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The Effect of Exchange Rate Changes on Japanese Consumption Exports

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Abstract

This paper investigates how exchange rates affect Japanese exports. This is difficult because many of Japan's exports are used to produce goods for re-export. An appreciation in the importing country that decreases exports can decrease its imported inputs from Japan. To correct for this bias we examine consumption exports. Using a panel dataset of Japan's consumption exports to 17 countries over the 1988–2009 period, we find that a 10% appreciation of the yen would reduce Japan's consumption goods exports by 9%. These results indicate that the large swings in the value of the yen over the last decade have caused large swings in the volume of Japanese exports.

JEL Classification: F30, F32

Contents

1. INTRODUCTION

The Japanese real effective exchange rate depreciated 43% between the end of 2000 and the onset of the global financial crisis (GFC) in the summer of 2007. It then appreciated 30% over the next year and a half and remained strong throughout 2010 and the first half of 2011. How do exchange rate swings such as these affect Japanese exports?

Japanese firms say that exchange rate appreciations since the GFC have caused major difficulties (see METI, 2010, and JETRO, 2010). They state that their profits have plummeted and that it has been hard to compete with firms in countries where the exchange rate has depreciated. Small and medium sized enterprises in particular complain that currency fluctuations have caused severe dislocation.

Empirical evidence, on the other hand, has indicated that exchange rate changes may not matter much for Japanese exports. Crane, Crowley, and Quayyum (2007), using Johansen maximum likelihood estimation and quarterly data over the 1981Q1–2006Q4 period, report that a 10% appreciation in the unit labor cost-deflated Japanese real effective exchange rate (reer) would reduce Japanese exports by 3.4%. Thorbecke and Komoto (2010), using dynamic ordinary least squares estimation and quarterly data over the 1981Q1–2008Q1 period, find that a 10% appreciation in the unit labor cost-deflated Japanese reer would reduce Japanese exports by 3.2%. Thorbecke (2008), using a variety of cointegration estimators and quarterly data over the 1988Q1–2005Q3 period, finds that a 10% appreciation in the consumer price index-deflated yen/dollar exchange rate would reduce Japanese exports to the United States (US) by less than 4%.

Estimates of Japan's export elasticity may be biased downward, however, because many of Japan's exports are parts and components and capital goods that are used to produce goods for re-export. A depreciation in the country importing these goods from Japan may increase that country's exports and thus its import of inputs that are used to produce exports. Therefore a depreciation in the importing country and an appreciation of the yen can be associated with an increase in Japanese exports, even if the appreciation of the yen is not causing Japanese exports to increase (see Kamada and Takagawa, 2005).

To correct for this bias we examine Japanese consumption goods exports. These goods are used for consumption in the importing country, unlike capital and intermediate goods exports that are often used to produce goods for re-export. Thus examining consumption goods exports can provide a cleaner test of how exchange rate changes affect Japanese exports than would be possible by examining aggregate exports.

Using dynamic ordinary least squares estimation and a panel dataset including Japan's consumption exports to 17 countries over the 1988–2009 period we find that a 10% appreciation of the yen would reduce Japanese consumption exports on average by 9%. We also find that a 10% reduction in income in the importing countries would reduce Japanese consumption exports on average by 9%. Finally, we find some evidence that a 10% depreciation among key competing countries would reduce Japanese consumption exports by about 6%. These results indicate that exchange rate swings exert a major impact on Japanese exports.

The next section presents the data and methodology we employ. Section 3 contains the results. Section 4 concludes.

2. DATA AND METHODOLOGY

Following the imperfect substitutes model of Goldstein and Khan (1985), exports can be modeled as a function of the real exchange rate and real income:

$$ex_t = \alpha_{10} + \alpha_{11}\, rer_t + \alpha_{12}\, rgdp_t + \varepsilon_t \qquad (1)$$

where ex_t represents the log of real exports, rer_t represents the log of the real exchange rate, and $rgdp$ represents the log of foreign real income.

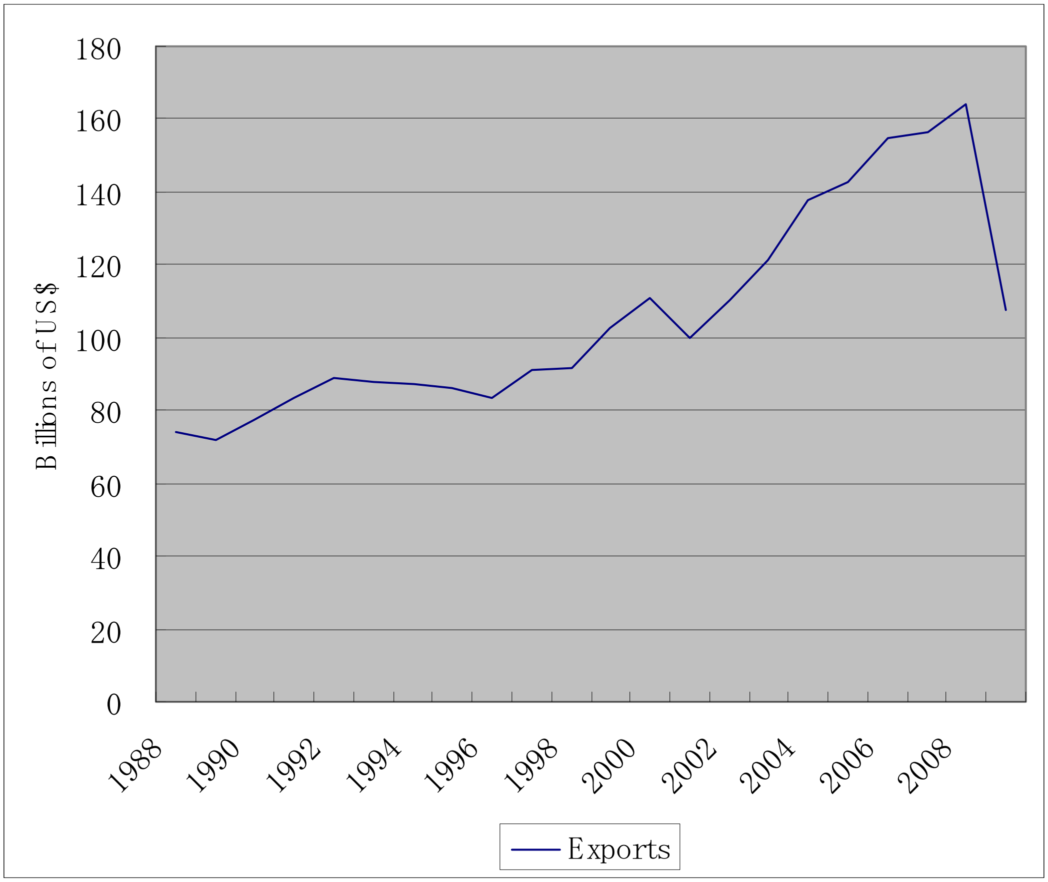
The dependent variable is final consumption goods exports. These data are obtained from the Centre D'Etudes Prospectives et D'Information Internationales (CEPII) CHELEM database.[1] They are measured in US dollars and deflated using two different indices. The first is the US Bureau of Labor Statistics price index for consumption goods imports. For every year from 1988-2009, consumption goods were the largest import category for US imports from Japan. The second is the US Bureau of Labor Statistics price index for imports from Japan.

Figure 1 shows the value of Japan's consumption good exports to the world. These exports are substantial, exceeding $100 billion in every year after 2001. Table 1 shows the countries that imported consumption goods from Japan in 2007. The US was the largest importer, but 16 other countries imported at least 1% of Japan's total consumption goods exports. We construct a panel data set including annual consumption goods exports from Japan to these countries over the 1988–2009 period.[2]

[1] Consumption goods, as defined by CEPII, includes goods in the following product categories: beverages, carpets, cars, cereal products, cinematographic equipment, clocks, clothing, consumer electronics, domestic electrical appliances, knitwear, miscellaneous manufactured articles, optics, pharmaceuticals, photographic equipment, preserved fruit and vegetable products, preserved meat and fish products, soaps and perfumes (including chemical preparations), sports equipments, toiletries, toys, and watches.

[2] We exclude the Russian Federation, since it did not exist for part of the sample period.

Figure 1: Value of Japanese Consumption Goods Exports to the World



Source: CEPII-CHELEM database.

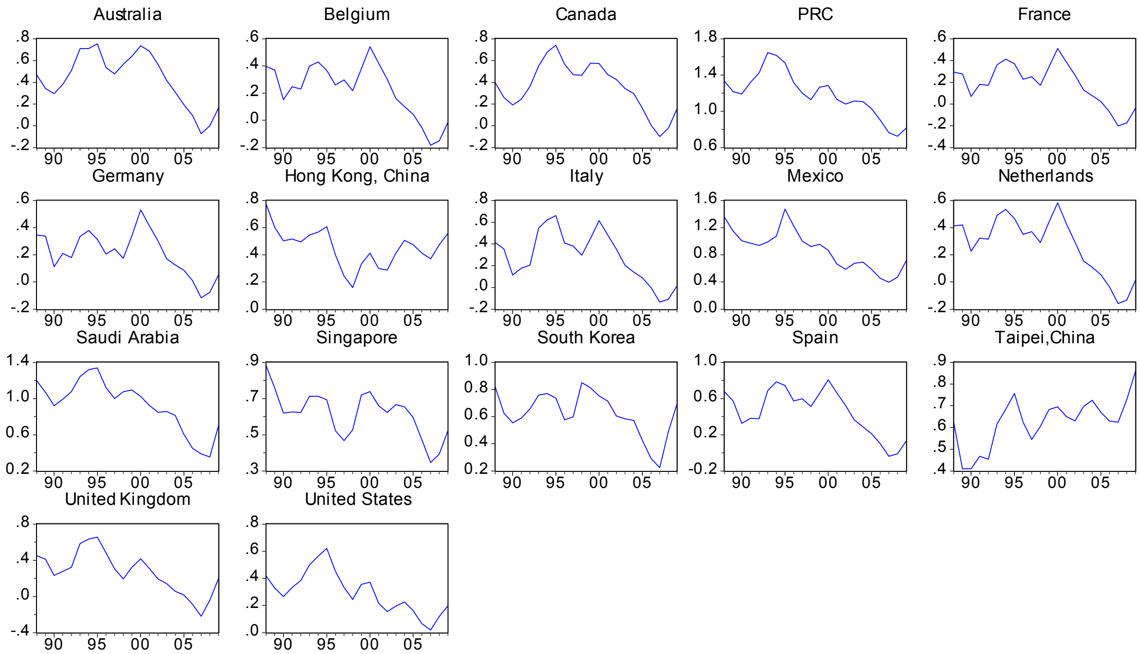
We seek to explain Japan's consumption goods exports using real income in the importing country ($rgdp_t$) and the real exchange rate between Japan and the importing country (rer_t). These data are obtained from the CEPII-CHELEM database. Real income is measured in 2005 dollars. The real exchange rate between Japan and country *j* is calculated by first dividing gross domestic product (GDP) in dollars for Japan by GDP in purchasing power parity (PPP) for Japan and doing the same for country *j*. The resulting ratio for Japan is then divided by the ratio for country *j*. This variable measures the units of PPP-defined GDP in country *i* needed to buy a unit of PPP-defined GDP in Japan. The major advantage of this variable is that it can be compared both across countries and over time. Higher values of rer represent a stronger yen.

As a second measure of the real exchange rate, we calculate the consumer price inflation (CPI)-deflated rer using data on bilateral nominal exchange rates and consumer price indices in the importing and exporting countries. These data are obtained from the International Monetary Fund (IMF) *International Financial Statistics*. Higher values of the real exchange rate again represent a stronger yen.

One difficulty with this measure is that bilateral exchange rates between exporting countries and importing countries vary markedly in magnitude. For instance, in 2009 the yen/Singapore dollar rate equaled 65 and the yen/ won rate equaled 0.07. To correct for this, bilateral exchange rates are set equal to the value given by the CEPII real exchange rate in the first year of the sample period (1988). The CPI-deflated bilateral real exchange rates are then used to calculate the rate of change in the real exchange rate for every year up to the end of the sample period (2009).

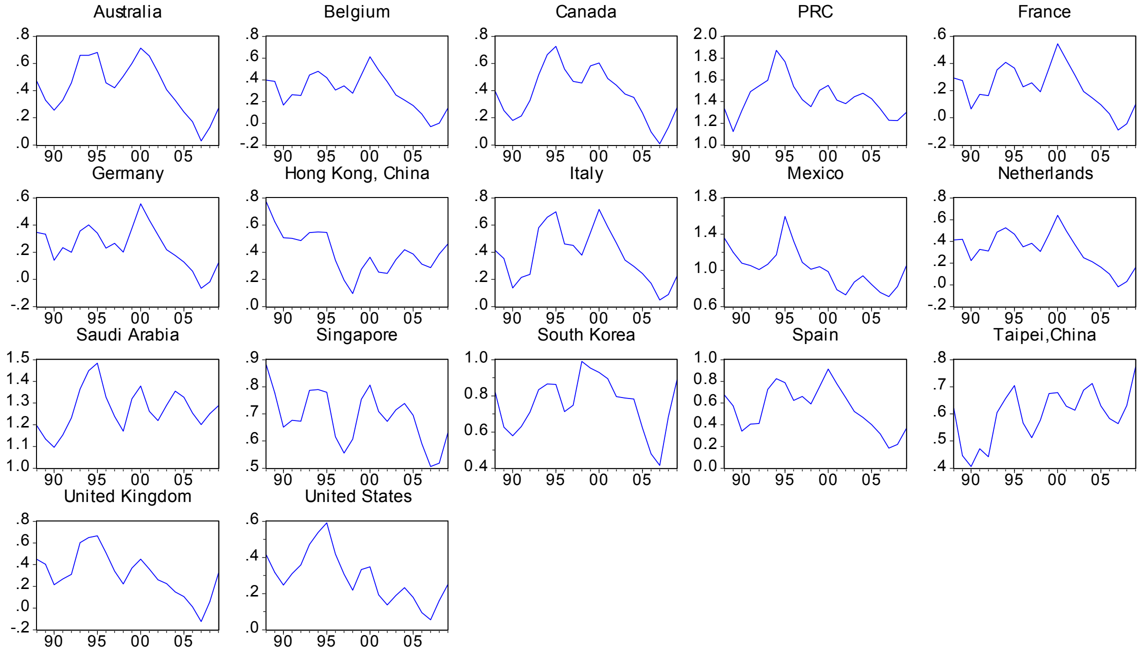
As Figure 2 shows, there has been substantial variation both cross-sectionally and over time in the yen exchange rate relative to the major importers of consumption goods. This approach should thus help to identify in an econometric sense how exchange rate changes affect consumption goods exports.

Figure 2a: CEPII-CHELEM Real Exchange Rates between Japan and the 17 Leading Importers of Consumption Goods, 1988–2009



Source: CEPII-CHELEM Database.

Figure 2b: CPI-deflated Real Exchange Rates between Japan and the 17 Leading Importers of Consumption Goods, 1988–2009



Source: IMF International Financial Statistics and CEPII-CHELEM Database.

To control for competition in other countries, we calculate a weighted exchange rate for the countries that compete with Japan in exporting consumption goods. To do this we use the shares of exports from the other 19 leading exporters of consumption goods each year. For every year between 1988 and 2009 we calculate weights based on the percentage of consumption goods coming from the 19 other leading exporters to the world. For instance, if in 2009 the Republic of Korea provided 10% of the consumption exports from the 19 leading exporters other than Japan then the Republic of Korea would have a weight of 0.10. When trying to explain exports to Germany in 2009, the bilateral real exchange rate between the Republic of Korea and Germany in 2009 would be multiplied by 0.10 (i.e., $0.10 * rer_{Korea,Germany,2009}$). We then proceed in the same way for the other 18 leading exporters, giving us a weighted exchange rate for Germany in 2009 that can be written:

$$crer_{Germany,2009} = \sum_{i=1}^{19} w_{i,2009} * rer_{i,Germany,2009} \qquad (2)$$

In the same way, we calculate weighted exchange rates in 2009 for the other importers listed in Table 1. We then repeat the procedure for each year going back to 1988, recalculating the weights and using whatever countries were the 19 leading exporters each year.

Table 1: Major Importers of Consumption Goods from Japan, 2007

Country	Value of Consumption Goods Imports from Japan (billions of US dollars)
United States	57.0
People's Republic of China	11.7
Russian Federation	7.8
Taipei,China	6.8
Germany	6.6
Australia	6.5
Canada	5.5
Republic of Korea	5.5
United Kingdom	4.2
France	3.2
Belgium & Luxembourg	3.2
Spain	3.0
Hong Kong, China	2.9
Italy	2.5
Netherlands	2.1
Saudi Arabia	2.1
Mexico	1.9
Singapore	1.8

Source: CEPII-CHELEM database.

To calculate *crer* in this way it is necessary to measure exchange rates using a common numeraire. Since the CEPII real exchange rate can be compared both across countries and over time, it can be used for this purpose. Higher values of *crer* represent stronger exchange rates among countries competing with Japan.

To specify the econometric model a battery of panel unit root tests is first performed on the levels and first differences of the variables ex_t, rer_t $rgdp_t$, and $crer_t$.[3] The results, presented in Table 2, indicate in most cases that the variables are integrated of order 1 (I(1)).

[3] These tests include the Im, Peseran, and Shin test, the ADF Fisher Chi-square test, the Phillips-Perron Fisher Chi-square test, the Levin, Lin, and Chu test, and the Hadiri test. These tests are discussed by Barbieri (2005).

Table 2: Results of Unit Root Tests

Level, trend and intercept included	(1)	(2)	(3)	(4)	(5)
Exports deflated by BLS consumption goods deflator	4.09	0.56	19.48	2.18	3.77**
Exports deflated by BLS Japanese import price deflator	4.26	1.33	16.48	3.88	4.14**
Competitor's RER	3.14	0.46	18.01	-0.29	5.80**
Bilateral RER (CEPII)	0.22	-3.24**	18.58	-2.73**	6.26**
Bilateral RER (CPI Deflated)	-2.02**	-4.05**	22.13	-3.06**	5.95**
Real GDP	4.93	2.62	14.05	2.40	5.79**
Level, intercept included	(1)	(2)	(3)	(4)	(5)
Exports deflated by BLS consumption goods deflator		0.22	26.95	-0.48	7.10**
Exports deflated by BLS Japanese import price deflator		-0.37	23.43	-1.37	6.63**
Competitor's RER		0.33	22.34	0.20	4.53**
Bilateral RER (CEPII)		-1.92**	27.86	-2.33**	6.68**
Bilateral RER (CPI Deflated)		-4.35**	40.26	-3.59**	3.99**
Real GDP		-0.43	77.93**	-5.08**	13.29**
First difference, trend and intercept included	(1)	(2)	(3)	(4)	(5)
Exports deflated by BLS consumption goods deflator	-0.42	-4.33**	80.18**	-6.33**	5.07**
Exports deflated by BLS Japanese import price deflator	-0.42	-3.43**	63.92**	-4.78**	5.79**
Competitor's RER	-6.15**	-7.71**	154.31**	-8.06**	9.81**
Bilateral RER (CEPII)	-3.75**	-5.75**	64.19**	-1.79**	1.28
Bilateral RER (CPI Deflated)	-6.31**	-6.99**	70.87**	-3.98**	1.33
Real GDP	2.68	-1.40**	55.30**	-0.60	5.21**
First difference, intercept included	(1)	(2)	(3)	(4)	(5)
Exports deflated by BLS consumption goods deflator		-7.19**	117.42**	-7.74**	0.83
Exports deflated by BLS Japanese import price deflator		-7.01**	101.82**	-6.91**	0.22
Competitor's RER		-9.28**	183.69**	-10.62**	1.16
Bilateral RER (CEPII)		-8.53**	102.40**	-5.12**	-1.24
Bilateral RER (CPI Deflated)		-9.66**	111.94**	-7.05**	-1.60
Real GDP		-3.27**	62.68**	-1.41	2.88**

Notes:

(1) Breitung t-statistic (null hypothesis: unit root)

(2) IM, Pesaran, and Shin W-statistic (null hypothesis: unit root)

(3) PP test-Fisher Chi-square statistic (null hypothesis: unit root)

(4) Levin, Lin, and Chu t-statistic (null hypothesis: unit root)

(5) Hadiri Heteroscedastic Consistent Z-statistic (null hypothesis: stationarity)

Lag selection is based on the Schwartz Information Criterion.

** denotes significance at the 5% level.

Source: Authors' calculations.

Kao residual cointegration tests are then performed for the variables.[4] The results indicate that the null hypothesis of no cointegration can be rejected in every case (see Table 3). Panel dynamic ordinary least squares (DOLS) estimation, a technique for estimating cointegrating relations, is thus employed.

Table 3: Results of Kao residual cointegration tests

Specification	t-statistic
Japanese exports deflated by BLS consumption goods deflator and CEPII-CHELEM real exchange rate	-2.20**
Japan exports deflated by BLS consumption goods deflator and CPI-deflated real exchange rate	-2.06**
Japanese exports deflated by BLS Japanese import price index and CEPII bilateral exchange rate	-1.94**
Japanese exports deflated by BLS Japanese import price index and CPI-deflated bilateral exchange rate	-1.94**

Notes: The table contains t-statistics from Kao residual cointegration tests of the null hypothesis of no cointegration.

Lag selection is based on the Schwartz Information Criterion.

** denotes significance at the 5 % level.

Source: Authors' calculations.

DOLS involves regressing the left hand side variable on a constant, the right hand side variables, and lags and leads of the first difference of the right hand side variables. The export equations have the form:

$$\begin{aligned} ex_{j,t} &= \beta_0 + \beta_1 rer_{j,t} + \beta_2 rgdp_{j,t} + \beta_3 crer_{j,t} + \beta_4 Time \\ &+ \sum_{k=-p}^{p} \alpha_{1,k} \Delta rer_{j,t-k} + \sum_{k=-p}^{p} \alpha_{2,k} \Delta rgdp_{j,t-k} + \sum_{k=-p}^{p} \alpha_{3,k} \Delta crer_{j,t-k} \\ &+ \mu_j + u_{j,t}, \\ & t = 1, \cdots, T; \quad j = 1, \cdots, N. \end{aligned} \tag{3}$$

Here $ex_{j,t}$ represents real consumption exports from Japan to country *j*, $rer_{j,t}$ represents the bilateral real exchange rate between Japan and country *j*, $crer_{j,t}$ represents the weighted exchange rate between the 19 other leading exporters of consumption goods and country *j*, $rgdp_{j,t}$ equals real income in country *j*, $Time$ is a time trend, and μ_j is a country j fixed effect.

The data set extends from 1988 to 2009. Because we use one lead and lag in the DOLS estimation, the actual sample period for the estimation extends from 1990 to 2008.[5]

[4] This test is discussed in Kao (1999).

[5] The large drop in exports in 2009 that is evident in Figure 1 is thus not included in the sample period.

3. RESULTS

Table 4a presents the results from estimating equation (3) using the CEPII real exchange rate and Table 4b presents the results from estimating equation (3) using the CPI-deflated real exchange rate. In both cases columns (1) and (2) present the results for Japanese exports deflated using the Bureau of Labor Statistics price deflator for imports from Japan and columns (3) and (4) present the results for exports deflated using the BLS price deflator for consumption goods.

Table 4a: Panel DOLS Estimates of Japan's Consumption Exports to 17 Countries over the 1988–2009 Period

	(1)	(2)	(3)	(4)
Real GDP	0.84***	0.59***	0.78***	0.59***
	(0.07)	(0.07)	(0.07)	(0.07)
Bilateral RER (CEPII)	-1.22***	-1.04***	-1.07***	-0.93***
	(0.14)	(0.17)	(0.13)	(0.16)
Competitor's RER	0.74***	0.63***	0.61***	0.52**
	(0.23)	(0.24)	(0.22)	(0.24)
Time		0.02***		0.01**
		(0.01)		(0.00)
Adjusted R-squared	0.94	0.94	0.94	0.94
No. of observations	323	323	323	323

Notes: DOLS(1,1) estimates. Heteroskedasticity-consistent standard errors are in parentheses. The data extend from 1988 to 2009. Since the DOLS estimation uses one lead and lag of the first difference of the right-hand side variables the actual sample period is from 1990–2008.

*** (**) denotes significance at the 1% (5%) level.

Source: Authors' calculations.

Table 4b: Panel DOLS Estimates of Japan's Consumption Exports to 17 Countries over the 1988–2009 Period

	(1)	(2)	(3)	(4)
Real GDP	1.09***	0.63***	1.01***	0.62***
	(0.07)	(0.07)	(0.06)	(0.07)
Bilateral RER (CPI-deflated)	-0.86***	-0.64***	-0.71***	-0.53***
	(0.20)	(0.21)	(0.19)	(0.20)
Competitor's RER	0.09	0.06	0.01	-0.02
	(0.26)	(0.27)	(0.24)	(0.26)
Time		0.02***		0.02**
		(0.00)		(0.00)
Adjusted R-squared	0.93	0.93	0.93	0.93
No. of observations	323	323	323	323

Notes: DOLS(1,1) estimates. Heteroskedasticity-consistent standard errors are in parentheses. The data extend from 1988 to 2009. Since the DOLS estimation uses one lead and lag of the first difference of the right-hand side variables the actual sample period is from 1990–2008.

*** (**) denotes significance at the 1% (5%) level.

Source: Authors' calculations.

The first row reports the coefficient on income in the importing country. In Table 4a the coefficients range from 0.59 to 0.84. The coefficients are all statistically significant at the 1% level. In Table 4b the coefficients range from 0.62 to 1.09. The coefficients are all statistically significant at the 1% level. These values imply that a 10% increase in income in the importing country would raise Japan's exports of consumption goods by between 6 and 11%. The values are smaller when a trend term is included. This may be because, for some countries in our sample, income resembles a deterministic time trend. Thus including the two variables simultaneously affects the results.

The income elasticities reported in Table 4 are smaller than the values reported by Crane, Crowley, and Quayyum (2008) and Thorbecke and Komoto (2010). Crane, Crowley, and Quayyum report an elasticity of 1.7 and Thorbecke and Komoto report an elasticity of 1.1. One reason why the income elasticities may be smaller than previous estimates is that Table 4 includes only consumption exports and not parts and components or capital goods exports. Exports of parts and components may be more sensitive to income in the importing country. For instance, Marquez and Schindler (2007) present robust evidence that the imports of parts for assembly of the People's Republic of China (henceforth, PRC) depended on PRC's production while PRC's other imports did not. Capital goods imports may also be more sensitive to business cycle conditions than consumption goods imports.

On the other hand, the evidence in Table 4 indicates that exchange rates exert an important effect on consumption goods exports. The second row reports the coefficient on the Japanese real exchange rate with the importing country. In Table 4a the elasticities range from -0.93 to -1.22 and in Table 4b they range from -0.53 to -0.86. The coefficients are all statistically significant at the 1% level. The values imply that a 10% appreciation of the yen would reduce consumption exports by between 5% and 12%.

The third row reports the coefficient on the weighted exchange rate among countries competing with Japan in exporting consumption goods to third markets. In Table 4a the elasticities range from 0.52 to 0.74 and are all statistically significant at the 5% level. The values imply that a 10% appreciation among countries competing with Japan in exporting consumption goods would increase Japan's exports by about 6%. However, in Table 4b these coefficients are not statistically different from zero.

Table 5a and 5b presents the results from estimating equation (3) without $crer_{j,t}$. This is the traditional way of estimating trade elasticities. The coefficients on income range from 0.59 to 1.08. The coefficients are all statistically significant at the 1% level. The coefficients on the Japanese real exchange rate range from -0.55 to -0.85. They are again all statistically significant at the 1% level. The results in Table 5 are thus similar to the results reported in Table 4.

Table 5a: Panel DOLS Estimates of Japan's Consumption Exports to 17 Countries over the 1988–2009 Period

	(1)	(2)	(3)	(4)
Real GDP	0.90***	0.59***	0.83***	0.60***
	(0.07)	(0.08)	(0.07)	(0.08)
Bilateral RER (CEPII)	-0.85***	-0.71***	-0.76***	-0.66***
	(0.12)	(0.13)	(0.11)	(0.13)
Time		0.02***		0.01***
		(0.01)		(0.00)
Adjusted R-squared	0.94	0.94	0.94	0.94
No. of observations	323	323	323	323

Notes: DOLS(1,1) estimates. Heteroskedasticity-consistent standard errors are in parentheses. The data extend from 1988 to 2009. Since the DOLS estimation uses one lead and lag of the first difference of the right-hand side variables the actual sample period is from 1990–2008.

*** (**) denotes significance at the 1% (5%) level.

Source: Authors' calculations.

Table 5b: Panel DOLS Estimates of Japan's Consumption Exports to 17 Countries over the 1988–2009 Period

	(1)	(2)	(3)	(4)
Real GDP	1.08***	0.64***	1.00***	0.63***
	(0.07)	(0.08)	(0.07)	(0.08)
Bilateral RER	-0.82***	-0.63***	-0.71***	-0.55***
(CPI-deflated)	(0.18)	(0.17)	(0.17)	(0.17)
Time		0.02***		0.02***
		(0.00)		(0.00)
Adjusted R-squared	0.93	0.93	0.93	0.93
No. of observations	323	323	323	323

Notes: DOLS(1,1) estimates. Heteroskedasticity-consistent standard errors are in parentheses. The data extend from 1988 to 2009. Since the DOLS estimation uses one lead and lag of the first difference of the right-hand side variables the actual sample period is from 1990–2008.

*** (**) denotes significance at the 1% (5%) level.

Source: Authors' calculations.

The fact that the trade elasticities remain of the right sign and statistically significant in every specification in Tables 4 and 5 indicates that the price effect is negative and the income effect positive. There is also some evidence that third-country effects are positive. The important implication of these results is that large exchange rate swings, such as occurred during the first decade of the 21st century, can significantly affect Japanese exports.

4. CONCLUSION

The Japanese real effective exchange rate depreciated 43% between the end of 2000 and the onset of the global financial crisis and then appreciated 30% over the next year and a half. Japanese firms complained that these exchange rate swings have had a devastating impact on profits, exports, and output.

Empirical evidence, on the other hand, often indicates that exchange rates may not matter much for Japanese exports. Crane, Crowley, and Quayyum (2007), for instance, report that a 10% appreciation of the Japanese reer would reduce exports by 3.4%.

One problem with these estimates, however, is that they may be biased downwards because many of Japan's exports are parts and components and capital goods that are used in the importing country to produce goods for re-export. When the exchange rate in the importing country appreciates, it exports less and thus imports fewer inputs from Japan. Thus, an appreciation in the importing country and a depreciation of the yen can be associated with a decrease in Japanese exports, even though the depreciation of the yen is not causing the decrease in exports.

To correct for this bias, we examine consumption goods exports. These goods are intended primarily for the domestic market, unlike parts and components exports that are used largely to assemble goods for re-export. We find that there is a cointegrating relationship between consumption exports, the real exchange rate, and other variables. The results indicate that long run exchange rate elasticities for the Japanese yen are approximately equal to 0.9. These results imply that, if the yen is 30% stronger, steady state consumption exports would be almost 30% less. Thus exchange rate changes exert important effects on Japan's exports.

Ogawa and Shimizu (2010) and Kawai (2010) discuss how the Japanese yen has been excessively volatile relative to fundamentals between 2004 and 2010. Because of the yen carry trade, investors borrowed in yen at low interest rates and invested in other currencies at higher interest rates. This contributed to the depreciation of the yen before the GFC. Then, as the crisis developed, capital flowed out of other countries and back to Japan. This contributed to the subsequent appreciation of the yen. These exchange rate swings in turn caused large fluctuations in Japanese exports. Policymakers should consider how this volatility can be reduced.

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