RIETI Discussion Paper Series 20-E-083

Exchange Rates, International Outsourcing, and Firm Export Dynamics

INUI, Tomohiko
Gakushuin University

KIM, Young Gak
Senshu University

RIETI
Research Institute of Economy, Trade & Industry, IAA

The Research Institute of Economy, Trade and Industry
https://www.rieti.go.jp/en/

RIETI Discussion Paper Series 20-E-083

October 2020

Exchange Rates, International Outsourcing, and Firm Export Dynamics*

Tomohiko INUI

Faculty of International Social Sciences, Gakushuin University

and

Young Gak KIM

School of Economics, Senshu University

Abstract

Using the most comprehensive Japanese firm-level dataset, we investigate the effect of exchange rate fluctuations on Japanese firms' performance in the international market. We examine firm characteristics based on firm export dynamics. The estimation results overall indicate the depreciation of the yen may play an important role in the expansion of export, but a limited role in terms of entry to the export market. The results also show that export elasticity is significantly affected by import intensity, and decreases from 0.81 in 1997 to 0.64 in 2015 because of the increased import intensity, indicating that fully globalized firms utilize imports to alleviate negative shocks from exchange rates on exports and to improve price competitiveness.

Keywords: Firm-level data; Exchange Rate; Outsourcing

JEL Classification: D24; F14; F31

* This study is conducted as a part of the Project "East Asian Industrial Productivity" undertaken at the Research Institute of Economy, Trade and Industry (RIETI). This study utilizes the data of the information based on the Basic Survey of Japanese Business Structure which is conducted by the Ministry of Economy, Trade and Industry (METI). The authors are grateful for helpful comments and suggestions by Makoto Yano (RIETI), Masayuki Morikawa (RIETI), Kyoji Fukao (Hitotsubashi University), Toshihiro Okubo (Keio University), and other Discussion Paper seminar participants at RIETI.

1. Introduction

Japanese manufacturers have been facing the fierce competition from Korean and Chinese Firms in the international export market in the recent years. For example, Japanese electrical machinery industry suffered a notable downturn in its international competitiveness. According to the UN Database, Japan accounted for 12.2% of the world's total export value in electrical machinery and equipment in 2000, but the share decreased to 4.4% in 2014. In contrast, South Korea and China increased their shares in export value in this industry from 4.7% each in 2000 to 5.8% and 24.3% respectively in 2014. These facts indicate Japanese electric machinery firms have decreased their international competitiveness in the 2000s and some firms exited from the export markets. We also calculated the revealed comparative advantage (RCA) of the three countries using the same UN database. Japan's RCA in the electrical machinery industry dropped from 1.6 in 2000 to 1.1 in 2014. On the other hand, the RCA of South Korea and China rose from 1.7 to 1.8 and from 1.2 to 1.9, respectively over the same period. Previous literature pointed out the increased productivity is a key determinant of firm entry to the export market and their expansion of the export amount. These facts clearly indicate South Korean and Chinese electric machinery firms have increased their productivity substantially and expanded their sales in the international market.

Fukao, et al. (2016) investigates how much each factor cost and productivity influenced cost competitiveness of Japanese and Korean firms in the late 1990s' and 2000s' using both countries' firm-level dataset. Their research results indicate that Korean firms increased the international procurement of the intermediate inputs and the reduction of their costs. This aggressive reduction of the intermediate input cost by Korean firms led to improve their competitiveness in the export market against Japanese firms.

This research investigates the heterogeneous effect of exchange rate by firm on its export expansion (intensive margin) and participation (extensive margin) by using comprehensive Japanese firm-level data. We investigate the effect of real exchange rate changes on firms' performance in the

export market by taking into various firm characteristics. According to the previous researches, the exporter reacts differently to the change in exchange rate by its characteristics. We especially focus to examine the role of the firm's international outsourcing[1] in its abilities to absorb the negative effects on export from the home currency appreciation.

The remainder of this paper is organized as follows. Section 2 reviews previous studies. Section 3 is an introduction to the data used. Section 4 describes the analysis methods and states the estimation results. The last section discusses the main findings from the estimations as well as policy implications.

2. Literature Review

The paper relates to two main strands of existing literature. First, our work is related to studies on exporter survival in the international market. There are many previous studies that examine the export decision and/or export behavior of firms and provided support for the hypothesis by Melitz (2003) that a firm will only engage in exports if it is sufficiently productive to cover the sunk fixed costs of exporting. These sunk costs represent an investment that is specific to export activities and includes, for example, the costs of collecting information on foreign markets or establishing a distribution network abroad, and can only be recovered through a stable stream of export revenues and profits. In other words, only firms that can reasonably expect a stable stream of profit will be willing to incur such sunk costs. However, a significant number of export starters, in fact, export their products only for a short period and then stop exporting.

Békés and Muraközy (2012), for example, find that about a fifth of Hungarian firms that export at some point do so only in a temporary fashion. Similarly, Esteve-Pérez et al. (2013), examining export spells of Spanish manufacturing export starters, report that the median duration of export

[1] International outsourcing, in this paper, means imported products and materials. Service transactions are not included.

spells is six years and that 25% of spells end after the first year of exporting. Inui et al. (2017) examine the determinants of Japanese firm survival in export markets by explicitly taking into account the impact of firms' previous export market experience and their product differentiation. Their research results show, first, that exporting experience plays an important role in firms' survival in export markets. Second, the probability of exiting from export markets tended to be lower when firms were more R&D intensive both prior to and after starting exports.

Bas and Staruss-Khan (2014) examine the effect of the role of imported intermediate goods on firm productivity and export scope using French firm-level data on imports for the 1996-2005 period. They find the imported input enhance firm productivity, and higher productivity firms export more varieties and survive in the export market. Imported input also affects directly firm export through lower input price.

Basile (2001) examines the relationship between innovation and Italian firms' export behavior, and he found the innovation capabilities are very important competitive factors in the international market, and innovative firms have higher export intensities than that of non-innovative firms.

Another important strand of literature that related to our work is to examine the effect of exchange rate change on firm's export entry, export exit and export revenue. Baggs, Beauiles, and Fung (2009) examines the effect of exchange rate movement on firm survival and sales by using Canadian firm level data from 1986 to 1997. They found both firm survival and sales are negatively affected by the appreciation of exchange rate, but the impact on survival is less pronounced to more productive firms.

Berman, Martin and Mayer (2012) examined the heterogeneous reaction by exporters to the real exchange rate change by using the French firm-level data for the period 1995–2005. They find that high–performance firms react to a depreciation by increasing significantly more their markup and by increasing less their export volume.

Amiti, Itskhoki, and Konings (2014) also confirmed the heterogeneous response to the change of exchange rate. They show that the response differs according to not only the export but import

intensity. Two-way traders are in general less sensitive to the exchange rate, because, for example, the appreciation of the home currency lowers the marginal cost through the import absorbing the negative effect.

Cheung and Sengupta (2013) examines the impact of exchange rate movements on Indian exports for the period 2000 and 2010, and found strong and significant negative impact from currency appreciation and currency volatility on Indian firms' export shares. They also find the smaller firms and service firms' export are more affected by the exchange rate fluctuation.

Fitzgerald and Haller (2017) estimate the effect of changes in tariffs and exchange rate on Ireland firm export participation and export revenue. They find both participation and revenue are more affected to tariffs than to real exchange rates.

3. Data

The source for Japanese firm-level data is the Basic Survey of Japanese Business Structure and Activities (BSJBSA) conducted annually by the Ministry of Economy, Trade, and Industry (METI). The BSJBSA data cover all firms that have over 50 employees and 30 million yen of paid-in capital in the manufacturing, mining, wholesale and retail, and several service sectors. Firms' responses to the survey are mandatory.

It covers a wide range of the information on firm's structure and activities, such as business structure and its change, management strategy, R&D and other intellectual property related activities, over sea production and transaction, detailed items of products, outsourcing, use of ICT, and so on. It also provides financial statement information, so that firm's activity can be investigated with its performance measurements such as growth, profitability, and productivity.

The survey has started in 1992 and been conducted every year after 1995, we can construct panel data longer than 20 years. The number of samples is around 25,000 firms in each year.

Following Good et al. (1997), we estimate the firm-level TFP using the chained-multilateral index number approach. We define the TFP level of firm *f* in year *t* in a certain industry in comparison with the TFP level of a hypothetical representative firm in the base year in that industry. By constructing a hypothetical firm for each cross-section, and then chaining the hypothetical firms together over time, we maintain transitivity (i.e., the comparison of observations does not depend on the ordering of the observations) in the following TFP index:

$$\ln TFP_{f,t} = \left(\ln Q_{f,t} - \overline{\ln Q_t}\right) - \sum_{i=1}^{n} \frac{1}{2}\left(S_{i,f,t} + \overline{S_{\iota,t}}\right)\left(\ln X_{i,f,t} - \overline{\ln X_{\iota,t}}\right) \qquad for\ \ t = 0,$$

and

$$\begin{aligned}\ln TFP_{f,t} = {} & \left(\ln Q_{f,t} - \overline{\ln Q_t}\right) - \sum_{i=1}^{n} \frac{1}{2}\left(S_{i,f,t} + \overline{S_{\iota,t}}\right)\left(\ln X_{i,f,t} - \overline{\ln X_{\iota,t}}\right) \\ & + \sum_{s=1}^{t}\left(\overline{\ln Q_s} - \overline{\ln Q_{s-1}}\right) \\ & - \sum_{s}^{t}\sum_{i=1}^{n} \frac{1}{2}\left(\overline{S_{\iota,s}} + \overline{S_{\iota,s-1}}\right)\left(\overline{\ln X_{\iota,s}} - \overline{\ln X_{\iota,s-1}}\right) \\ & for\ \ t \geq 1. \qquad (1)\end{aligned}$$

where $Q_{f,t}$, $S_{i,f,t}$, and $X_{i,f,t}$ denote the gross output of firm *f* in year *t*, the cost share of factor *i* for firm *f* in year *t*, and firm *f*'s input of factor *i* in year *t*, respectively. Variables with an upper bar denote the industry average. The representative firm for each industry is a hypothetical firm whose output, inputs, and cost shares of all production factors are identical to the industry average. All the deflators and indexes for converting nominal values to real are taken from the sectoral data of the Japan Industrial Productivity Database (JIP) 2015, RIETI.

We calculated industry-specific real exchange rate, $RX_{i,t}$, as follows.

$$\Delta \ln RX_{i,t} = \sum_{c} \frac{Export_{i,c,2000}}{Export_{i,2000}} \cdot \Delta \ln RX_{c,t},$$

and

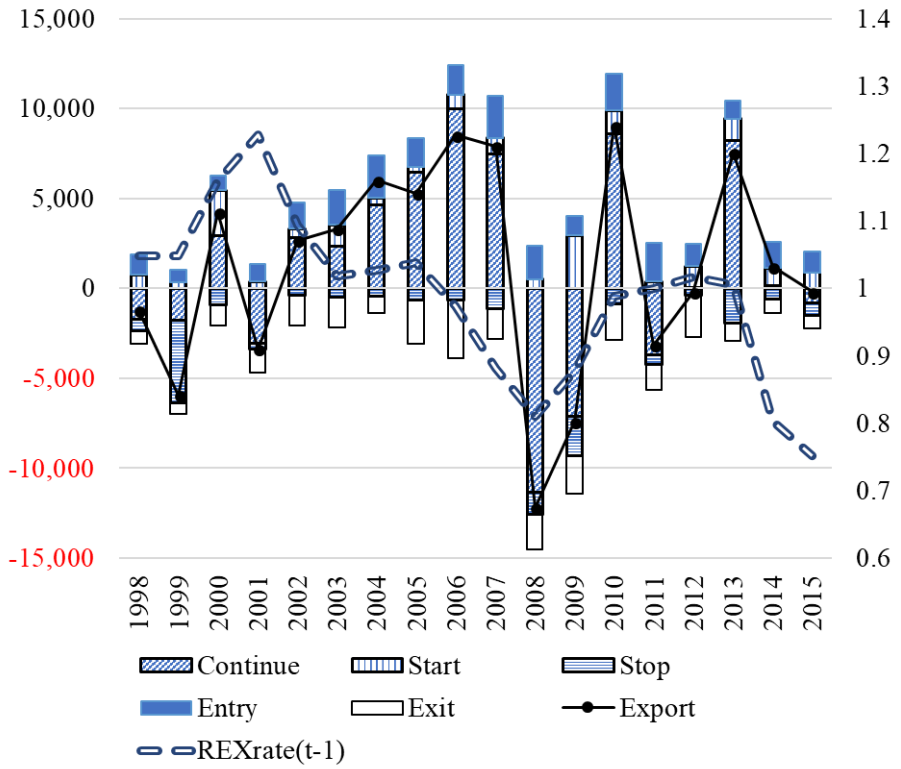
$$RX_{c,t} = \frac{ER_{c/US,t}}{ER_{Japan/US,t}} \cdot \frac{CPI_{Japan,t}}{CPI_{c,t}} \quad . \qquad (2)$$

where $Export_{i,c,2000}$ is the export of industry i to country c in year 2000, $Export_{i,2000}$ is the total export of industry i in year 2000, $ER_{c/US,t}$ is nominal exchange rate of country c as US dollar in year t, and $CPI_{c,t}$ is the consumer price index of the country c in year t. The industry-specific real exchange rate is calculated as a divisia index, and set to be 1 in year 2010. Data on export are from JIP 2015, RIETI. Although the data on export for every year, we only use that of year 2000 to minimize the possible endogeneity problem between the regional exchange rate and export / import. As a result, industry-specific real exchange rates for 43 manufacturing industries are available and used for the firm-level analyses.

4. Empirical Analysis

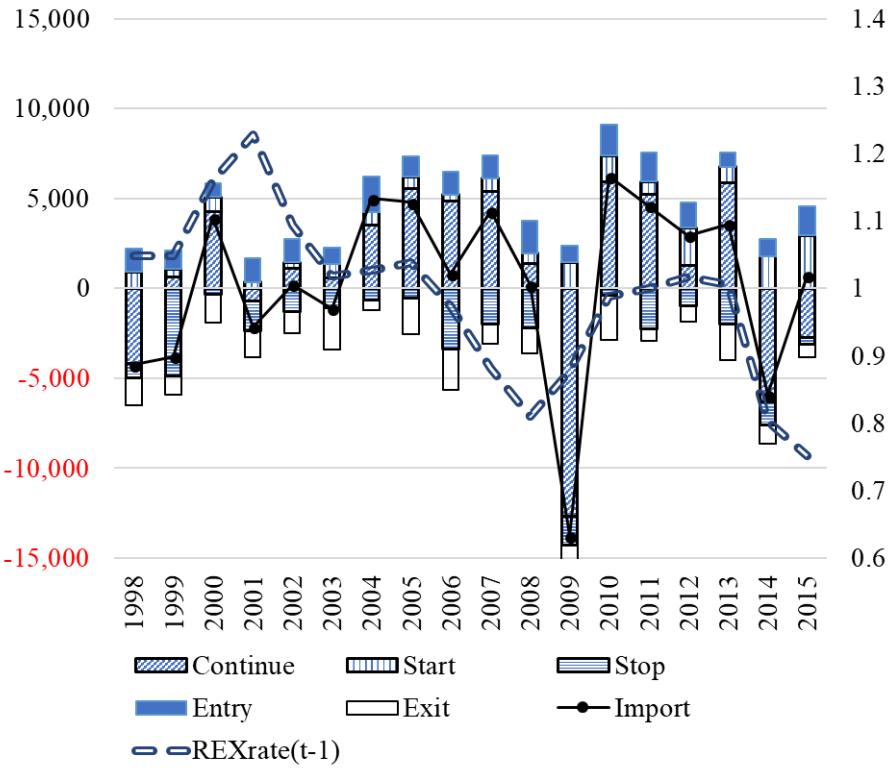
Figures 1 and 2 are the decompositions of net increase of export/import using BSJBSA data set. It is clear that the increase of export by the continuing exporter drives the overall export dynamics. It also emphasizes the importance of the investigation on the intensive margin of export.

Figure 1. Change of Export (BSJBSA)



Note. 1. Increase of export from *t*-1 to *t* in BSJBSA. *Continue* is the increase of export by firms which keeps exporting from *t*-1 to *t*. *Start* is the increase of export by firms who did not export at *t*-1 and exports at *t*. *Stop* is the decrease of export by firms who exported at *t*-1 but do not export at *t*. *Entry* is the increase of export by firms who shows up first time and export at *t*. *Exit* is the decrease of export by firms who exported at *t*-1 but exit from the data set at *t*. *Export* is the total net increase of export from *t*-1 to *t*. *REXrate(t-1)* is the real effective exchange rate at *t*-1.

Figure 2. Change of Import (BSJBSA)



Note. 1. Increase of import from *t*-1 to *t* in BSJBSA. *Continue* is the increase of import by firms which keeps importing from *t*-1 to *t*. *Start* is the increase of import by firms who did not import at *t*-1 and imports at *t*. *Stop* is the decrease of import by firms who imported at *t*-1 but do not import at *t*. *Entry* is the increase of import by firms who shows up first time and import at *t*. *Exit* is the decrease of import by firms who imported at *t*-1 but exit from the data set at *t*. *Import* is the total net increase of import from *t*-1 to *t*. *REXrate(t-1)* is the real effective exchange rate at *t*-1.

Utilizing the aforementioned datasets, we can measure various characteristics of Japanese firms, such as their productivity level, R&D intensity[2], age, and experience in international markets. Then we investigate the effect of real exchange rate changes on firms' performance in the export market by taking into various firm characteristics. Previous studies (for example, Berman et al., 2012) found that highly productivity firm has low pass-through and these results imply those films have weak reactions of exports to exchange rate movements. Fully globalized firms may have more accumulated knowledge on the international market and may cope with various shocks in the market. Less globalized firms may respond more sensitively to the exchange rate shock. Their profit may be more vulnerable to it and fluctuate more. The knowledge-intensive firms may be in a more favorable

[2] R&D intensity is the ratio of R&D expenditure over total sales.

condition because specified knowledge such as intellectual property gives them better competitiveness not only in the domestic but also in the international market. As indicated in Fukao et al. (2016), overseas procurement (proxied by firm import) reduces the intermediate inputs cost and the marginal cost of firm's final products.

As the first step, we observed how Japanese firms respond to the change of exchange rate using the data set constructed with the BSJBSA data. We first regress various firm performances such as export, import, and foreign activities in terms of the number of overseas affiliates on real effective exchange rate. The results in the first panel of Table 1 indicate that the appreciation of yen constricts overall firm performance including import and foreign activities, which may not be consistent with our intuition. The second panel adopts industry-specific real exchange rate calculated following Equation (2) showing that although appreciation of yen constricts firm's export, it does not import or overseas activity, which is more consistent with common economic data. Third, fourth, and fifth panels show that the response to the exchange rate may differ by firms' state in terms of export and import. Two-way trader (exporting and importing firm) seems less sensitive to the exchange rate in terms of export, whereas one-way trader (exporter or importer) is more sensitive to the exchange rate. Although the results are simple and intuitive, they do not control for many firm characteristics.

Table 1. Exchange rate and firm's response

	Dep. Var.:	ln(Export$_{f,t}$)	ln(Import$_{f,t}$)	ln(# affil.$_{f,t}$)
	ln(Real Effective Exchange rate$_{t-1}$)	-0.693***	-0.960***	-0.354***
		(0.090)	(0.122)	(0.031)
	Observation	113,785	115,201	88,537
	Adj. R-Squared	0.080	0.103	0.048
	ln(Real Exchange rate$_{i,\ t-1}$)	-1.123***	-0.567	-0.344
		(0.330)	(0.466)	(0.210)
	Observation	79,537	69,300	58,161
	Adj. R-Squared	0.091	0.103	0.050
Exporting & Importing firms	ln(Real Exchange rate$_{i,\ t-1}$)	-0.399	-1.145**	-0.023
		(0.367)	(0.432)	(0.227)
	Observation	51,705	51,705	32,671
	Adj. R-Squared	0.103	0.108	0.046
Exporting & not-Importing firms	ln(Real Exchange rate$_{i,\ t-1}$)	-2.439***		-1.017**
		(0.497)		(0.473)
	Observation	27,832		10,565
	Adj. R-Squared	0.082		0.089
Not-Exporting & Importing firms	ln(Real Exchange rate$_{i,\ t-1}$)		1.420**	0.902
			(0.699)	(0.787)
	Observation		17,595	4,203
	Adj. R-Squared		0.137	0.071
	Year F.E.	Yes	Yes	Yes
	Industry F.E.	Yes	Yes	Yes

Note. 1. The greater value of exchange rate means appreciation of Japanese yen. # *affil.$_{f,r,t}$* is the number of affiliates of the firm *f* at *t*. 2. Each regression has year fixed effect (F.E.), and industry F.E. 3. Figures in parentheses are robust standard error. 4. OLS. 5. * p<0.10, ** p<0.05, *** p<0.01. 6. Zero values of dependent variables are excluded in the regressions.

Before discussing about the estimation models in detail, it is best to make clear the assumptions put in this paper. We assume that exchange rate is exogenous, and firms are not forward-looking. Although exchange rate may be affected by the trade, we assume it exogenous for the brevity of the discussion. Forward-looking firms may expand their activities to overseas (FDI). This research also focuses on the empirics, so that theoretical analysis should be added to it. Taking into account of these firm activities such as export, import, and FDI altogether in theory and empirics, however, is out of the range of the research. We leave these issues for the future works.

4.A. Intensive Margin

Amiti, Itskhoki, and Konings (2014) point out, import is expected to alleviate the negative effect

on export from the exchange rate appreciation, because the appreciation may lower the marginal cost of the importer. We examine the effects on the intensive or extensive margin of export from the exchange rate, separately. We first regress the following equation in order to investigate the effect on the intensive margin of export.

$$\ln(\text{Export}_{f,t})$$
$$= \alpha_i + \alpha_t + \beta_{RX}\ln(RX_{i,t}) + \gamma_{imp}\ln(RX_{i,t}) \cdot ImportInt_{f,t-1} + \beta_{imp}ImportInt_{f,t-1}$$
$$+ \beta_{R\&D}R\&Dint_{f,t-1} + \beta_{TFP}lnTFP_{f,t-1} + \beta_{EMP}\ln(Employee_{f,t-1})$$
$$+ \varepsilon_{f,r,t}$$
$$(4)$$

where $Export_{f,t}$ is the export of the firm f at t; α_i is industry fixed effect; α_t is time fixed effect; $ImportInt_{i,t\text{-}1}$ is the ratio of import over the sum of total purchase and wage of the firm f at t-1; $R\&Dint_{f,t}$ is the R&D intensity of firm f in period t-1; $TFP_{f,t\text{-}1}$ is the TFP level of firm f in period t-1; and $Employee_{f,t\text{-}1}$ is the number of the employees of firm f in period t-1.

Estimation results for the equation (4) are in Table 2-(a) and (b). The results show that, as expected, appreciation of yen decreases the export even controlling for various firm characteristics such as import intensity, productivity, and R&D investment. The results in Table 2-(a) indicates that two-way traders (i.e. firms that both export and import) do not respond to changes in real exchange rate, or do respond but much less sensitively compared with firms that export-only firm. The estimation with results on interaction term between exchange rate and import intensity in Table 2-(b) show that the differences of the responses to the exchange rate between two-way traders and export-only firms are statistically significant. Amiti, Itskhoki, and Konings (2014) predict that the coefficient of the interaction term of change exchange rate and import intensity are positive to

alleviate the negative effect of the appreciation of the currency. We do observe the effect in Table 2[3].

Results of Model (3) in Table 2-(b) mean that firms which export and do not import respond to the 1% of depreciation of Yen with 1.1% increase of export, whereas firms which export and import respond to the 1 % of depreciation of Yen with 1% increase of export (less sensitively)[4].

Table 2-(a). Intensive margin (1)

Dep. Var.: ln(Export$_{f,t}$)	OLS			FXE		
		twoway trader	Export only		twoway trader	Export only
	(1)	(2)	(3)	(4)	(5)	(6)
lnRX$_{i,t-1}$	-1.101***	-0.758	-1.740***	-1.046***	-0.706**	-1.006**
	(0.379)	(0.617)	(0.484)	(0.290)	(0.351)	(0.484)
R&D intensity$_{f,t-1}$	15.254***	14.875***	14.311***	0.499	0.239	0.348
	(1.593)	(1.541)	(2.091)	(0.662)	(0.859)	(1.025)
lnTFP $_{f,t-1}$	2.974***	3.051***	2.672***	0.786***	0.908***	0.490***
	(0.190)	(0.207)	(0.249)	(0.082)	(0.102)	(0.130)
ln(# Employee$_{f,t-1}$)	1.207***	1.190***	1.164***	0.769***	0.795***	0.607***
	(0.039)	(0.044)	(0.038)	(0.045)	(0.055)	(0.079)
Observation	65,936	41,525	24,411	65,936	41,525	24,411
R-Squared	0.460	0.490	0.383	0.086	0.087	0.069
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes

Note. 1. $RX_{i,t-1}$ indicates industry-specific real effective exchange rate. The greater value of exchange rate means appreciation of Japanese yen. *Import intensity=import/*(*purchase+wage*). *R&D intensity=R&D expenditure/sales*. *TFP* is total factor productivity of the firm. 2. Each regression has year fixed effect (F.E.), and industry F.E., and been clustered by industry level. 3. Figures in parentheses are robust standard error. 4. * p<0.10, ** p<0.05, *** p<0.01.

Table 2-(b). Intensive margin (2)

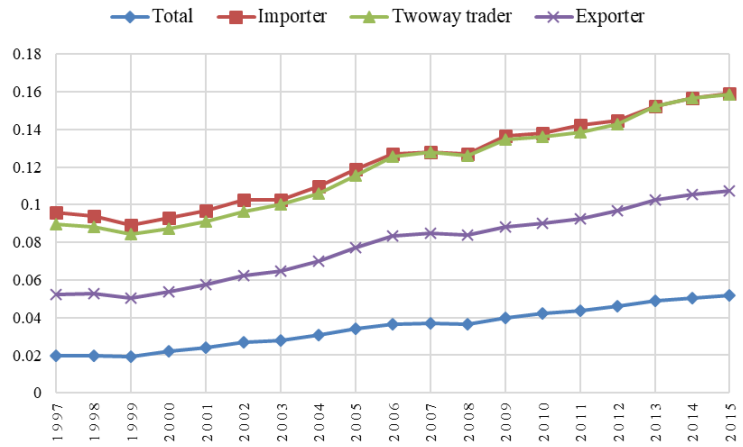
[3] Since the dataset does not provide the information on price and volume of export products, we cannot decompose the change in export value into the change of price or that of volume.
[4] Average import intensity is 0.073.

Dep. Var.: ln(Export$_{f,t}$)	OLS		FXE	
		twoway trader		twoway trader
	(1)	(2)	(3)	(4)
lnRX$_{i,t-1}$	-1.225***	-0.812	-1.125***	-0.807**
	(0.380)	(0.586)	(0.291)	(0.353)
lnRX$_{i,t-1}$·Import intensity $_{f,t-1}$	1.622*	1.432	1.097***	1.059***
	(0.839)	(0.912)	(0.356)	(0.390)
Import intensity$_{f,t-1}$	2.620***	2.537***	0.578***	0.604***
	(0.202)	(0.201)	(0.088)	(0.098)
R&D intensity$_{f,t-1}$	14.982***	14.759***	0.485	0.241
	(1.381)	(1.273)	(0.664)	(0.866)
lnTFP $_{f,t-1}$	2.802***	2.866***	0.792***	0.925***
	(0.182)	(0.206)	(0.082)	(0.102)
ln(# Employee$_{f,t-1}$)	1.215***	1.225***	0.774***	0.801***
	(0.039)	(0.042)	(0.045)	(0.054)
Observation	65,899	41,488	65,899	41,488
R-Squared	0.479	0.514	0.088	0.090
Year F.E.	Yes	Yes	Yes	Yes
Industry F.E.	Yes	Yes	Yes	Yes

Note. 1. $RX_{i,t-1}$ indicates industry-specific real effective exchange rate. The greater value of exchange rate means appreciation of Japanese yen. *Import intensity=import*/(*purchase*+*wage*). *R&D intensity=R&D expenditure*/*sales*. *TFP* is total factor productivity of the firm. 2. Each regression has year fixed effect (F.E.), and industry F.E., and been clustered by industry level. 3. Figures in parentheses are robust standard error. 4. * p<0.10, ** p<0.05, *** p<0.01.

This effect is expected to be even greater in the recent years because of the increase of import intensity in this period. Figure 3 shows how import intensity has developed in the period. It was about 2% in 1997, and 5.2% in 2015. If we focus on two-way traders, it increases from 9% to 16%. Considering of these change, Model (4) of Table 2-(b) means that whereas 1% of depreciation of Yen translated to the 0.71% increase of export in 1997, it translates to the 0.64% increase in 2015.

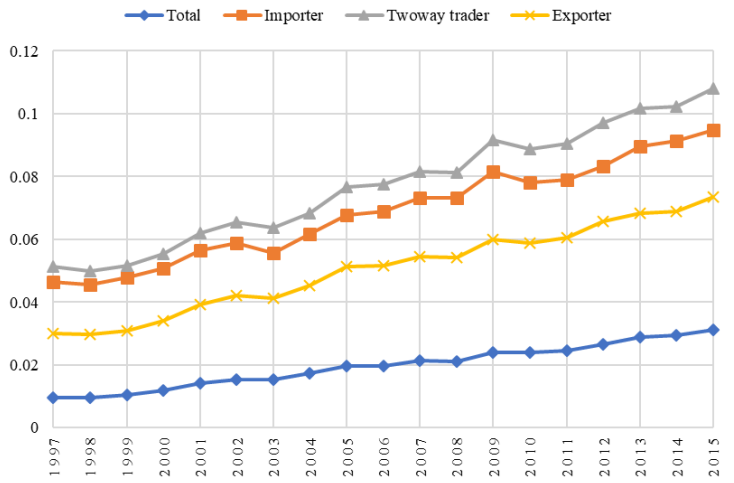
Figure 3. Import intensity



Note. Total imports / total purchase. Two-way trader means firms that exports and imports. Source: Authors' calculation using BSJBSA.

The increase of import intensity is more prominent in the case of intra-firm trade. Figure 4 shows the ratio of import from the affiliates overseas over the total purchase. Two-way traders increase their intensity from 5% to 11% in the period.

Figure 4. Import intensity (intra-firm trade)

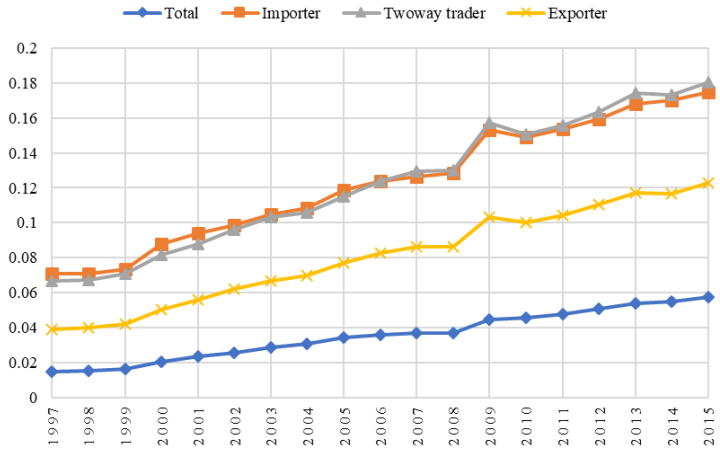


Note. Imports from the affiliates overseas / total purchase. Two-way trader means firms that exports and imports. Source: Authors' calculation using BSJBSA.

Figure 5 plots the ratio of imports from Asian countries over the total purchase, showing that

the increase of the intensity is even greater. In the sample period, imports from North America or Europe do not increase[5].

Figure 5. Import intensity (from Asia)



Note. Imports from the Asian countries / total purchase. Two-way trader means firms that exports and imports. Source: Authors' calculation using BSJBSA.

Takin into account that the export share of two-way trader is about 75% in the sample, we may conclude that at least a part of the weaker response of export to the exchange rate in recent years are attributable to the increase of two-way trade as predicted by Amiti, Itskhoki, and Konings (2014). Intensified intra-firm trade, especially with affiliates located in Asian countries, seems to have reinforced it.

4.B. Extensive Margin

We examine the effect of real exchange rate on extensive margin of export as in Equation (5). We investigate the effect of experience of export on the entry to the export by adding the cross term between exchange rate and dummy variable for past export experience.

[5] See appendix.

$$\begin{aligned}&\mathrm{Entry}_{f,t}\\&=\alpha_i+\alpha_t+\beta_{XR}\ln(RX_{i,t})+\beta_{imp}ImportInt_{f,t-1}+\beta_{exp}1(exp_{f,t-1})\\&+\beta_{TFP}lnTFP_{f,t-1}+\beta_{R\&D}R\&Dint_{f,t-1}+\beta_{EMP}\ln\left(Employee_{f,t-1}\right)+\gamma_{imp}\ln(RX_{i,t})\\&\cdot ImportInt_{f,t-1}\\&+\varepsilon_{f,r,t}\end{aligned}\qquad(5)$$

where $Entry_{f,t}$ is the dummy variable which takes value 1 if the firm *f* does not export at *t*-1 and export at *t*, and 0 if the firm does not export from *t*-1 to *t*; α_i is industry fixed effect; α_t is time fixed effect; $ImportInt_{i,t-1}$ is the ratio of import over the sum of total purchase and wage of the firm *f* at *t*-1; $TFP_{f,t}$ is the TFP level of firm *f* in period *t*; $R\&Dint_{f,t-1}$ is the R&D intensity of firm *f* in period *t-1*; $1(exp_{f,t})$ is the dummy variable which takes 1 if firm *f* experienced export in the past, and 0 otherwise.

The estimation results of Equation (5) are in Table 3. In Models (1) and (2), entry to export market is defined as the case a firm did not export at *t*-1 and exports at *t*, so that we do not take into account the past experience of export. In Models (3) and (4), the definition is limited as the case a firm have not exported in the last three years and do export at *t*. In Models (5) and (6), the definition is limited further as the case a firm have no experience of export and do export at *t*. Overall, real exchange rate has no significant effect on the extensive margin[6]. Import intensity does not reinforce nor alleviate the impact of exchange rate. Estimated coefficients of other control variables are consistent with previous studies.

[6] Issues on marginal effects of each variables and cross terms between them are addressed in the appendix.

Table 3. Extensive margin

Dep. Var.: Start($Export_{f,t}$)	New Entry to Export		New Entry to Export after 3-year- non-export		New Entry to Export w/o export experience	
	Probit	Panel Probit	Probit	Panel Probit	Probit	Panel Probit
	(1)	(2)	(3)	(4)	(5)	(6)
$lnRX_{i,t-1}$	0.15	0.044	0.255	0.215	0.608	0.574
	(0.346)	(0.317)	(0.371)	(0.399)	(0.432)	(0.472)
$lnRX_{i,t-1}$·Import intensity $_{f,t-1}$	1.007	0.957	1.608	1.553*	0.742	0.738
	(0.715)	(0.701)	(1.046)	(0.868)	(0.975)	(0.996)
Import $intensity_{f,t-1}$	1.001***	1.185***	1.052***	1.144***	1.190***	1.310***
	(0.167)	(0.101)	(0.194)	(0.121)	(0.159)	(0.143)
Export $experience_{f,t-1}$	0.828***	0.762***	0.505***	0.485***		
	(0.021)	(0.025)	(0.021)	(0.030)		
R&D $intensity_{f,t-1}$	6.750***	8.222***	7.018***	7.567***	8.186***	9.024***
	(0.591)	(0.661)	(0.754)	(0.760)	(0.775)	(0.888)
$lnTFP_{f,t-1}$	0.287***	0.342***	0.459***	0.486***	0.471***	0.514***
	(0.104)	(0.085)	(0.120)	(0.102)	(0.122)	(0.116)
ln(# $Employee_{f,t-1}$)	0.105***	0.141***	0.120***	0.135***	0.130***	0.151***
	(0.013)	(0.011)	(0.014)	(0.013)	(0.016)	(0.017)
Observation	127,888	127,888	90,809	90,809	83,761	83,761
R-Squared	0.122		0.075		0.055	
Log-likelihood	-17,587	-17,485	-10,063	-10,056	-8,114	-8,111
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes

Note. 1. $RX_{i,t-1}$ indicates industry-specific real effective exchange rate. The greater value of exchange rate means appreciation of Japanese yen. *Import intensity=import/(purchase+wage)*. *R&D intensity=R&D expenditure/sales*. *TFP* is total factor productivity of the firm. $Export\ experience_{ft}$ is the dummy variable which takes 1 if firm *f* experienced export in the past at time *t*, and 0 otherwise. 2. Each regression has year fixed effect (F.E.), and industry F.E., and been clustered by industry level. 3. Figures in parentheses are robust standard error. 4. * p<0.10, ** p<0.05, *** p<0.01.

Probit model used in the estimation above is non-linear, so that it is well known that the marginal effect of the cross term should be interpreted with greater care. To check the robustness of the estimations, we adapted linear probability model using OLS and fixed effect estimation. The results lead to the almost same conclusion to that of the probit estimation model in Table 3.

Table 4. Extensive margin (OLS and Fixed effect model)

Dep. Var.: Start(Export$_{f,t}$)	New Entry to Export		New Entry to Export after 3-year- non-export		New Entry to Export w/o export experience	
	OLS	FXE	OLS	FXE	OLS	FXE
	(1)	(2)	(3)	(4)	(5)	(6)
lnRX$_{i,t-1}$	0.011	-0.064***	0.02	-0.032	0.043*	-0.02
	(0.024)	(0.023)	(0.021)	(0.025)	(0.021)	(0.023)
lnRX$_{i,t-1}$·Import intensity $_{f,t-1}$	0.086	-0.054	0.11	-0.09	0.032	-0.134
	(0.119)	(0.093)	(0.118)	(0.095)	(0.098)	(0.095)
Import intensity$_{f,t-1}$	0.111***	0.138***	0.090***	0.125***	0.080***	0.098***
	(0.024)	(0.018)	(0.022)	(0.019)	(0.017)	(0.019)
Export experience$_{f,t-1}$	0.111***	-0.008	0.049***	-0.063***		
	(0.005)	(0.006)	(0.003)	(0.008)		
R&D intensity$_{f,t-1}$	0.848***	0.966***	0.700***	0.766***	0.711***	0.591***
	(0.084)	(0.112)	(0.102)	(0.120)	(0.098)	(0.115)
lnTFP $_{f,t-1}$	0.017***	0.019**	0.024***	0.021***	0.022***	0.019***
	(0.006)	(0.008)	(0.006)	(0.008)	(0.005)	(0.007)
ln(# Employee$_{f,t-1}$)	0.008***	0.023***	0.008***	0.021***	0.007***	0.016***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
Observation	127,888	127,888	90,941	90,941	83,881	83,881
Adj. R-Squared	0.052		0.021		0.012	
Within R-Squared		0.007		0.022		0.017
Overall R-Squared		0.017		0.004		0.007
Between R-Squared		0.058		0.004		0.005
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Industry F.E.	Yes	Yes	Yes	Yes	Yes	Yes

Note. 1. $RX_{i,t-1}$ indicates industry-specific real effective exchange rate. The greater value of exchange rate means appreciation of Japanese yen. *Import intensity=import*/(*purchase+wage*). *R&D intensity=R&D expenditure*/*sales*. *TFP* is total factor productivity of the firm. *Export experience*$_{ft}$ is the dummy variable which takes 1 if firm *f* experienced export in the past at time *t*, and 0 otherwise. 2. Figures in parentheses are robust standard error. 3. * p<0.10, ** p<0.05, *** p<0.01.

The estimation results overall indicate the appreciation (depreciation) of Yen has a negative (positive) and significant impact on the expansion of the export. On the other hand, we find that the export behavior of firms that import more from abroad are less affected by of the change in exchange rate.

Contrastingly, changes of exchange rate do not seem to have significant impact on the decision of entry to the export market. Other firm characteristics such as productivity level, R&D investment prove to play an important role in the decision. In addition, past export experience is important to revive to the export market.

5. Conclusion and Policy Implications

Using the most comprehensive Japanese firm-level dataset, we investigate the effect of exchange rate on Japanese firm's performance in the international market by taking into account of various characteristics. The estimation results overall indicate the depreciation of exchange rate may play an important role in the expansion of export (intensive margin). The estimations also found that the elasticity of export to the exchange rate is significantly affected by the import intensity (import / purchase), so that the elasticity decreased from 0.71 in 1997 to 0.64 in 2015 because of the increased import intensity (from 9% in 1997 to 16% in 2017). The intensity rose up mainly because imports from the Asian countries increased. It is also pointed out that growth of imports through intra-firm contributes to the increased intensity.

Contrastingly, the estimations found only a limited role of the exchange rate for the new entry to the export market. On the other hand, firm characteristics such as productivity, R&D intensity play an important role in the stage of export market entry. In addition, past export experience is important to revive to the export market.

The results indicate that the recent weaker responses of Japanese firms' export to the depreciation of Yen are partly attributable to the increased imports from their affiliates in Asian countries (intra-firm trade). In the other sense, exporting firms in Japan have utilized import to alleviate the negative shock from the exchange rate on the export for the price competitiveness. The exporting firm's international procurement may contribute to stabilization of the profit of exporting firm who facing the volatility of exchange rate.

Most common policy for promoting the firm export activity is to depreciate own currency exchange rate. However, our results indicate this policy may play a limited role for export starter. The exporting firms face the large uncertainty when they penetrate into the international market, especially due to the large fluctuation of exchange rate. Our results indicate that importing firms may reduce their sales volatility coming from the exchange rate fluctuation somewhat. Hence in order to assist the firm's entry into export market, the government also would consider the policy for support for the global intermediate goods procurement of the firm.

References

Amiti, M., O. Itskhoki, and J. Konings (2014), 'Importers, exporters, and exchange rate disconnect', *The American Economic Review*, 104(7): 1942-1978.

Baggs, J., E. Beaulieu, and L.Fung (2009), 'Firm survival, performance, and the exchange rate', *Canadian Journal of Economics*, 42(2):393-421.

Bas, M. and V. Strauss-Khan (2014), 'Does Importing More Input Raise Exports? Firm-level Evidence from France', *Review of World Economics*, 150: 241-275.

Basile, R. (2001), 'Export Behavior of Italian Manufacturing Firms over the nineties: The Role of Innovation', *Research Policy* 30: 1185-1201.

Békés, G. and B. Muraközy (2012), 'Temporary Trade and Heterogeneous Firms', *Journal of International Economics*, 87(2): 232-246.

Berman, N., P. Martin, and T. Mayer, (2012), 'How do Different Exporters React to exchange rate

changes?', *The Quarterly Journal of Economics*, 27: 437–492.

Blum, B. S., S. Claro, and I. J. Horstmann (2013), 'Occasional and perennial exporters', *Journal of International Economics*, 90(1): 65-74.

Cheung, Y. and R. Sengupta, (2013), 'Impact of exchange rate movements on exports: An analysis of Indian non-financial sector firms', *Journal of International Money and Finance*, 39:231–245

Esteve-Pérez, S., F. Requena-Silvente, and V. J. Pallardó-Lopez, (2013), 'The Duration of Firm-Destination Export Relationships: Evidence from Spain, 1997-2006', *Economic Inquiry* 51(1): 159-180.

Fitzgerald, D. and S. Haller, (2017), 'Exporters and Shocks: Dissecting the International Elasticity Puzzle', *NBER Working Paper*, No. 19968

Fukao, K., K. Ikeuchi, Y. Kim, H. Kwon, and T. Makino, (2016), 'International Competitiveness: A Comparison of the Manufacturing Sectors in Korea and Japan', *Seoul Journal of Economics*, 29: 43-68.

Good, D. H., M. I. Nadiri, and R. Sickles. (1997). "Index Number and Factor Demand Approaches to the Estimation of Productivity," In Hashem Pesaran and Peter Schmidt, eds., *Handbook of Applied Econometrics*. *Vol. 2: Microeconometrics*. London: Basil Blackwell.

Inui, T., K. Ito, and D. Miyakawa, (2017), 'Export Experience, Product Differentiation and Firm Survival in Export Markets', *The Japanese Economic Review*, 68(2): 217-231.

Japan Industrial Productivity Database 2015, RIETI. https://www.rieti.go.jp/en/database/JIP2015/index.html.

Appendix

Appendix 1. Summary statistics.

The estimation period is the period between 1997 and 2014.

Summary statistics of the variables used in the regressions are as follows.

Table A1 Summary statistics of variables for the estimation of intensive margin

Variable	Obs	Mean	Std. Dev.	Min	Max
$\ln(\text{Export}_{f,t})$	65,936	5.884	2.477	0.000	15.876
$\ln RX_{i,t-1}$	65,936	-0.009	0.125	-0.318	0.380
$\ln RX_{i,t-1} \cdot$Import intensity $_{f,t-1}$	65,899	-0.002	0.021	-0.276	0.280
Import intensity$_{f,t-1}$	65,899	0.073	0.141	0	0.981
R&D intensity$_{f,t-1}$	65,936	0.016	0.020	0	0.087
$\ln TFP_{f,t-1}$	65,936	-0.026	0.098	-0.682	0.562
$\ln$(# Employee$_{f,t-1}$)	65,936	5.583	1.116	3.912	11.300

Note. *RX* indicates industry-specific real effective exchange rate. The greater value of exchange rate implies the appreciation of Japanese yen. *Import intensity=import*/(*purchase+wage*). *R&D intensity= R&D expenditure*/*sales*. *TFP* is total factor productivity of the firm.

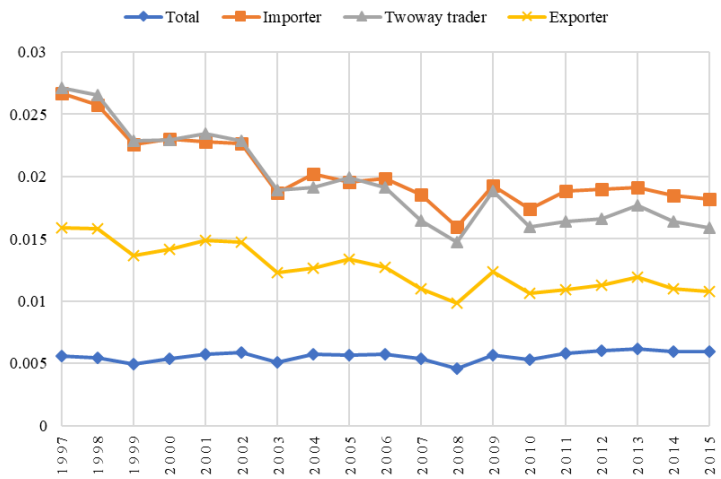
Table A2 Summary statistics of variables for the estimation of extensive margin

Variable	Obs.	Mean	S.D.	Min.	Max.
Entry1	322,458	0.024	0.154	0	1
Entry2	225,909	0.017	0.129	0	1
Entry3	212,982	0.014	0.116	0	1
$\ln RX_{i,t-1}$	259,433	0.005	0.125	-0.318	0.380
$\ln RX_{i,t-1} \cdot$Import intensity $_{f,t-1}$	222,565	-0.001	0.014	-0.276	0.280
Import intensity$_{f,t-1}$	443,386	0.031	0.112	0	0.999
Export experience$_{f,t-1}$	541,261	0.244	0.429	0	1
R&D intensity$_{f,t-1}$	454,977	0.005	0.012	0	0.087
$\ln TFP_{f,t-1}$	439,645	-0.059	0.161	-1.366	0.909
$\ln$(# Employee$_{f,t-1}$)	459,781	5.235	1.019	3.912	11.801

Note. 1. *Entry 1*, *2*, and *3* are the New Entry to Export based on the observation of every year, the New Entry to Export after the non-export of at least 3 years, and New Entry to Export without export experience in the data set, respectively. $RX_{i,t-1}$ indicates industry- specific real effective exchange rate. The greater value of exchange rate means appreciation of Japanese yen. *Import intensity=import*/(*purchase+wage*). *R&D intensity=R&D expenditure*/*sales*. *TFP* is total factor productivity of the firm. *Export experience*$_{ft}$ is the dummy variable which takes 1 if firm *f* experienced export in the past at time *t*, and 0 otherwise. 2. Each regression has year fixed effect (F.E.), and industry F.E., and been clustered by industry level. 3. Figures in parentheses are robust standard error. 4. OLS. 5. * p<0.10, ** p<0.05, *** p<0.01.

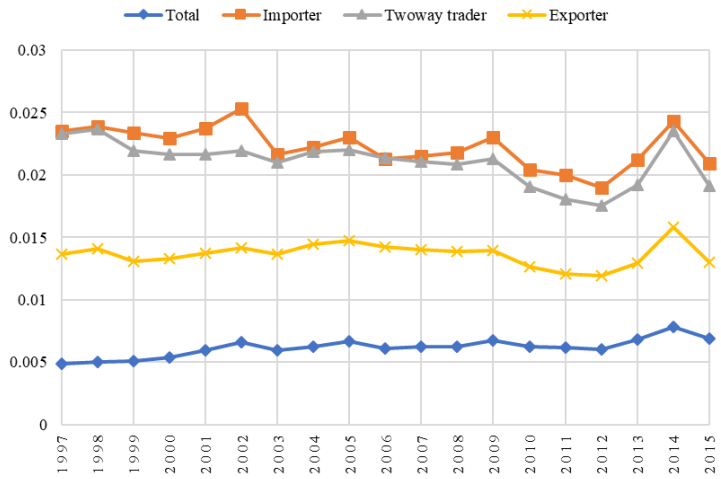
Appendix 2. Import intensity of imports from North America and Europe

Figure A1. Import intensity (from North America)



Note. Imports from the affiliates overseas / total purchase. Two-way trader means firms that exports and imports. Source: Authors' calculation using BSJBSA.

Figure A2. Import intensity (from Europe)



Note. Imports from the affiliates overseas / total purchase. Two-way trader means firms that exports and imports. Source: Authors' calculation using BSJBSA.

Appendix 3. Issues on marginal effects of non-linear estimation model (probit)

Table A3 is the simple marginal effects estimated from the estimation results of Models (1), (3), and (5) of Table 3.

Table A3. Marginal effects of Table 3.

Dep. Var.	Indep. Var.	dy/dx	S.E.	*p*-value
New Entry to Export	$\ln RX_{i,t-1}$	0.011	0.025	0.664
	$\ln RX_{i,t-1}$·Import intensity $_{f,t-1}$	0.071	0.051	0.16
	Import intensity$_{f,t-1}$	0.071	0.012	0
	Export experience$_{f,t-1}$	0.059	0.001	0
	R&D intensity$_{f,t-1}$	0.479	0.041	0
	$\ln TFP_{f,t-1}$	0.020	0.007	0.006
	ln(# Employee$_{f,t-1}$)	0.007	0.001	0
New Entry to Export after 3-year- non-export	$\ln RX_{i,t-1}$	0.014	0.021	0.492
	$\ln RX_{i,t-1}$·Import intensity $_{f,t-1}$	0.090	0.059	0.125
	Import intensity$_{f,t-1}$	0.059	0.011	0
	Export experience$_{f,t-1}$	0.028	0.001	0
	R&D intensity$_{f,t-1}$	0.393	0.042	0
	$\ln TFP_{f,t-1}$	0.026	0.007	0
	ln(# Employee$_{f,t-1}$)	0.007	0.001	0
New Entry to Export w/o export experience	$\ln RX_{i,t-1}$	0.029	0.021	0.159
	$\ln RX_{i,t-1}$·Import intensity $_{f,t-1}$	0.036	0.047	0.447
	Import intensity$_{f,t-1}$	0.058	0.008	0
	R&D intensity$_{f,t-1}$	0.396	0.037	0
	$\ln TFP_{f,t-1}$	0.023	0.006	0
	ln(# Employee$_{f,t-1}$)	0.006	0.001	0

It is often argued that the total marginal effect of the cross term is different from the estimated marginal effect of it. In the estimation above, we have cross term between the real exchange rate and import intensity. Although estimated coefficient (and its marginal effect) is not significant statistically, if it is the case, the total marginal effect should be discussed.

Suppose the output *Y* (Decision on export) is the function of *ER* (Exchange rate), *II* (import intensity), and *X* (control variables) in the following way in Equation (A1). Marginal effect of the cross term between *ER* and *II* is, then, Equation (A2), not β_{12}. However, one may observe that both of β_1 and β_{12} are not significant, so that they are not different from 0. If it is the case, then, total marginal effect of the cross term is expected not to be different from 0.

$$E[Y|ER\ ,II\ ,X\ ] = F(\beta_1 ER\ + \beta_{12} ER\ II\ + \beta_2 II\ + X\beta) \quad \text{(A1)}$$

$$\frac{\partial^2 F(\cdot)}{\partial ER\ \partial II} = \boldsymbol{\beta_{12}} F'(\cdot) + (\boldsymbol{\beta_1} + \boldsymbol{\beta_{12}} II\ )\ (\beta_2 + \boldsymbol{\beta_{12}} ER\ )\ F'' \quad \text{(A2)}$$

Additionally, we estimated marginal effect of exchange rate on export probability according import intensive level with the estimation results of Model (1), (3), and (5) in Table 3. Although the estimated marginal effect of exchange rate is higher according to the increase of import intensity in each model, it is clear that none of them are statistically significant.

Figure A3. Marginal Effect of exchange rate on export probability by import intensity level

New Entry to Export | New Entry to Export after 3-year- non-export | New Entry to Export w/o export experience