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Exchange Rate Movements, Exporting by Japanese firms, and the Role of R&D and Global Outsourcing

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Abstract: *We investigate the effect of the exchange rate on Japanese firms' performance in the international markets, using a comprehensive Japanese firm-level dataset. We examine the effect of firm characteristics on firm export dynamics at the firm–region export level. The estimation results overall indicate that a depreciation in the exchange rate may play an important role in export expansion or entry, but a limited role in additional entry to a new regional market. The results also indicate that Japanese firms strategically utilise imports to alleviate negative shocks from the exchange rate on exports for price competitiveness.*

***Keywords*:** Firm-level data; Exchange Rate; R&D; Outsourcing.
***JEL Classification*:** D24; F14; F31

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. Introduction

Japanese manufacturers have been facing fierce competition from Korean and Chinese firms in international export markets in recent years. For example, the Japanese electrical machinery industry suffered a notable downturn in its international competitiveness. According to UN Comtrade Database, Japan accounted for 12.2% of the world's total export value in electrical machinery and equipment in 2000, but the share fell to 4.4% in 2014. In contrast, the Republic of Korea (henceforth, Korea) and China increased their shares of the export value in the same industry from 4.7% each in 2000 to 5.8% and 24.3%, respectively, in 2014. These facts indicate that Japanese electric machinery firms became less competitive internationally in the 2000s, and some firms exited the export markets.

Using the same UN database, the revealed comparative advantage (RCA) of the three countries in the electrical machinery industry is shown to drop from 1.6 in 2000 to 1.1 in 2014, whereas the RCA of Korea rose from 1.7 to 1.8 and that of China from 1.2 to 1.9 over the same period. Previous literature has pointed out that increased productivity is a key determinant of firm entry to the export market and the expansion of export amounts. These facts clearly indicate that Korean and Chinese electric machinery firms have increased their productivity substantially and expanded their sales in the international market.

Fukao et al. (2016) investigated how much intermediate, capital, and labour cost and productivity influenced the cost competitiveness of Japanese and Korean firms in the late 1990s and 2000s using firm-level datasets for both countries. The Japanese real wage rate did not increase very much in the estimation period, but the Korean real wage increased substantially during that period. In addition, the Japanese electrical and

electronic machinery industry's productivity grew very rapidly. However, even though Japanese firms in the industry enjoyed these cost advantages, the reduction rates of Japanese firms' average costs were about the same as those of the Korean firms in the 1994–2010 period. This is because Korean firms reduced their intermediate input costs on a larger scale than the Japanese firms. This aggressive reduction in intermediate input costs by Korean firms allowed them to maintain their competitiveness in the export market against Japanese firms.

Using comprehensive Japanese firm-level data, this research examines the role of Japanese firms' research and development (R&D) and outsourcing activities in their ability to absorb the negative effects of an exchange rate appreciation.

2. Literature Review

This paper relates to two main strands in the 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 decisions and/or export behaviour of firms and provide 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, found that about one-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, reported that the median duration of export spells is 6 years and that 25% of spells end after the first year of exporting. Inui et al. (2017) examined 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 showed, first, that exporting experience plays an important role in firms' survival in export markets. Second, they showed that 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 Strauss-Khan (2014) examined the effect of the role of imported intermediate goods on firm productivity and export scope using French firm-level data on imports for 1996–2005. The authors found that imported inputs enhance firm productivity, and higher productivity firms export more varieties and survive in the export market. Imported inputs also directly affect firm exports through lower input prices.

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

The second important strand of literature related to our work is that which examines the effect of exchange rate changes on firms' export entry, export exit, and export revenue. Baggs et al. (2009) examined the effect of exchange rate movements on firm

survival and sales by using Canadian firm-level data from 1986 to 1997. They found that both firm survival and sales are negatively affected by an appreciation in the exchange rate, but the impact on survival is less pronounced for more productive firms.

Berman et al. (2012) examined the heterogeneous reaction by exporters to the real exchange rate change by using French firm-level data for the period 1995–2005. The authors found that high-performance firms react to currency depreciation by increasing their markup significantly more and by reducing increases in their export volume.

Amiti et al. (2014) confirmed the existence of heterogeneous responses to exchange rate changes and showed that the response differs according to both export intensity and 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 as imports absorb the negative effect.

Cheung and Sengupta (2013) examined the impact of exchange rate movements on Indian exports from 2000 to 2010 and found strong and significant negative impacts from currency appreciation and currency volatility on Indian firms' export shares. The authors also found that exports of smaller firms and service firms are more affected by exchange rate fluctuation.

Fitzgerald and Haller (2017) estimated the effect of changes in tariffs and the exchange rate on firm export participation and export revenue for Ireland. They found that both participation and revenue are more affected by tariffs than by the real exchange rate.

3. Data

The source of the Japanese firm-level data used in this study is the Basic Survey of Japanese Business Structure and Activities (BSJBSA), conducted annually by the Ministry of Economy, Trade, and Industry. The BSJBSA data cover all firms that have more than 50 employees or 30 million yen of paid-in capital in the manufacturing sector, mining industry, wholesale and retail industry, and service sectors. Firms are obliged to respond to the survey.

The data covers a wide range of information on firms' structure and activities, such as the business structure and its changes, management strategy, R&D and other intellectual property related activities, overseas production and transactions, detailed lists of products, outsourcing, and the use of information and communications technology (ICT). The data also provides financial statement information so that firms' activities can be investigated along with performance measurements, such as growth, profitability, and productivity.

The survey started in 1992 and has been conducted annually since 1995. We can construct panel data for more than 20 years. The number of observations is around 25,000 firms for each year.

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

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

and

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

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. The 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 values are taken from the sectoral data of the Japan Industrial Productivity Database 2015.

We calculate the region-specific exchange rate, $RX_{r,t}$, as follows.[1]

$$\Delta \ln RX_{r,t} = \sum_{c \in r} \frac{GDP_{c,t}}{GDP_{r,t}} \cdot \Delta \ln RX_{C,t},$$

and

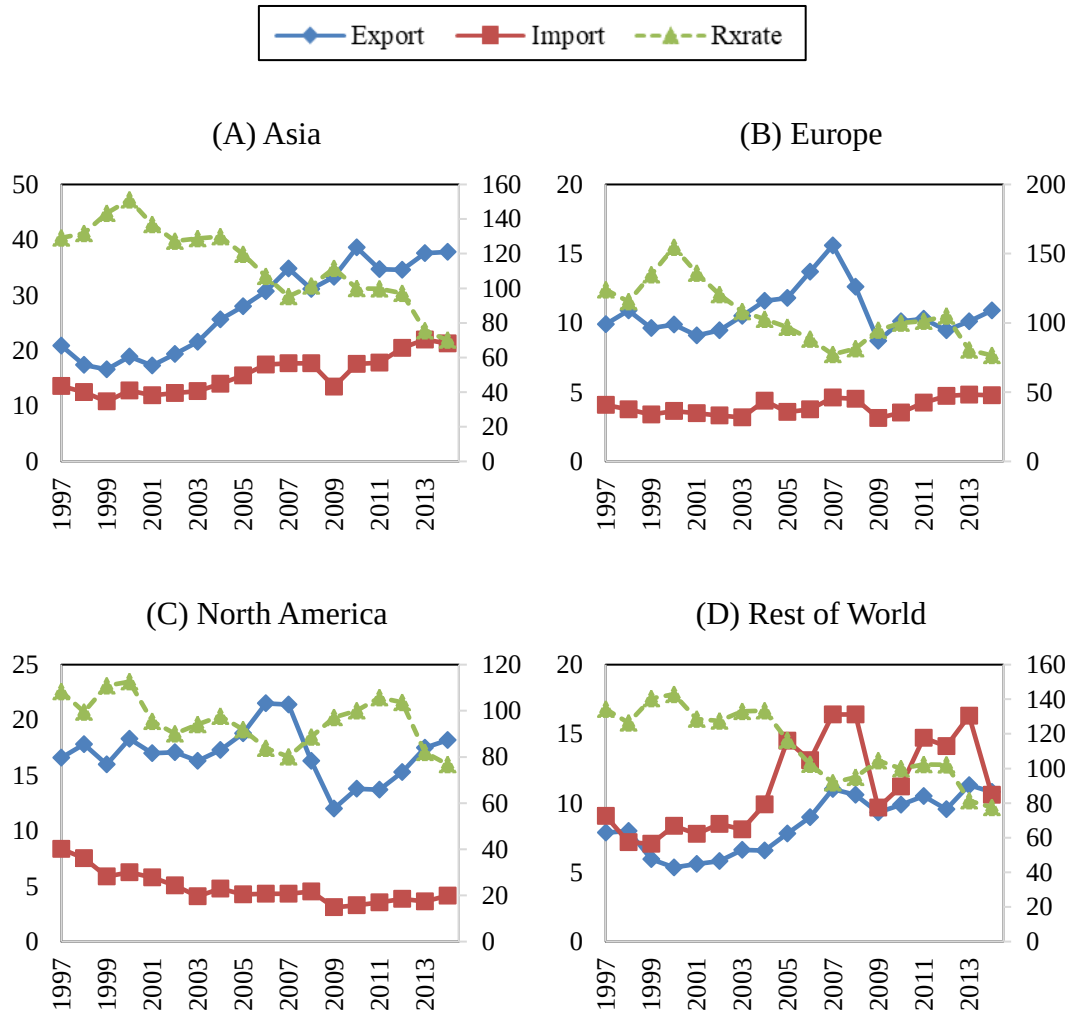
$$RX_{c,t} = \frac{ER_{c/US,t}}{ER_{Japan/US,t}} \cdot \frac{CPI_{Japan,t}}{CPI_{c,t}}. \quad (2)$$

where GDP $_{c,t}$ is the gross domestic product (GDP) of country *c* in year *t*; GDP $_{r,t}$ is the GDP of region *r* in year *t*; $ER_{c/US,t}$ is the nominal exchange rate of country *c* in US dollars in year *t*; and CPI $_{c,t}$ is the consumer price index of the country *c* in year *t*.

[1] The region-specific real exchange rate is calculated as an index with value 100 in 2010.

The development of the region-specific exchange rate ($RX_{r,t}$) used in the analysis and the total Japanese firm export and import amounts by region are shown in Figure 1. It is clear that a depreciation in the yen brings about an increase in exports in the markets. One may also observe that the response of imports to the exchange rate is less sensitive than that of exports in the markets.

Figure 1. Region-specific Real Exchange Rate (right axis, 2010=100) and Aggregate Export/Import Amounts by Region (left axis, trillion yen)



Notes: 1. Calculated by authors. 2. *Rxrate* is the region-specific real exchange rate calculated following Equation (2). A greater value of the real exchange rate means an appreciation of the Japanese yen.
Source: Authors.

4. Empirical Analysis

Utilising the aforementioned datasets, we measure various characteristics of the Japanese firms, such as their productivity level, R&D intensity, age, and experience in international markets. We then investigate the effect of real exchange rate changes on firms' performance in the export market by taking into account various firm characteristics. Previous studies (e.g. Berman et al. [2012]) have shown that high productivity firms have a low pass-through, implying that they have weak reactions of exports to exchange rate movements. Fully globalised firms may have more accumulated knowledge in international markets than other firm types and may cope better with various shocks in these markets. Less globalised firms may respond more sensitively to an exchange rate shock. Their profit may be more vulnerable to the shock and fluctuate more. Knowledge-intensive firms may have a more favourable position because specified knowledge, such as intellectual property, gives them better competitiveness not only in the domestic markets but also in the international market. As indicated in Fukao et al. (2016), overseas procurement (proxied by firm imports) reduces the intermediate inputs cost and the marginal cost of a firm's final products.

As the first step in our analysis, we observe how Japanese firms respond to a change in the exchange rate using the BSJBSA data. We first regress firm performance, in various areas, such as exports, imports, and foreign activities by a number of overseas affiliates, on the real effective exchange rate. The results in Table 1 indicate that an appreciation of the yen constricts overall firm performance, including imports and foreign activities.

Table 1. Exchange Rate and Firm Performance

	ln(Export$_{f,r,t}$)	ln(Import$_{f,r,t}$)	ln(# affil.$_{f,r,t}$)	ln(# affil. MFG$_{f,r,t}$)	ln(# affil. Trade$_{f,r,t}$)	ln(# affil. Others$_{f,r,t}$)
ln(RX$_{r,t-1}$)	-0.182***	-0.269***	-0.060***	-0.022***	-0.030***	-0.013***
	(0.013)	(0.015)	(0.002)	(0.002)	(0.002)	(0.001)
Observations	2,044,144	2,044,143	2,044,144	2,044,144	2,044,144	2,044,144
Adj. R-Squared	0.116	0.075	0.058	0.064	0.025	0.012

Notes. 1. *RX* is the region-specific real exchange rate calculated following Equation (2). A greater value of the exchange rate means an appreciation of the Japanese yen. # *affil.*$_{f,r,t}$ is the number of affiliates of firm *f* in region *r* at time *t*. # *affil. MFG* is the number of manufacturing affiliates. # *affil. Trade* is the number of retail or wholesale affiliates at *t*. # *affil. Others* is the number of affiliates that are not classified as manufacturing nor trade at *t*. 2. Each regression has year fixed effects (FE), region FE, and industry FE. 3. Figures in parentheses are robust standard errors. 4. The estimation method is OLS. 5. * p<0.10, ** p<0.05, *** p<0.01.
Source: Authors.

Amiti, et al. (2014) pointed out that imports are expected to alleviate the negative effect on exports from an exchange rate appreciation because the appreciation may lower the marginal costs of the importer. We examine the effects on the intensive and extensive margins of exports from the exchange rate, separately. We first regress the following equation in order to investigate the effect on the intensive margin of exports.

$$\begin{aligned}\ln(\text{Export}_{frt}) = {} & \alpha_i + \alpha_t + \beta_{RX}\ln(RX_{rt}) + \beta_{imp}\ln(Import_{ft-1}) \\ & + \beta_{ms}\, Market\ share_{frit-1} + \beta_{R\&D} R\&D_{ft-1} + \beta_{TFP} lnTFP_{ft-1} \\ & + \beta_{R\&D}\ln(Employee_{ft-1}) + \gamma_{imp}\ln(RX_{rt}) \cdot \ln(import_{ft-1}) \\ & + \gamma_{ms}\ln(RX_{rt}) \cdot Market\ share_{frit-1} + \gamma_{R\&D}\ln(RX_{rt}) \cdot R\&D_{ft-1} \\ & + \varepsilon_{frt} \qquad (3)\end{aligned}$$

$Market\ share_{frit-1}$ is the market share of firm *f* in the export market of industry *i* into the target region *r* in year *t*-1.

The estimation results for equation (3) are shown in Table 2. The results show that, as expected, an appreciation of the yen decreases exports, even controlling for various firm characteristics, such as import intensity, productivity, and R&D investment. Amiti et al. (2014) predicted that the coefficient of the interaction term of the change in the exchange rate and import intensity is positive to alleviate the negative effect of the currency appreciation. We observe this effect in Table 2. However, the estimated coefficient of the interaction term between the exchange rate and the market share is not significant statistically. The market share variable is expected to capture the degree of the markup of the firm in the export market. Berman et al. (2012) showed that firms with a greater markup in the export market respond less sensitively to the change in the exchange rate to stabilise the export volume. The estimation results show that such behaviour is not observed in the case of Japanese firms.[2]

[2] Our data do not provide information on the price and volume of the export products. Hence, we cannot decompose the change in export value into the change of price or that of volume.

Table 2. Exchange Rate and Exports (firm-region level, manufacturing, OLS)

Dep. Var.: $\ln(Export_{r,t})$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\ln RX_{r,t-1}$	-0.7396***	-0.4344***	-0.8193***	-0.8095***	-0.8495***	-0.4679***	-0.8670***	-0.8583***	-0.5836***
	(0.0387)	(0.0531)	(0.0744)	(0.0761)	(0.0430)	(0.0573)	(0.0826)	(0.0737)	(0.1000)
$\ln RX_{r,t-1} \cdot \ln(\text{Import intensity}_{f,t-1})$		0.0841***				0.0880***			0.0895***
		(0.0080)				(0.0087)			(0.0088)
$\ln RX_{r,t-1} \cdot \ln(\text{Market share}_{f,r,i,t-1})$			-0.0028				-0.0031		-0.0154
			(0.0111)				(0.0124)		(0.0127)
$\ln RX_{r,t-1} \cdot \ln(\text{R\&D intensity}_{t-1})$				0.0072				-0.0021	-0.0081
				(0.0145)				(0.0141)	(0.0143)
$\ln(\text{Import intensity}_{f,t-1})$		-0.0338***			0.0106***	-0.0553***	0.0106***	0.0106***	-0.0562***
		(0.0064)			(0.0025)	(0.0070)	(0.0025)	(0.0025)	(0.0070)
$\ln(\text{Market share}_{f,r,i,t-1})$			0.3687***		0.3492***	0.3483***	0.3516***	0.3492***	0.3601***
			(0.0093)		(0.0042)	(0.0042)	(0.0104)	(0.0042)	(0.0105)
$\ln(\text{R\&D intensity}_{f,t-1})$				-0.011	0.0016	0.0019	0.0016	0.0031	0.008
				(0.0118)	(0.0045)	(0.0045)	(0.0045)	(0.0115)	(0.0117)
$\ln TFP_{f,t-1}$					0.4160***	0.4150***	0.4161***	0.4162***	0.4159***
					(0.0446)	(0.0446)	(0.0446)	(0.0446)	(0.0446)
$\ln(\text{\# Employee}_{f,t-1})$					0.5343***	0.5308***	0.5343***	0.5342***	0.5307***
					(0.0169)	(0.0169)	(0.0169)	(0.0169)	(0.0169)
Observations	161,563	143,773	143,954	115,288	112,669	112,669	112,669	112,669	112,669
R-Squared	0.036	0.040	0.108	0.044	0.126	0.127	0.126	0.126	0.127

OLS = ordinary least squares.

Notes. 1. *RX* indicates the region-specific real effective exchange rate. A greater value of the exchange rate means an appreciation of the Japanese yen. *Import intensity=import*/(*purchase+wage*). *Market share* is the share of exports in each region, industry, and year. *R&D intensity=R&D expenditure*/*sales*. *TFP* is the total factor productivity of the firm. 2. Each regression has year fixed effects (FE), region FE, and industry FE. 3. Figures in parentheses are robust standard errors. 4. OLS. 5. * p<0.10, ** p<0.05, *** p<0.01.

Source: Authors.

We examine the effect of the real exchange rate on the extensive margin of exports using Equation (4). To take into account the heterogeneity of the regional market structure, we examine the firm-region level export entry.

$$\begin{aligned}\text{Entry}_{frt} = {} & \alpha_i + \alpha_r + \alpha_t + \beta_{XR}\ln(RX_{rt}) + \beta_{imp}1\left(Import_{ft-1}\right) + \beta_{exp}1(exp_{ft-1}) \\ & + \beta_{R\&D}1(R\&D_{ft-1}) + \beta_{TFP}lnTFP_{ft-1} + \gamma_{imp}\ln(RX_{rt}) \\ & \cdot 1\left(Import_{ft-1}\right) + \gamma_{exp}\ln(RX_{rt}) \cdot 1(exp_{ft-1}) + \gamma_{R\&D}\ln(RX_{ft}) \\ & \cdot 1(R\&D_{ft-1}) + \varepsilon_{frt} \qquad (4)\end{aligned}$$

where $Entry_{fgt}$ is a dummy variable that takes a value of 1 if the firm *f* does not export to the region *g* from *t*-5 to *t*-1 and exports at *t*, and 0 if the firm does not export from *t*-5 to *t*; α_{ind} is the industry fixed effects; α_g is the region fixed effects; α_t is the time fixed effect; $1(import_{it\text{-}1})$ is a dummy variable that takes a value of 1 if the firm imports at *t*-1; TFP_{it} is the TFP level of firm *f* in period *t*; $1(R\&D_{ft})$ is a dummy variable that takes a value of 1 if the R&D expenditure of firm *f* in period *t* has a positive value, and 0 otherwise; $1(exp_{ft})$ is a dummy variable that takes a value of 1 if firm *f* experienced exporting in the past, and 0 otherwise.

The estimation results of Equation (4) are shown in Table 3. Since the analysis here is the firm–region level, the firm export market entry may have at least two cases. The first case is a non-exporting firm begins to export to a certain region, and the second is an exporting firm begins to export to a region where the firm did not export previously. In the same vein, import and export experience may have two meanings, respectively, that is, firm level and region level.

The obtained results in columns (1)–(3) of Table 3 indicate that the appreciation of the yen has a negative impact on the decision of firms to enter into the international market. The interaction term between the exchange rate and firms' imports has

positive and significant effects in columns (1)–(3). The results indicate that a firm's import activity alleviates the negative effect on starting to export from the appreciation of the currency. Column (3) indicates that past export experience to any region also alleviates the negative effect from the exchange rate appreciation on starting to export.

The estimation results for the case of exporting firms' additional entry to export to a region where they did not export previously are shown in columns (4)–(6) in Table 3. The results indicate that the appreciation of the yen has no impact on the decision of a firm to enter into the new regional market. None of the estimated coefficients of the interaction term between the exchange rate and import activity in columns (4)–(6) are significant. The results suggest that the importing activities of the exporting firms do not alleviate the negative effect on entry decisions to the new regional market from the exchange rate appreciation.[3]

The estimation results in columns (1)–(6) do not indicate that R&D alleviates the negative effect of the exchange rate appreciation on entry decisions to the export market. However, the results do indicate that R&D performing firms are more likely to begin exporting.

[3] The coefficients of the dummy variable of importing from the region are estimated positively and significantly in columns (5) and (6) of Table 3. These results imply that the firm is more likely to begin to export to a region when it imports from there.

Table 3. Extensive Margin (entry to export)

Dep. Var.: Entry to export$_{f,t}$	First entry to the export market at firm level			Additional entry to the regional export market		
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln RX_{r,t-1}$	-0.010***	-0.006**	-0.010***	-0.022	-0.015	-0.022
	(0.003)	(0.003)	(0.003)	(0.014)	(0.013)	(0.014)
$\ln RX_{r,t-1} \cdot 1$ (Import $_{f,t-1}$)	0.012**		-0.002	0.014		0.015
	(0.006)		(0.006)	(0.010)		(0.010)
$\ln RX_{r,t-1} \cdot 1$ (Import $_{f,r,t-1}$)		0.031**	0.032**		0	-0.009
		(0.015)	(0.016)		(0.024)	(0.025)
$\ln RX_{r,t-1} \cdot 1$ (Export experience $_{f,t-1}$)	0.010*		0.016***			
	(0.005)		(0.005)			
$\ln RX_{r,t-1} \cdot 1$ (Export experience $_{f,r,t-1}$)		0.018	0.002			
		(0.022)	(0.023)			
$\ln RX_{r,t-1} \cdot 1(R\&D_{f,t-1})$	0	0.001	0.001	-0.01	-0.006	-0.008
	(0.003)	(0.003)	(0.003)	(0.010)	(0.010)	(0.010)
1 (Import $_{f,t-1}$)	0.002		0.007	0.005		-0.003
	(0.004)		(0.004)	(0.008)		(0.008)
1 (Import $_{f,r,t-1}$)		0.01	0.002		0.050***	0.053***
		(0.011)	(0.012)		(0.018)	(0.019)
1 (Export experience $_{f,t-1}$)	0.014***		0.006			
	(0.004)		(0.004)			
1 (Export experience $_{f,r,t-1}$)		0.034**	0.033**			
		(0.016)	(0.016)			
1 ($R\&D_{f,t-1}$)	0.008***	0.010***	0.007***	0.030***	0.027***	0.028***
	(0.002)	(0.002)	(0.002)	(0.008)	(0.008)	(0.008)
$\ln TFP_{f,t-1}$	0.021***	0.023***	0.018***	0.079***	0.073***	0.073***
	(0.002)	(0.002)	(0.002)	(0.008)	(0.008)	(0.008)
Observations	309,350	309,350	309,350	83,572	83,572	83,572
Adj. R-Squared	0.019	0.020	0.024	0.017	0.019	0.019

Notes. 1. The dependent variable is a dummy variable that takes a value of 1 if a firm has not exported at *t*-5, *t*-4, *t*-3, *t*-2, or *t*-1 and exports at *t*; 0 not exported at *t*-5, *t*-4, *t*-3, *t*-2, *t*-1 or *t*. 2. *RX* is the region-specific real exchange rate calculated from Equation (2). A greater value of the exchange rate means an appreciation of the Japanese yen. 3. ($Import_{f,t-1}$) is a dummy variable that takes a value 1 if the firm is importing from another country/region, and 0 if not. ($Import_{f,r,t-1}$) is a dummy variable that takes a value of 1 if the firm is importing from a specific region at *t*-1, and 0 if not. ($Export\ experience_{f,t-1}$) is a dummy variable that takes a value of 1 if the firm has any experience of exporting to some regions six or more years ago at *t*-1, and 0 if not. ($Export\ experience_{f,r,t-1}$) is a dummy variable that takes a value of 1 if the firm has experience of exporting to a specific region six or more years ago at period *t*-1, and 0 if not. 4. Each regression has year fixed effects (FE), region FE, and industry FE. 5. Figures in parentheses are robust standard errors. 6. OLS. 7.* p<0.10, ** p<0.05, *** p<0.01.
Source: Authors.

The estimation results overall indicate that an appreciation in the exchange rate has a negative and significant impact on expansion and entry into an export market, but no significant impact on the decision of an exporting firm to enter a new additional regional market. On the other hand, we find that the export behaviour of

firms that import more from abroad are less affected by the change in the exchange rate. Other firm characteristics, such as productivity and R&D investment, play an important role in starting to export. In addition, past export experience is important to return to the export market.

To survive in the international market, firms can choose two options: compete on price or through product differentiation. Our estimation results suggest that Japanese firms alleviate shocks from the exchange rate appreciation by reducing production costs by importing more intermediate inputs. However, we do not find any evidence that Japanese firms utilise R&D to hedge the negative effect of the exchange rate appreciation.

5. Conclusion and Policy Implications

Using the most comprehensive Japanese firm-level dataset, we investigated the effect of the exchange rate on Japanese firms' performance in international markets. We examined the effect of firm characteristics on firm export dynamics at the firm-region export level. The estimation results overall indicate that a depreciation in the exchange rate may play an important role in expansion and entry for exports, but a limited role for additional entry to new regional markets. On the other hand, firm characteristics, such as productivity and R&D intensity, play an important role at the stage of export market entry. In addition, past export experience is important to return to the export market.

The results also indicate that Japanese firms strategically utilise imports to alleviate a negative shock from the exchange rate on exports for price competitiveness. The most common way to promote firms' exporting activities is to depreciate the domestic currency exchange rate. However, our results suggest this policy may also

have a negative impact on export behaviour through increases in the price of imported intermediate products and production costs. In addition, the results indicate that when a firm has experience of joining the international market (either through exports or imports), it is more likely to restart or increase exporting.

Japanese small and medium-sized firms usually experience difficulties in conducting R&D and differentiating their products. Hence, to promote the entry of medium and small firms into the export market, the government should consider policies for supporting the provision of international market information and product differentiation.

In addition, small and medium-sized firms are vulnerable to exchange rate fluctuations. An appreciation of the yen may lead firms to exit the international market. Our results indicate that firms' imports can mitigate the negative shock from an appreciation of the exchange rate. Therefore, to assist firms' entry into the export market, the government also should consider policies for supporting firms' global procurement of intermediate goods and services.

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Appendix

The estimation period is 1997–2014.

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

Table A1. Summary Statistics of Variables for the Estimation of the Intensive Margin

Variable	Obs	Mean	Std. Dev.	Min	Max
$\ln(\text{Export}_{r,t})$	225,025	5.289914	2.40304	0.6931472	15.2386
$\ln RX_{r,t-1}$	225,025	0.7724162	0.1804851	0.4126187	1.129575
$\ln RX_{r,t-1} \cdot \ln(\text{Import intensity}_{f,t-1})$	198,894	-3.208228	1.921832	-7.802828	-0.00301
$\ln RX_{r,t-1} \cdot \ln(\text{Market share}_{f,r,i,t-1})$	199,283	-4.504576	1.524999	-7.802828	0.001129
$\ln RX_{r,t-1} \cdot \ln(\text{R\&D intensity}_{t-1})$	135,465	-3.435028	1.394988	-12.89142	-1.012328
$\ln(\text{Import intensity}_{f,t-1})$	198,894	-4.179494	2.216957	-6.907755	-0.004261
$\ln(\text{Market share}_{f,r,i,t-1})$	199,283	-5.918269	1.406517	-6.907755	0.0009995
$\ln(\text{R\&D intensity}_{f,t-1})$	135,465	-4.501888	1.454534	-12.80961	-2.44546
$\ln TFP_{f,t-1}$	193,463	0.0027724	0.1383986	-0.834876	0.5849717
$\ln(\#\ \text{Employee}_{f,t-1})$	199,372	5.775037	1.234885	3.912023	11.30023

Notes: *RX* indicates the region-specific real effective exchange rate. A greater value of the exchange rate implies an appreciation in the Japanese yen. *Import intensity=import*/(*purchase*+*wage*). *Market share* is the share of exports in each region, industry, and year. *R&D intensity= R&D expenditure*/*sales*. *TFP* is the total factor productivity of the firm.
Source: Authors.

Table A2. Summary Statistics of Variables for the Estimation of the Extensive Margin

Variable	Obs	Mean	Std. Dev.	Min	Max
Entry to export$_{f,t}$	1,137,277	0.012216	0.109849	0	1
ln$RX_{r,t-1}$	2,044,144	0.7704517	0.1803894	0.4126187	1.129575
ln$RX_{r,t-1}$·1 (Import $_{f,t-1}$)	2,044,144	0.1366401	0.2994335	0	1.129575
ln$RX_{r,t-1}$·1 (Import $_{f,r,t-1}$)	2,044,144	0.0596035	0.2100146	0	1.129575
ln$RX_{r,t-1}$·1 (Export experience $_{f,t-1}$)	2,044,144	0.17865	0.3288201	0	1.129575
ln$RX_{r,t-1}$·1 (Export experience $_{f,r,t-1}$)	2,044,144	0.1042978	0.2671728	0	1.129575
ln$RX_{r,t-1}$·1(R&D$_{f,t-1}$)	2,044,144	0.2084955	0.3536152	0	1.129575
1 (Import $_{f,t-1}$)	2,044,144	0.1816858	0.3855855	0	1
1 (Import $_{f,r,t-1}$)	2,044,144	0.0786168	0.2691398	0	1
1 (Export experience $_{f,t-1}$)	2,044,144	0.2403529	0.4272979	0	1
1 (Export experience $_{f,r,t-1}$)	2,044,144	0.1395029	0.3464706	0	1
1 (R&D$_{f,t-1}$)	2,044,144	0.2716932	0.4448327	0	1
lnTFP $_{f,t-1}$	1,651,604	-0.0592034	0.1609508	-1.366048	0.9089172

Notes: *Entry to export*$_{f,t}$ is a dummy variable that takes a value of 1 if a firm has not exported at *t*-5, *t*-4, *t*-3, *t*-2, or *t*-1 and exports at *t*; 0 not exported at *t*-5, *t*-4, *t*-3, *t*-2, *t*-1, or *t*. *RX* is the region-specific real exchange rate calculated as in Equation (2). A greater value of the exchange rate implies an appreciation in the Japanese yen. (*Import*$_{f,t-1}$) is a dummy variable that takes a value of 1 if the firm is importing from another country/region, and 0 if not. (*Import*$_{f,r,t-1}$) is a dummy variable that takes a value off 1 if the firm is importing from a specific region at *t*-1, and 0 if not 1. (*Export experience*$_{f,t-1}$) is a dummy variable that takes a value off 1 if the firm has any experience of exporting to some regions six or more years ago at *t*-1, and 0 if not 1. (*Export experience*$_{f,r,t-1}$) is a dummy variable that takes a value of 1 if the firm has experience of exporting to a specific region six or more years ago at *t*-1, and 0 if not.

Source: Authors.

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