0018
	(0.0019)	(0.0068)	(0.0029)	(0.0062)	(0.0058)
(g) R&D expenditure (lnR&D exp)					
	0.9664	2.3205	2.9209	4.0153	4.4645
	(1.4966)	(2.5162)	(2.7583)	(3.2764)	(2.8545)
(h) R&D expenditure growth rate: pre-export level (s=-1)					
	0.1393	-0.4879	-2.7956	-2.4023	-2.6873
	(0.7929)	(2.0349)	(2.2592)	(2.4439)	(1.7564)
(i) R&D employment (lnR&D emp)					
	-0.1133	-0.0994	0.0826	0.7269	0.3655
	(0.2487)	(0.5277)	(0.3983)	(0.4602)	(0.5408)
(j) R&D employment growth rate: pre-export level (s=-1)					
	0.2290	0.2214	0.2816	0.6055 *	-0.0702
	(0.1448)	(0.2901)	(0.2791)	(0.3094)	(0.3296)
(k) Employment (ln employment)					
	-0.2544	-0.2539	-0.3234	-0.2386	-0.3643
	(0.1639)	(0.3291)	(0.3419)	(0.3743)	(0.3839)
(l) Employment growth rate: pre-export level (s=-1)					
	0.0076	-0.0052	0.0270	0.1423 *	0.0992
	(0.0173)	(0.0383)	(0.0545)	(0.0744)	(0.1123)
(m) Capital stock (ln K)					
	-0.1134	-0.1511	0.1499	0.0175	-0.2705
	(0.2431)	(0.4549)	(0.5165)	(0.4938)	(0.5603)
(n) Capital stock growth rate: pre-export level (s=-1)					
	-0.0400	-0.3158	-0.0712	-0.0421	0.0574
	(0.0459)	(0.1339)	(0.1682)	(0.1548)	(0.1689)
(o) R&D employment share					
	0.0051	0.0245	0.0260	0.0439	0.0234
	(0.0089)	(0.0334)	(0.0204)	(0.0370)	(0.0253)
(p) Difference in R&D employment share: pre-export level (s=-1)					
	0.0051	0.0199	0.0146	0.0309	-0.0182
	(0.0057)	(0.0248)	(0.0102)	(0.0290)	(0.0170)

Notes: Bootstrapped standard errors are in parentheses (100 repetitions). ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

However, the results in Tables 10 to 12 confirm that starting to export to North America/Europe has a larger positive effect on the growth rates of productivity, sales, R&D activity, and employment than starting to export to Asia. Table 13 provides a summary of the differences in the impact two and four years after starting to export to North America/Europe and to Asia. Specifically, the Table shows the difference in the growth rate of various performance indicators of export starters vis-à-vis firms with the closest propensity score that did not export. The figures clearly indicate that starting to export to North America/Europe has a much larger positive impact on sales and employment growth.[20] Moreover, firms show an improvement in productivity only when they start exporting to North America/Europe.

Table 13. Relative Superiority of Exporters (Based on the Results from Tables 10 and 11)

Growth rate from t = -1 to t = 2		
	NA/EUR	ASIA
TFP	3.8pp higher	1.5pplower (n.s.)
Sales	11.5pp higher	4.8pp higher
R&D expenditure	97.2pp higher (n.s.)	86.3pp higher
R&D employment	30.9pp higher	17.4pp higher
Employment	5.7pp higher	2.7pp higher
Growth rate from t = -1 to t = 4		
	NA/EUR	ASIA
TFP	4.1pp higher	1.0pp lower (n.s)
Sales	12.2pp higher	7.5pp higher
R&D expenditure	139pp higher	132pp higher
R&D employment	25.3pp higher	12.5pp higher
Employment	7.6pp higher	2.4pp higher (n.s.)

4.3. Robustness Checks

In order to check the robustness of the above results, the multinomial logit model

[20] As for R&D expenditure, firms starting to export to Asia tend to be smaller in size and are less likely to be firms that conduct R&D before they start exporting. A significant number of firms report zero R&D expenditures before they start exporting but start reporting positive R&D expenditure after they start exporting. The growth rate of R&D expenditure here is calculated as $ln(1+ R\&D\ expenditure)_{t=s} - ln(1 + R\&D\ expenditure)_{t=-1}$. Therefore, firms which increased R&D expenditure from zero to a positive value tend to show a very high growth rate of R&D expenditure.

was also estimated using labor productivity (value added per employee) as a productivity measure and the ATT and the DID estimators calculated using the labor productivity-based propensity score matching.[21] The estimated effects on labor productivity are summarized in Appendix Table 6. For the sample including export switchers and all surviving firms, starting to export to North America/Europe has a strong positive impact on labor productivity growth even two years after initiating exports, while exporting to Asia has a weakly significant positive impact on productivity growth (Panel 1). However, looking at the results based on the balanced sample where export switchers and all pairs where one (or both) of the firms exited are excluded, the strong positive productivity effect disappears three years after starting to export to North America/Europe, while exporting to Asia actually starts to have a strong positive effect on productivity growth after two years (Panel 2).

However, it should be noted that the ATT and DID estimators for later years are subject to serious selection biases. For example, surviving non-exporters may have improved their productivity not by starting to export but by adopting some sort of technology that helps to raise productivity in other ways in later years in order to survive. Moreover, in the case of the balanced sample of treated and control observations (i.e., Panel 2 in Appendix Table 6), productive surviving exporters may have been dropped from the ATT and DID analyses because their matched non-exporters exited, or productive surviving non-exporters may have been dropped from the ATT and DID analyses because their matched exporters exited and/or stopped exporting.

Thus, great care should be taken in interpreting the results particularly for later years. However, as far as earlier years (e.g., up to two years after starting to export) are concerned, starting to export to North America/Europe has a strong positive impact on productivity growth regardless of the choice of productivity measure. Moreover, as for other performance variables, the estimated effects on sales, R&D activity, and employment are mostly consistent with those based on the TFP measure. Therefore, the result that initiating exporting to North America/Asia has a positive and larger impact on firm performance is not driven by the selection of a specific sample of firms and a

[21] The multinomial logit estimation results using labor productivity as the productivity measure are available upon request.

specific measure of productivity.

4.4. Further Investigation and Discussion

The matching results above indicate that firms which started exporting to North America/Europe saw an improvement in the growth rates of productivity, sales, and employment. They also saw a much greater increase in R&D expenditure and R&D employment than firms which did not start exporting. Although firms which started exporting to Asia also registered an increase in sales, employment, and R&D activity, the magnitudes are much smaller than those for firms which started exporting to North America/Europe.

As the multinomial logit estimation results in Table 4 show, firms that are large (as measured by employment), R&D intensive, and financially healthy are more likely to be export starters to North America/Europe than to be export starters to Asia. As for the productivity level, productive firms are more likely to be export starters to North America/Europe, although the coefficient in the estimation is not statistically significant. These results imply that export starters to North America/Europe are potentially better-performing firms than export starters to Asia. In this subsection, for a better understanding and interpretation of the different learning-by-exporting effects across destination regions, differences in various characteristics across groups of firms are examined. In order to do so, the following equation is estimated:

$$Y_{ijt} = \alpha_0 + \alpha_1 \cdot \mathrm{OTHERS}_{ijt} + \alpha_2 \cdot \mathrm{ASIA}_{ijt} + \alpha_3 \cdot \mathrm{NAEUR}_{ijt} + \alpha_4 \cdot \mathrm{ALWAYS}_{ijt} + \mu_j + \tau_t + \varepsilon_{ijt} \quad (3)$$

Various regressions are run using different performance and other firm characteristics as the dependent variable. OTHERS, ASIA, NAEUR, and ALWAYS are dummy variables which indicate firm *i*'s export status. Industry specific and year specific effects are controlled by dummy variables, μ_j and τ_t, respectively. The subscript *j* denotes the industry firm *i* belongs to. The above equation is estimated using ordinary least squares, taking observations at the time of first-time exports for export starters and all observations for firms that always exported (ALWAYS) and firms that never

exported (NEVER). The reference case here is NEVER, and we can examine differences in the various characteristics and performance indicators across groups of firms by looking at the estimated coefficients.

The results are shown in Table 14 and indicate that ALWAYS exporters clearly outperform others in terms of size, performance, and capital and R&D intensities. The table also shows the results of F-tests which examine whether two coefficients are significantly different from each other. As can be seen, the two pairs of coefficients examined (ASIA and NAEUR, NAEUR and ALWAYS) are significantly different in most cases. First-time exporters which chose North America/Europe as their export destination were significantly more productive than first-time exporters which chose Asia as their export destination. This implies that the fixed costs of starting to export to North America/Europe are higher than those to Asia and that export starters to North America/Europe need to be more productive than export starters to Asia in order to cover the high fixed costs (self-selection effects). First-time exporters to North America/Europe are superior to first-time exporters to Asia also in terms of size, profitability, wage rates, and capital and R&D intensities. This, in turn, means that they are likely to have greater absorptive capacity, which itself may be a source of the larger positive learning-by-exporting effects.

Moreover, first-time exporters exporting to Asia are more likely to be subcontractors and/or subsidiaries, implying that they are more likely to be small parts suppliers. When looking at trade intensities, the intra-firm export ratio is significantly higher for first-time exporters to Asia than first-time exporters to North America/Europe.[22] These observations suggest that first-time exporters to Asia tend to conduct exporting in order to supply parts and components to related- or non-related Japanese firms in Asia and do not necessarily have to be very innovative.

[22] In the trade intensity estimations, the reference case is export starters exporting to other regions (OTHERS) and firms that never exported are excluded, for the obvious reason that the export variables would take a value of zero for firms that never exported.

Table 14. Differences in Characteristics by Export Status

	No. of obs.	First-time export destination						ALWAYS		F-test (Asia=NAEUR)		F-test (NAEUR=ALW)	
		OTHERS		ASIA		NAEUR							
ln(employment)	117,026	0.285	***	0.276	***	0.531	***	0.978	***	42.4	***	86.3	***
ln(sales)	117,026	0.496	***	0.420	***	0.756	***	1.312	***	51.5	***	51.5	***
ln(assets)	117,026	0.621	***	0.476	***	0.872	***	1.565	***	55.5	***	44.0	***
lnTFP	117,026	0.013		0.006		0.035	***	0.054	***	21.3	***	14.0	***
lnVAP	117,026	0.099		0.078	***	0.196	***	0.270	***	21.8	***	12.1	***
Profitability	117,026	-0.009		0.002	*	0.011	***	0.014	***	10.4	***	3.5	*
lnWAGE	117,026	0.118	***	0.049	***	0.119	***	0.188	***	19.4	***	28.3	***
ln(KL ratio)	117,026	0.239	**	0.117	***	0.230	***	0.401	***	6.6	**	21.8	***
R&D intensity	117,026	0.002		0.003	***	0.009	***	0.018	***	38.3	***	18.5	***
R&D worker share	117,026	0.014	**	0.011	***	0.026	***	0.040	***	29.4	***	37.7	***
Age	116,382	1.739		3.244	***	2.374	**	8.954	**	1.1		89.3	***
Debt-asset ratio	116,283	-0.030		-0.014	*	-0.036	***	-0.097	***	3.0	*	34.5	***
Subcontracter	98,521	-0.104	**	-0.071	***	-0.119	***	-0.263	***	4.7	**	61.5	***
Co-R&D w/foreign firm	26,671	0.003		0.048		-0.002		0.146	***	0.2		2.9	*
Subsidiary	117,026	-0.047		-0.076	***	-0.090	***	-0.130	***	0.8		9.2	***

Table 14 (continued). Differences in Characteristics by Export Status

	No. of obs.	First-time export destination									
		OTHERS	ASIA		NAEUR		ALWAYS		F-test (Asia=NAEUR)		F-test (NAEUR=ALW)	
Export ratio	29,951	n.a.	-0.185	***	-0.173	***	-0.102	***	2.5		27.8	***
Import ratio	29,912	n.a.	-0.075	***	-0.078	***	-0.046	**	0.1		23.3	***
Intra-firm exp. Ratio	22,809	n.a.	0.141	***	0.082	*	0.102	**	9.7	***	1.5	
Intra-firm imp. Ratio	22,809	n.a.	-0.033	***	-0.026	**	-0.001		1.6		28.0	***

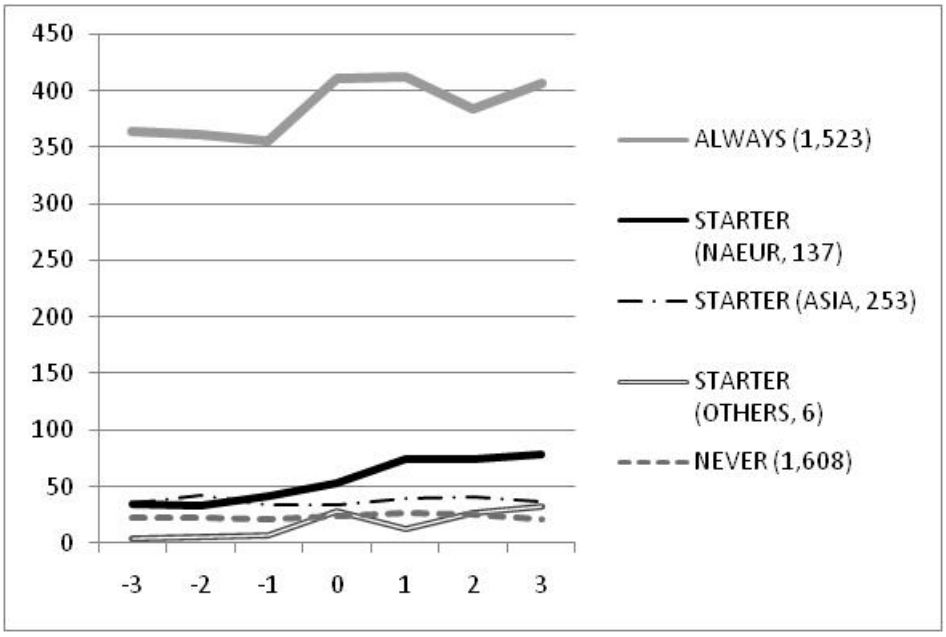
n.a. = not applicable.

Notes: *Profitability*= (Operating profits)/(Sales). *Subcontractor*= A dummy variable which takes 1 if a firm served as a subcontractor in 1994 and/or 1997. *Co-R&D w/foreign firm*= A dummy variable which takes 1 if a firm has a joint R&D project with a foreign firm. *Export (Import) ratio*= Exports (Imports) divided by sales. *Intra-firm exp. (imp.) ratio*= Intra-firm exports (imports) divided by total exports (imports). The survery asks about the subcontractor status only in 1994 and 1997 and about joint R&D projects only in 1997, 2000, and 2003. Therefore, for these two variables, the number of observations is significantly reduced.

In fact, looking at the number of patents owned shows that first-time exporters to North America/Europe recorded an increase in the number of patents owned. Figure 2 shows the trajectory of the average number of patents owned for different groups. For export starters, zero on the horizontal axis represents the year in which firms started to export. For firms that never or always exported throughout the sample period, time zero is 2003. Since consistent patent data are available only for 2000-2006, the patent analysis focuses on this period only. Although firms that always export outperform all other firms in terms of the number of patents, the figure clearly shows that first-time exporters to North America/Europe in the years after starting to export become much more innovative than firms starting to export to Asia or other regions.

Although the DID analysis above indicated that export starters to Asia tend to increase their R&D efforts after starting to export, the patent trajectory analysis here does not suggest that they became more innovative after starting to export. One possible interpretation of these observations is that R&D activities by export starters to Asia may more geared toward product modifications rather than product innovation or the development of new technologies.

Figure 2. Trajectory of Number of Patents Owned



Note: Numbers in parentheses are the average number of observations per year.

5. Policy Implications and Directions for Future Research

The aim of this study was to examine whether first-time exporters achieve productivity improvements through learning-by-exporting effects. According to the results, starting exporting to North America/Europe has larger positive effects on productivity, sales, R&D activities, and employment than starting exporting to Asia. The results also suggest that export starters to North America/Europe are larger, more productive, more R&D intensive, and more capital intensive than export starters to Asia even before they start exporting, suggesting that the former are potentially better performers than the latter. In other words, the former have greater absorptive capacity, and this absorptive capacity itself may be a source of the larger positive learning-by-exporting effects. Moreover, export starters to North America/Europe become more innovative than export starters to Asia after starting exporting.

These observations suggest that export starters to North America/Europe may be able to exploit the positive interplay between exporting, learning from export markets, and the development of innovative capabilities, while export starters to Asia are less likely to have such opportunities. This may be partly because export starters to Asia tend to be smaller parts suppliers to Japanese affiliated firms in Asian countries.

The results of this paper imply that potentially innovative non-exporters should be supported through an export promotion policy. Recently, some policy makers and managers of Japanese firms have emphasized the importance of tapping growing Asian markets and the promotion of exports to Asia. Although the results of this paper confirm that starting exporting to Asia has a positive impact, they also show that exporting only to Asia may not have a strong positive impact in terms of boosting productivity and innovative capabilities. Therefore, firms that have the potential to be sufficiently innovative to export to developed regions are likely to benefit from doing so through the positive interaction between exporting and innovation. Furthermore, firms should target not only developing markets but also developed markets in order to realize stronger learning-by-exporting effects.

Last but not least, several remaining issues should be pointed out. First, this paper confirms the R&D enhancing effect and positive scale effect of starting exporting.

However, the analytical framework of this paper does not allow us to evaluate which effect is more relevant in terms of contributing to productivity improvements. While answering this question presents a challenge, it is important to do so to gain a better understanding of the mechanisms underlying learning-by-exporting effects. However, this would probably require a different analytical framework. One example would be to estimate the relationship among changes in productivity, markups, and scale economies. Although employing such an approach may be a promising avenue, it would require overcoming many difficult data issues. In fact, Melitz and Ottaviano (2008) argue that markups possibly differ across destination markets, while De Loecker and Warzynski (2009) empirically show that firms' markups significantly increase after firms enter export markets. Investigating whether and how the relationships among changes in productivity, markups, and scale economies across destination markets differ between exporters and non-exporters is one possible direction for future research.[23]

Second, a significant number of firms switch their export status. In fact, many export starters stop exporting, while others increase their range of export destinations and, moreover, may become ALWAYS exporters.[24] Given the huge performance gap between ALWAYS exporters and other firms, another important research issue is to examine the determinants of the transition from being an export starter to a firm that always exports. Investigating such dynamics of exporters should provide important indications of how firms grow in the globalized economy and what kind of policy support or other efforts are necessary to facilitate firms' growth.

Third, productivity analyses always face measurement and conceptual challenges. Although changes in export status may be associated with changes in product composition or quality, no productivity measure can fully capture such changes. Moreover, although in practice managers may care more about profitability than productivity, profitability measures tend to be more volatile than productivity measures and measuring the true performance of firms is always very difficult.

[23] De Loecker (2010) argues that initiating exporting changes firms' technology choices and that input decisions are endogenous to firms' export status. Estimating production functions controlling for differences in productivity shocks between exporters and non-exporters, he finds that production function estimates without controlling for differences in productivity shocks produce biased results.

[24] Appendix Table 7 shows transition matrices of export destinations for export starters.

Although we still have a long way to go to open up the productivity-export-innovation black box, this study provides important evidence of learning-by-exporting effects. Particularly, it shows that starting to export does contribute to firms' growth in terms of sales and employment as well as the development of innovative capabilities. Further investigation of the dynamics of firms' behavior in a global market and the growth of firms should help to deepen our understanding of the impact of globalization on firm dynamics at the micro level and countries' economic growth at the macro level.

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Appendix

Table 1. List of Industries and Number of Observations by Industry (After Data Cleaning)

			No. of observations		
			1994	2006	(%)
1-30	Manufacturing Total		11,340	11,267	(100.0)
	1	Food products and beverages	1,354	1,396	(12.4)
	2	Textiles	788	409	(3.6)
	3	Lumber and wood products	318	229	(2.0)
	4	Pulp, paper and paper products	397	335	(3.0)
	5	Printing	475	525	(4.7)
	6	Chemicals and chemical fibers	293	280	(2.5)
	7	Paint, coating, and grease	134	117	(1.0)
	8	Pharmaceutical products	189	194	(1.7)
	9	Miscellaneous chemical products	222	254	(2.3)
	10	Petroleum and coal products	35	45	(0.4)
	11	Plastic products	557	627	(5.6)
	12	Rubber products	133	127	(1.1)
	13	Ceramic, stone and clay products	546	412	(3.7)
	14	Iron and steel	366	385	(3.4)
	15	Non-ferrous metals	294	250	(2.2)
	16	Fabricated metal products	856	824	(7.3)
	17	Metal processing machinery	221	218	(1.9)
	18	Special industry machinery	316	399	(3.5)
	19	Office and service industry machines	143	132	(1.2)
	20	Miscellaneous machinery	650	689	(6.1)
	21	Electrical machinery and apparatus	359	372	(3.3)
	22	Household electric appliances	147	101	(0.9)
	23	Communication equipment	127	218	(1.9)
	24	Computer and electronic equipment	125	164	(1.5)
	25	Electronic parts and devices	500	608	(5.4)
	26	Miscellaneous electrical machinery	162	231	(2.1)
	27	Motor vehicles and parts	825	845	(7.5)
	28	Other transportation equipment	201	230	(2.0)
	29	Precision machinery	298	319	(2.8)
	30	Miscellaneous mfg. industries	309	332	(2.9)

Table 2. Number of Export Starters (First-Time Exporters) and Export Quitters by Year

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total	
Starters	418	278	209	167	156	209	143	190	161	185	142	150	2,408	(100%)
SMEs	280	207	154	110	125	145	109	147	125	145	115	118	1,780	(74%)
Large Firms	138	71	55	57	31	64	34	43	36	40	27	32	628	(26%)
Quitters	99	145	212	115	88	135	102	126	135	122	149	208	1,636	(100%)
SMEs	81	114	138	90	63	103	87	91	92	91	105	150	1,205	(74%)
Large Firms	18	31	74	25	25	32	15	35	43	31	44	58	431	(26%)

Table 3. Estimated Production Function Coefficients (Olley-Pakes Method)

Industry	Labor		Capital		Material		No. of obs.	Sum of coef.
1	0.1013	***	0.0382	***	0.8323	***	16,128	0.9718
2	0.1874	***	0.0238	***	0.7550	***	5,847	0.9663
3	0.1661	***	0.0045		0.8170	***	3,154	0.9876
4 & 5	0.2264	***	0.0062		0.7332	***	10,802	0.9659
6 & 7 & 8 & 9	0.1439	***	0.0161	**	0.8040	***	10,680	0.9641
10 & 11 & 12	0.1358	***	0.0344	***	0.8047	***	9,257	0.9749
13	0.1649	***	0.0281	**	0.7740	***	5,827	0.9670
14 & 15 & 16	0.1843	***	0.0214	***	0.7660	***	17,876	0.9717
17 & 18 & 19 & 20	0.2071	***	0.0191	*	0.7538	***	16,325	0.9800
21	0.2033	***	0.0249	**	0.7766	***	4,049	1.0049
22	0.1725	***	0.0429		0.7918	***	1,473	1.0072
23 & 24	0.1923	***	0.0010		0.8013	***	4,777	0.9947
25	0.1846	***	0.0353	***	0.7617	***	7,212	0.9815
26	0.2206	***	0.0438	***	0.7457	***	2,389	1.0101
27 & 28	0.1905	***	0.0167	*	0.7658	***	13,277	0.9731
29	0.2191	***	0.0464	***	0.7416	***	3,690	1.0071
30	0.1591	***	0.0344	**	0.8062	***	3,346	0.9997

Table 4. Balancing Tests for Matching

(a) Logit model (Column 1 in Table 4)

Variable	Sample	Mean		% bias	% reduct.	t-test	
		Treated	Control		|bias|	t	p>|t|
lnTFP (OP)	Unmatched	2.453	2.445	2.1		0.89	0.375
	Matched	2.453	2.462	-2.3	-10.1	-0.83	0.408
ln(employment)	Unmatched	5.245	4.953	35.4		17.12	0
	Matched	5.252	5.382	-15.8	55.2	-4.59	0
R&D intensity	Unmatched	0.012	0.004	35.4		23.25	0
	Matched	0.012	0.011	4.3	87.9	1.14	0.256
Age	Unmatched	36.938	36.149	4.7		1.98	0.047
	Matched	36.995	36.954	0.2	94.8	0.09	0.931
Debt-asset ratio	Unmatched	0.703	0.719	-6.2		-2.56	0.010
	Matched	0.702	0.690	4.7	23.4	1.64	0.101
Import ratio	Unmatched	0.038	0.010	24.8		16.56	0
	Matched	0.037	0.031	5.7	76.9	1.46	0.143
FDI ratio	Unmatched	0.011	0.002	32.2		23.73	0
	Matched	0.011	0.005	20.8	35.4	6.09	0

(b) Multinomial logit model: First-time exporters to North America or Europe (Column 2 in Table 4)

Variable	Sample	Mean		% bias	% reduct.	t-test	
		Treated	Control		|bias|	t	p>|t|
lnTFP (OP)	Unmatched	2.467	2.445	5.6		1.32	0.186
	Matched	2.467	2.471	-1.2	78.5	-0.24	0.814
ln(employment)	Unmatched	5.435	4.953	54.2		15.78	0
	Matched	5.441	5.503	-6.9	87.2	-1.08	0.278
R&D intensity	Unmatched	0.017	0.004	47.1		23.01	0
	Matched	0.018	0.014	11.9	74.7	1.73	0.084
Age	Unmatched	36.565	36.149	2.4		0.58	0.561
	Matched	36.690	36.492	1.1	52.3	0.22	0.824
Debt-asset ratio	Unmatched	0.689	0.719	-11.9		-2.73	0.006
	Matched	0.688	0.677	4.1	65.9	0.79	0.431
Import ratio	Unmatched	0.031	0.010	20.7		7.3	0
	Matched	0.030	0.029	0.8	96	0.11	0.909
FDI ratio	Unmatched	0.010	0.002	31.6		12.09	0
	Matched	0.010	0.006	16.5	47.7	2.37	0.018

(c) Multinomial logit model: First-time exporters to Asia (Column 3 in Table 4)

Variable	Sample	Mean		% bias	% reduct	t-test	
		Treated	Control		|bias|	t	p>|t|
lnTFP (OP)	Unmatched	2.445	2.445	0.2		0.05	0.956
	Matched	2.445	2.447	-0.5	-194.4	-0.13	0.893
ln(employment)	Unmatched	5.160	4.953	26.3		9.9	0
	Matched	5.168	5.318	-19.2	27.2	-4.58	0
R&D intensity	Unmatched	0.009	0.004	29.4		13.04	0
	Matched	0.009	0.010	-6.4	78.1	-1.39	0.163
Age	Unmatched	37.173	36.149	6.2		2.09	0.036
	Matched	37.186	36.913	1.6	73.3	0.48	0.633
Debt-asset ratio	Unmatched	0.710	0.719	-3.5		-1.19	0.232
	Matched	0.709	0.689	7.8	-118.4	2.2	0.028
Import ratio	Unmatched	0.040	0.010	26.3		14.77	0
	Matched	0.040	0.030	9.5	64	2	0.046
FDI ratio	Unmatched	0.012	0.002	33.2		21.05	0
	Matched	0.011	0.005	20.1	39.4	4.81	0

(d) Multinomial logit model: First-time exporters to other regions (Column 4 in Table 4)

		Mean		% reduct.		t-test	
Variable	Sample	Treated	Control	% bias	|bias|	t	p>|t|
lnTFP (OP)	Unmatched	2.473	2.445	7		0.61	0.54
	Matched	2.471	2.468	0.7	90	0.05	0.963
ln(employment)	Unmatched	5.197	4.953	29		2.87	0.004
	Matched	5.185	5.447	-31.2	-7.7	-1.64	0.103
R&D intensity	Unmatched	0.009	0.004	28.7		3.01	0.003
	Matched	0.009	0.008	8.4	70.8	0.47	0.641
Age	Unmatched	35.915	36.149	-1.4		-0.12	0.906
	Matched	36.160	35.889	1.6	-16	0.12	0.905
Debt-asset ratio	Unmatched	0.702	0.719	-6.4		-0.54	0.591
	Matched	0.703	0.686	6.4	0	0.42	0.673
Import ratio	Unmatched	0.050	0.010	28.5		4.91	0
	Matched	0.050	0.026	17.1	39.9	1	0.319
FDI ratio	Unmatched	0.008	0.002	21.5		3.48	0
	Matched	0.008	0.004	15	30.2	0.92	0.358

Table 5. Number of Export Starters by Boarder Region (Period Total)

	Total		SMEs		Large firms	
Export starters	2,408	(100%)	1,780	(74%)	628	(26%)
Destinations total	2,408	(100%)	1,780	(100%)	628	(100%)
Case 4						
ALL (NA/EUR + Asia + Others)	115	(5%)	53	(3%)	62	(10%)
NA/EUR + Asia	261	(11%)	166	(9%)	95	(15%)
NA/EUR + Others	14	(1%)	9	(1%)	5	(1%)
NA+EUR	25	(1%)	20	(1%)	5	(1%)
NA only	264	(11%)	186	(10%)	78	(12%)
EUR only	67	(3%)	54	(3%)	13	(2%)
Case 3						
Asia only	1,526	(63%)	1185	(67%)	341	(54%)
Asia + Others	50	(2%)	42	(2%)	8	(1%)
Case 2						
Others only	86	(4%)	65	(4%)	21	(3%)
Case 1						
NEVER exporters	12,926	(100%)	11,297	(87%)	1,629	(13%)

Note: The percentage figures in parenthes for cases 2, 3, and 4 denote the share of each destination category in the total number of export starters. The percentage figures in parentheses for export starters and case 1 denote the shares of SMEs and large firms.

Table 6. Robustness Checks

(1) lnVAP specification

s	0		1		2		3		4
Exporting to NA/EUR									
No. of observations	1,260		1,102		985		871		761
Treated	630		551		498		445		389
Control	630		551		487		426		372
(a) Productivity level (lnVAP)									
	0.0450		0.0505		0.0604	**	0.0289		0.0087
	(0.0341)		(0.0376)		(0.0306)		(0.0384)		(0.0423)
(b) Productivity growth rate: pre-export level (s=-1)									
	0.0715	***	0.0700	**	0.1005	***	0.0573		0.0631
	(0.0265)		(0.0312)		(0.0288)		(0.0348)		(0.0411)

Table 6 (Continued). Robustness Checks

(1) lnVAP specification

s	0	1	2	3	4
Exporting to Asia					
No. of observations	2,714	2,261	2,035	1,795	1,580
Treated	1,357	1129	1019	909	798
Control	1,357	1132	1016	886	782
(a) Productivity level (lnVAP)					
	-0.0272	-0.0196	-0.0066	-0.0061	-0.0081
	(0.0226)	(0.0237)	(0.0218)	(0.0215)	(0.0277)
(b) Productivity growth rate: pre-export level (s=-1)					
	0.0074	0.0195	0.0421 *	0.0453 *	0.0410
	(0.0193)	(0.0196)	(0.0233)	(0.0246)	(0.0282)

(2) lnVAP specification (Excluding switchers & quitters)

s	0	1	2	3	4
Exporting to NA/EUR					
No. of observations	1,260	816	626	506	408
Treated	630	408	313	253	204
Control	630	408	313	253	204
(a) Productivity level (lnVAP)					
	0.0450	0.0630	0.0551	0.0210	-0.0571
	(0.0341)	(0.0396)	(0.0430)	(0.0476)	(0.0608)
(b) Productivity growth rate: pre-export level (s=-1)					
	0.0715 ***	0.0729 **	0.0990 ***	0.0155	-0.0318
	(0.0265)	(0.0363)	(0.0354)	(0.0499)	(0.0649)
Exporting to Asia					
No. of observations	2,714	1,394	1,072	834	716
Treated	1,357	697	536	417	358
Control	1,357	697	536	417	358
(a) Productivity level (lnVAP)					
	-0.0272	-0.0263	0.0060	0.0039	0.0020
	(0.0226)	(0.0296)	(0.0334)	(0.0406)	(0.0358)
(b) Productivity growth rate: pre-export level (s=-1)					
	0.0074	0.0293	0.0645 **	0.0889 **	0.1222 ***
	(0.0193)	(0.0259)	(0.0293)	(0.0374)	(0.0393)

Table 7. Transition of Export Destinations for Export Starters

t=0	1 year after starting exporting (t=1)					Total
	NAEUR	ASIA	OTHERS	Stop	Drop	
NAEUR	453	40	5	125	123	746
	(60.7%)	(5.4%)	(0.7%)	(16.8%)	(16.5%)	(100.0%)
ASIA	65	815	6	390	300	1576
	(4.1%)	(51.7%)	(0.4%)	(24.7%)	(19.0%)	(100.0%)
OTHERS	11	6	13	40	16	86
	(12.8%)	(7.0%)	(15.1%)	(46.5%)	(18.6%)	(100.0%)

t=0	3 years after starting exporting (t=3)					Total
	NAEUR	ASIA	OTHERS	Stop	Drop	
NAEUR	309	41	2	125	269	746
	(41.4%)	(5.5%)	(0.3%)	(16.8%)	(36.1%)	(100.0%)
ASIA	86	487	1	432	570	1576
	(5.5%)	(30.9%)	(0.1%)	(27.4%)	(36.2%)	(100.0%)
OTHERS	15	14	1	32	24	86
	(17.4%)	(16.3%)	(1.2%)	(37.2%)	(27.9%)	(100.0%)

t=0	5 years after starting exporting (t=5)					Total
	NAEUR	ASIA	OTHERS	Stop	Drop	
NAEUR	221	40	2	113	370	746
	(29.6%)	(5.4%)	(0.3%)	(15.1%)	(49.6%)	(100.0%)
ASIA	85	345	5	333	808	1576
	(5.4%)	(21.9%)	(0.3%)	(21.1%)	(51.3%)	(100.0%)
OTHERS	16	8	1	30	31	86
	(18.6%)	(9.3%)	(1.2%)	(34.9%)	(36.0%)	(100.0%)