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Investigating Japan's Machinery and Equipment Exports after the Global Financial Crisis※

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Abstract

Japan exports sophisticated capital goods. Since the Global Financial Crisis (GFC) Japanese companies have offshored the production of lower-end goods and parts and components to Asian countries. Because of this, Sato and Shimizu (2015) argued that a weaker yen no longer stimulates machinery exports as much because an increase in Japanese exports increases parts and components imports from overseas Asian subsidiaries. This paper finds that, after the GFC, a weaker yen no longer increases Japanese machinery exports to Asia but continues to stimulate exports outside of Asia. It also finds that, independent of its impact on exports, a weaker yen increases stock prices for many Japanese machinery producers. Thus the weaker yen since 2020 does not help Asian firms to import vital Japanese capital goods but does increase the profitability of Japanese manufacturers and their exports to non-Asian countries.

Keywords: Japan, Capital goods, Export volumes, Pricing-to-market, Exchange rate exposure

JEL classification: F14, G10

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1. Introduction

Japan has a comparative advantage in producing machinery and capital goods. It manufactures excavators, machine tools, turbines, robots, machinery to manufacture semiconductors and textiles, and other capital goods. Japan has traditionally played an important role in exporting these goods to downstream Asian countries. Kwan (2004) noted that, if Asian firms are unable to obtain capital goods from Japan, they are frequently unable to obtain them at all.

Japan's machinery exports are sophisticated. Hidalgo & Hausmann (2009) developed a method to measure the sophistication of products. They observed that complex goods require advanced capabilities. These products are more likely to be made by countries with diverse export baskets. They defined an economy's complexity based on its ability to export varied and advanced products. They defined a product's sophistication based on its non-ubiquity. Iterating between measures of an economy's complexity and a product's ubiquity, they calculated product complexity indices (PCIs) for more than 1,200 products. Higher PCI values indicate more advanced products.

These PCIs can be used to gauge the complexity of Japan's machinery exports in comparison to the other three leading machinery exporters, the U.S., China, and Germany. Taking a weighted average of Japan's top ten machinery exports in 2021, the average machinery PCI in 2021 equaled 1.53. The values for the U.S., China, and Germany were, respectively, 1.27, 1.02, and 1.10. Thus Japan's machinery exports are advanced relative to comparable countries.

Are these sophisticated exports sensitive to exchange rates? This question is relevant as the Japanese real effective exchange rate in 2024 is close to its lowest level in 50 years. Abiad et al. (2018) argued that more complex goods are harder to produce and thus have fewer substitutes. Because of this, they noted that the price elasticity of demand should be lower for more complex products and thus that exports of these goods should be less sensitive to exchange rates.

Baek (2013) employed an autoregressive distributed lag (ARDL) model and quarterly data over the 1991-2010 period to investigate Japan's machinery and transport equipment and other exports to South Korea. The ARDL coefficient indicates that real exchange rates do not impact Japan's exports to Korea in the long run. He explained this finding by noting that, since Korea relies on machinery from Japan, demand does not respond to exchange rate-driven price changes. Walter et al. (2012) used an ARDL model and quarterly data over the 1989 to 2011 period to investigate Japan's exports of machinery and transportation and other goods to the U.S. They also found that real exchange rates do not impact Japan's machinery and transportation exports to the U.S.

Sato et al. (2013) examined how industry-specific real exchange rates affect Japanese exports of three electrical machinery industries (office machinery, electrical apparatuses, communication equipment) and of transportation equipment. They employed a monthly vector autoregression (VAR) over the 2001-2013 period and Japan's exports to the world. They reported impulse-response functions indicating that a positive exchange rate shock (yen appreciation) produced long-lasting declines in exports for each category.

Chinn (2013) investigated Japan's exports to the world over the 1990 to 2012 period. He used quarterly data and Johansen maximum likelihood techniques. He reported that exchange rate elasticities that were correctly signed and varied between 0.4 and 0.7.

Thorbecke (2015) examined Japanese capital and equipment goods exports to 15 countries over the 1982-2009 period. He employed panel dynamic ordinary least squares techniques and annual day. Using several specifications, he found that a 10 percent real appreciation of the yen decreases exports by about 5 percent.

Sasaki et al. (2022) observed that when the yen appreciated during the 2008-2009 Global Financial Crisis (GFC), Japanese multinational corporations relocated manufacturing overseas. This helped to offset the loss of price competitiveness from the strong yen, Then, as the yen began depreciating in 2012, Japanese firms did not reshore production but continued to produce abroad.

Sato and Shimizu (2015) noted that Japanese firms responded to the strong yen during the GFC by expanding the production of low-end products abroad and producing high end products domestically. They employed Kalman filter methods to investigate exchange rate pass through to major machinery industries. Using monthly data from 1980 to 2014, they found that when the yen was strong between 2009 and 2012 the degree of pass-through increased. They also reported that as the yen weakened after 2012, firms chose to price to market rather than to pass through depreciations into foreign prices. Keeping foreign currency prices stable as the yen depreciated reduced the stimulative impact of the depreciation on export volumes.

Sato and Shimizu (2015) also examined the relationship between the yen real effective exchange rate, industrial production in Japan and its trading partners, and the Japanese trade balance. Using an ARDL model and monthly data they found evidence of a J-curve effect over the 1985-1998 period but not over the 1999-2014 period. They noted that for several decades Japan had been increasing overseas production. Their production networks were centered in Asian countries. As the yen appreciated during the GFC, they accelerated the division of labor by relocating more production to Asia. Because of this, Sato and Shimizu argued that a weaker yen no longer stimulates machinery exports as much because an increase in exports increases imports of parts and components from overseas subsidiaries in Asia.

If production of parts and components has been relocated to Asian countries, then the yen exchange rate would have less of an impact on Japanese exports to these countries. A depreciation of the yen against the currency of an Asian country providing parts and components to Japan would increase the yen costs of these imported inputs. This increase in costs would mitigate the increase in price competitiveness arising from the impact of a weaker yen on Japanese value-added exported back to this country. Thus if Japan has offshored more production to Asian countries after the GFC, a yen depreciation against an Asian country's currency would have less of a stimulative effect on exports to that country after 2009.

This paper investigates whether the influence of exchange rates on Japan's machinery exports has declined since the GFC. It also investigates whether the exchange rate mattered less for exports to Asian countries after the 2008-2009 GFC. To do this, it extends the model of Thorbecke (2015) to include the 2010-2020 period. The results indicate that, for the lion's share of machinery exports, exchange rates no longer matter for Japan's exports to Asian countries but do matter for Japan's exports to non-Asian countries. The weak yen after the COVID-19 pandemic thus will not help companies in Asian countries purchase vital capital goods from Japan but will benefit companies in other regions.

This study also examines how exchange rates impact machinery stock returns. Since finance theory indicates that stock prices equal the expected present value of future cash flows, the effect of exchange rates on stock returns can shed light on how exchange rates impact profitability. Ito et al. (2016) investigated how exchange rates impact Japanese machinery stocks. Employing monthly data between 2005-2009, they found that appreciations of both the yen relative to the dollar and of the yen nominal effective exchange rate reduce returns on Japanese machinery stocks. Results reported below indicate that yen appreciations continue to reduce machinery stock prices after the GFC.

The next section discusses the data and methodology. Section 3 presents the results. Section 4 concludes.

2. Data and Methodology

The first step is to investigate the degree of exchange rate pass through in the Japanese machinery sector. If manufacturers pass through exchange rate changes into export prices, then the quantity demanded in importing countries is more likely to respond. If on the other hand they price to market, exchange rate changes are less likely to impact export volumes.

Campa and Goldberg (2005) examined the theoretical foundations of export pricing. They found that export prices depend on demand conditions in importing countries and on exporters' costs. In their framework export prices equal the product of firms' marginal costs and their markups. Marginal costs depend on demand in importing countries and on input costs. The markup depends on macroeconomic factors such as exchange rates and industry-specific factors.

Nguyen and Sato (2019) estimated pricing to market models for Japan where yen-based export prices are a function of the exchange rate, the input price, and world industrial production. They employed ARDL and nonlinear ARDL (NARDL) models to estimate export pricing behavior.

This paper also uses ARDL and NARDL estimation. It seeks to explain yen-based export prices based on the yen/dollar nominal exchange rate, the industry-specific producer price index to proxy for costs, and industrial production in OECD countries to proxy for the state of world demand. In the ARDL specification, the first difference of the dependent variable is regressed on lagged levels and lagged first differences of the dependent and independent variables (see Pesaran and Shin, 1999). The ARDL equation takes the form:

$$\Delta lnEP_{i,t} = \beta_0 + \beta_1 \, lnEP_{t-1} + \beta_2 \, lnYen_{t-1} + \beta_3 lnPPI_{i,t-1} + B_4 lnIP_{t-1} + \sum_{i=1}^{k} \gamma_{1i} \, \Delta lnEP_{t-i} + \sum_{i=0}^{m} \gamma_{2i} \Delta lnYen_{t-i} + \sum_{i=0}^{n} \Delta lnPPI_{t-i} + + \sum_{i=0}^{n} \Delta lnIP_{t-i} + u_{i,t} \quad (1)$$

where $EP_{i,t}$ represents yen export prices in industry i, Yen_{t-1} is the yen/dollar nominal exchange rate, $PPI_{i,t-1}$,is the producer price index for industry i, and IP_{t-1} represents industrial production in OECD countries. The long run pricing to market coefficient is then given by β_2/β_1. The Schwartz information criterion can be used to determine the number of lags.

In the NARDL specification, the first difference of the dependent variable is regressed on partial sums of exchange rate changes for appreciation and depreciation periods and lagged levels and lagged first differences of the dependent and other independent variables (see Shin et al., 2014). The NARDL equation takes the form:

$$\Delta lnEP_{i,t} = \beta_0 + \beta_1 \, lnEP_{i,t-1} + \beta_2 lnYen^{+}{}_{t-1} + \beta_3 lnYen^{-}{}_{t-1} + B_4 lnPPI_{i,t-1} + B_4 lnIP_{t-1} + \sum_{i=1}^{k} \gamma_{1i} \, \Delta lnEP_{t-i} + \sum_{i=0}^{m} (\gamma^{+}{}_{2i} \Delta lnYen^{+}{}_{t-1} + \gamma^{-}{}_{2i} \Delta lnYen^{-}{}_{t-1}) + \sum_{i=0}^{n} \Delta lnPPI_{t-i} + + \sum_{i=0}^{n} \Delta lnIP_{t-i} + v_t \quad (2)$$

where $lnYen^{+}$ is the partial sum of exchange rate changes during periods when the yen/dollar exchange rate increases and $lnYen^{-}$ is the partial sum during periods when the yen/dollar exchange rate decreases. To calculate $lnYen^{+}_{t-1}$, the change in the exchange rate is summed for all months up to t-1 when the yen/dollar rate increased. To calculate $\ln Yen^{-}_{t-1}$, the change in the exchange rate is summed for all months up to t-1 when the yen/dollar rate decreased. The long run pricing to market coefficient when the yen/dollar rate was increasing is given by β_2/β_1 and the long run pricing to market coefficient when the yen/dollar rate was decreasing is given by β_3/β_1. The null hypothesis that the pricing to market coefficient is symmetric between appreciation and depreciation periods can be tested by using Wald tests of the null hypothesis that $\beta_2/\beta_1 = \beta_3/\beta_1$.

Data on yen export prices for general purpose, production, and business-oriented machinery are obtained from the Bank of Japan website. Data on tne yen/dollar exchange rate are obtained from the Federal Reserve Bank of St. Louis FRED website. Producer price indices for general purpose, production, and business-oriented machinery are obtained from the Bank of Japan website. Industrial production indices for OECD countries are obtained from the OECD website. The sample period extends from January 2000 to October 2023. To investigate whether pricing behavior changed after the GFC, one model is estimated over the January 2010 to October 2023 period.

To estimate export elasticities, Thorbecke's (2015) model is extended using recent data. Employing the imperfect substitutes model, he examined Japanese machinery exports to 15 countries over the 1982-2009 period. The imperfect substitutes model posits that exports depend on the real exchange rate and on GDP in the importing countries. The same 15 countries are employed here and the sample period is extended to 2020.[1]

Annual data on Japanese machinery and equipment exports are measured in U.S. dollars and obtained from the CEPII-CHELEM database. These are deflated using the U.S. Bureau of

[1] These countries are Australia, Canada, China, France, Germany, Hong Kong, Indonesia, Malaysia, the Netherlands, Singapore, South Korea, Taiwan, Thailand, the United Kingdom, and the United States.

Labor Statistics deflator for Japanese exports. The results reported below are almost identical when Japanese exports are deflated using the Bank of Japan's export price index for machinery exports converted to U.S. dollars using the yen/dollar exchange rate. Data on bilateral real exchange rates between Japan and the importing countries and on real GDP in the importing countries are also obtained from the CEPII-CHELEM database.

A battery of panel unit root tests indicates that machinery and equipment exports and real exchange rates are stationary. They also indicate that real GDP has a unit root. The model is thus estimated using panel ordinary least squares with exports and real exchange rates included in levels and with real GDP included in first differences. Period and cross-sectional fixed effects are included.

The CEPII-CHELEM database also disaggregates machinery and equipment exports into 12 categories. These are aeronautics, agricultural equipment, commercial vehicles, computer equipment, construction equipment, electrical apparatuses, electrical equipment, machine tools, precision instruments, ships, specialized machines, and telecommunications equipment. Exchange rate elasticities are also estimated for each of these subcategories.

To estimate the exposure of Japanese machinery stock returns to exchange rates, the returns on several categories of machinery stocks are regressed on the yen/dollar nominal exchange rate and on several control variables. The estimated equations take the form:

$$\Delta R_{i,t} = \alpha_0 + \alpha_1 \Delta R_{m,Japan,t} + \alpha_2 \Delta R_{m,World,t} + \alpha_3 \Delta\left(\frac{yen}{dollar}\right)_t + \alpha_4 \Delta Dubai_t, \qquad (3)$$

where $\Delta R_{i,t}$ is the monthly stock return for Japanese machinery sector *i*, $\Delta R_{m,Japan,t}$ is the change in the log of the price index for Japan's aggregate stock market, $\Delta R_{m,World,t}$ is the change in the log of the price index for the world stock market, $\Delta(\text{yen/dollar})_t$ is the change in the log of the nominal yen per dollar exchange rate, and $\Delta Dubai_t$ is the change in the log of the spot price for Dubai crude oil.

Equation (3) is estimated using daily data over the 1 January 2000 to 31 December 2010 and 1 January 2010 to 31 December 2020 sample periods. The data to estimate equation (3) come from the Datastream database.

3. Results

The results of estimating equation (1) over the January 2000 to October 2023 period indicate that the pricing-to-market coefficient equals 0.505 with a probability value of 0.029. This indicates that exporters pass through half of exchange rate changes to foreign prices. Results over the January 2000 to December 2010 period indicate that the pricing-to-market coefficient equals 0.389 with a probability value of 0.0000. Results over the January 2010 to October 2023 period indicate the pricing-to-market coefficient equals 0.496 with a probability value of 0.0001.[2] Results of estimating equation (2) also indicate that Wald tests do not permit rejection of the null hypothesis that pricing-to-market coefficients are the same in appreciation and depreciation periods. The finding that half of exchange rate changes are passed through to foreign prices indicates that exchange rate changes may also impact export volumes.

Table 1 presents the results of estimating exchange rate elasticities for all machinery exports and for the 12 subcategories. Column (2) lists the share of each subcomponent in total machinery exports in 2020. Column (3) presents the results for the entire 1990-2020 sample period. The exchange rate matters for Japanese machinery exports. A 10% yen appreciation reduces exports by 7.6%. For the individual subcategories, nine of the 12 categories exhibit

[2] Results over the January 2010 to December 2020 period yielded very similar results. The pricing-to-market coefficient equaled 0.512 with a probability value of 0.0002.

statistically significant export declines in response to yen appreciations. Only the exchange rate coefficient on ship exports is incorrectly signed.

Results for the 1990-2000 subsample in column (4) and the 2000-2010 subsample in column (5) also indicate that appreciations reduce exports. For total machinery exports, a 10% appreciation reduces exports by about 6%. Many of the individual subcategories also exhibit decreases in exports in response to appreciations.

The results for the 2010-2020 subsample in column (6) no longer present strong evidence that appreciations reduce machinery exports. The exchange rate coefficient for total machinery exports is small and not statistically significant. For most of the large subcategories exchange rate depreciations no longer increase exports.

Table 2 presents exchange rate elasticities separately for Asian and non-Asian countries. Focusing on the 2010-2020 period, column (8) reports elasticities for Asian countries and column (9) for non-Asian countries. Column (8) for Asian countries continues to indicate that exchange rate depreciations do not stimulate exports for most categories. The coefficient for total machinery exports is small and statistically insignificant. Coefficients for six of the 12 subcategories are positive (incorrectly signed), with the coefficient on electrical apparatuses being positive and having a probability value of 0.055 and the coefficient on machine tools being positive and having a probability value of 0.035.

Column (9) for non-Asian countries, on the other hand, indicates that depreciations stimulate machinery exports. For total machinery exports, a 10% depreciation increases exports to non-Asian countries by almost 6%. There is also a statistically significant relationship between exchange rate depreciations and increased exports for five of the 12 subcategories. The results in columns (8) and (9) are consistent with Sato and Shimizu (2015) hypothesis that the relocation of production to Asian countries has weakened the link between exchange rate depreciations and Japanese machinery exports to Asia

Table 3 presents the coefficients on the yen/dollar exchange rate from estimating equation (3). A depreciation benefits agricultural machinery stocks in both the first period (1 January 2000 to 31 December 2010) and in the second period (1 January 2010 to 31 December 2020). The effect is larger in the first period, even though Table 1 indicates that depreciations barely matter for agricultural equipment exports in the first period but stimulate these exports in the second period. A depreciation also benefits automobile stocks, used as a proxy for commercial vehicle stocks, in both periods.[3]

The coefficients on construction machinery are about the same in both periods. In the first period it is significant at the 5% level and in the second period at the 10% level. In both cases the results indicate that depreciations are associated with higher stock returns.

The coefficient on electronic instruments (gauges) is significant in the first period but not in the second period. The results indicate that in the first but not in the second period a depreciation raises stock returns. The lack of significance in the second period occurs despite the fact that Table 1 indicates that depreciations raise exports of precision instruments in the second period.

For machine tools, there is no evidence of exchange rate exposure in the first period but depreciations cause higher stock prices in the second period. This happens despite the finding in Table 1 that exchange rates stimulate exports in the first period but not in the second period. Office equipment stocks benefit from depreciations in both periods and specialized machinery stocks only benefit from depreciations in the first period.

[3] Many of the companies producing commercial vehicles are the same ones that produce automobiles.

The implication of the results in Table 3 is that many types of Japanese machinery stocks benefit from depreciations in both periods. In many cases, sectors where depreciations do not increase exports in a period still have stocks that benefit from depreciations. Thus exchange rates do not impact machinery stocks only by impacting export volumes but also by affecting profit margins.

4. Conclusion

Japan plays a vital role in global supply chains, exporting sophisticated capital goods to Asia and the rest of the world. The Japanese yen also began depreciating at the end of 2020 and in 2024 is close to its weakest level in 50 years. This paper investigates how the yen exchange rate impacts Japan's machinery exports.

Sato and Shimizu (2015) observed that as the yen appreciated during the GFC, Japanese firms relocated production to Asia. If production of parts and components has been relocated to Asian countries, then the yen exchange rate would have less of an impact on Japanese exports to these countries.

This paper finds that, after the GFC, the yen exchange rate does not impact Japan's machinery exports to Asian countries but does impact these exports to non-Asian countries. It also finds that, independent of its impact on exports, a weaker yen after the GFC increases stock prices for many types of Japanese machinery companies.

The weak yen since 2020 thus may not benefit companies in Asian countries that depend on Japanese capital goods.[4] It will benefit many Japanese machinery companies, however, by

[4] In discussion of exchange rate coordination in Asia, some have emphasized the beneficial impact that this will have on trade in the region (see, e.g., Yoshitomi, 2007). The results in this paper suggest that estimates of exchange rate elasticities should be updated before concluding that exchange rate stability will facilitate trade in the region.

increasing their profitability and by increasing their exports to non-Asian countries. It will also benefit firms outside of Asia by allowing them to purchase more Japanese capital goods. Thus the notion that a weak yen is harmful for firms in other countries should be tempered by the recognition that it also allows them to purchase more vital inputs from Japan.

Ito at al. (2023) found that Japan has moved upstream in global value chains. This involves exporting not only capital goods to firms in downstream countries but also exporting parts and components. This paper has investigated the changing impact of exchange rates on Japanese capital goods exports. Future research should investigate how exchange rates impact Japanese exports of parts and components and other intermediate inputs. Future research should also investigate whether the knowledge spillovers from Japanese exports to downstream firms outside of Asia is comparable to the knowledge diffusion from exporting to Asian firms.

Table 1. Panel Ordinary Least Squares Estimates of Exchange Rate Elasticities for Japan's Machinery Exports to 15 Countries.

Export Category	Share of Machinery Exports in 2020	Sample Period			
		1990-2020	1990-2000	2000-2010	2010-2020
(1)	(2)	(3)	(4)	(5)	(6)
Machinery (All)	1.00	-0.764***	-0.577***	-0.601***	-0.274
		(0.115)	(0.176)	(0.120)	(0.171)
Electrical apparatuses	0.227	-0.660***	-0.665***	-0.215	0.354
		(0.146)	(0.191)	(0.174)	(0.279)
Specialized machines	0.206	-0.455**	-0.745***	-0.283	0.387
		(0.207)	(0.214)	(0.213)	(0.460)
Precision instruments	0.142	-1.427***	-0.930***	-1.268***	-1.057***
		(0.170)	(0.155)	(0.217)	(0.396)
Construction equipment	0.075	-1.400***	-1.204***	-1.929***	-0.465
		(0.139)	(0.363)	(0.339)	(0.432)
Computer equipment	0.059	-1.871***	0.361	-1.541***	0.441
		(0.173)	(0.336)	(0.258)	(0.535)
Ships	0.052	0.955**	-1.220	1.120	1.878
		(0.400)	(1.045)	(0.790)	(1.567)
Machine tools	0.052	-0.965***	-0.689***	-0.836***	1.717*
		(0.180)	(0.257)	(0.232)	(0.906)
Electrical equipment	0.050	-0.429***	0.070	-0.531**	-0.958**
		(0.148)	(0.413)	(0.219)	(0.440)
Commercial vehicles	0.049	-0.904***	-2.286***	-0.966**	0.522
		(0.251)	(0.608)	(0.396)	(0.756)
Telecommunications equipment	0.045	-0.329	0.896	0.698	-1.921***
		(0.311)	(0.807)	(0.574)	(0.422)
Aeronautics	0.032	-0.205	-0.900	0.162	-2.026***
		(0.341)	(0.644)	(0.597)	(0.739)
Agricultural equipment	0.010	-1.01***	-1.261***	-0.377	-1.170**
		(0.191)	(0.473)	(0.292)	(0.564)

Notes: The table presents estimates of exchange rate elasticities from a panel ordinary least squares model of Japan's exports to 15 countries. Exports are measured in U.S. dollars and deflated using price deflators for Japanese exports obtained from the U.S. Bureau of Labor Statistics. The explanatory variables include the bilateral CPI-deflated real exchange rate between Japan and each of the importing countries and real GDP in the importing countries. The 15 importing countries are: Australia, Canada, China, France, Germany, Hong Kong, Indonesia, Malaysia, the Netherlands, Singapore, South Korea, Taiwan, Thailand, the UK, and the U.S. Country and year fixed effects are included in the estimation. White standard errors are reported in parentheses.
*** (**) [*] denotes significance at the 1% (5%) [10%] level.

Table 2. Panel Ordinary Least Squares Estimates of Exchange Rate Elasticities for Japan's Machinery Exports to 15 Countries.

Export Category	Sample Period: 1990-2020		1990-2000		2000-2010		2010-2020	
	Exports to: Asian Countries	Non-Asian Countries	Asian Countries	Non-Asian Countries	Asian Countries	Non-Asian Countries	Asian Countries	Non-Asian Countries
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Machinery (All)	-0.953***	-0.295***	-0.350	-0.860***	-0.792***	-0.410***	-0.201	-0.583***
	(0.117)	(0.097)	(0.024)	(0.177)	(0.144)	(0.134)	(0.171)	(0.187)
Electrical apparatuses	-0.887***	-0.095	-0.388	-0.101***	-0.527***	0.098	0.515*	-0.329
	(0.149)	(0.117)	(0.244)	(0.211)	(0.201)	(0.190)	(0.266)	(0.263)
Specialized machines	-0.633***	-0.009	-0.630**	-0.889***	0.402	-0.164	0.478	0.085
	(0.204)	(0.208)	(0.293)	(0.290)	(0.360)	(0.269)	(0.502)	(0.355)
Precision instruments	-1.627***	-0.930***	-0.750***	-1.154***	-1.534***	-1.000***	-1.113***	-0.770**
	(0.167)	(0.103)	(0.190)	(0.203)	(0.258)	(0.196)	(0.422)	(0.370)
Construction equipment	-1.166***	-1.971***	-1.526***	-0.803**	-2.160***	-1.699***	-0.158	-1.774***
	(0.141)	(0.159)	(0.508)	(0.372)	(0.371)	(0.339)	(0.437)	(0.420)
Computer equipment	-2.273***	-0.822***	0.798	-0.188	-1.619***	-1.463***	0.343	0.764
	(0.186)	(0.179)	(0.405)	(0.344)	(0.310)	(0.269)	(0.593)	(0.459)
Ships	0.338	2.495***	-1.702	-0.613	-0.010	2.252**	1.589	3.123
	(0.440)	(0.538)	(1.214)	(1.425)	(0.726)	1.100	(1.528)	(2.395)
Machine Tools	-1.059***	-0.733***	-0.477	-0.954***	-1.049***	-0.622***	2.050**	0.726
	(0.186)	(0.222)	(0.377)	(0.262)	(0.262)	(0.265)	(0.961)	(0.827)
Electrical equipment	-0.392**	-0.527***	0.496	-0.461	-0.745***	-0.348	-0.822*	-1.316**
	0.159	(0.194)	(0.479)	(0.417)	(0.238)	(0.238)	(0.450)	(0.506)
Commercial Vehicles	-1.087***	-0.450*	-2.256***	-2.323***	-1.374***	-0.557	0.943	-1.266
	(0.285)	(0.262)	(0.777)	(0.684)	(0.430)	(0.414)	(0.756)	(0.992)
Telecomm-unications equipment	-0.442	-0.047	1.808*	-0.241	1.083	0.313	-2.132***	-1.024**
	(0.314)	(0.338)	(0.992)	(0.684)	(0.609)	(0.577)	(0.443)	(0.394)
Aeronautics	-0.437	0.373	-0.763	-1.070	0.320	0.004	-2.196***	-1.301
	(0.358)	(0.403)	(0.801)	(0.852)	(0.800)	(0.393)	(0.732)	(0.971)
Agricultural equipment	-0.965***	-1.128***	-1.633**	-0.798*	-0.827*	0.075	-1.117*	-1.395**
	(0.223)	(0.209)	(0.642)	(0.472)	(0.432)	(0.302)	(0.595)	(0.597)

Notes: The table presents estimates of exchange rate elasticities from a panel ordinary least squares model of Japan's exports to 15 countries. Exports are measured in U.S. dollars and deflated using price deflators for Japanese exports obtained from the U.S. Bureau of Labor Statistics. The explanatory variables include the bilateral CPI-deflated real exchange rate between Japan and each of the importing countries and real GDP in the importing countries. Asian countries include China, Hong Kong, Indonesia, Malaysia, Singapore, South Korea, Taiwan, and Thailand. Non-

Asian countries include Australia, Canada, France, Germany, the Netherlands, the UK, and the U.S. Country and year fixed effects are included in the estimation. White standard errors are reported in parentheses.
*** (**) [*] denotes significance at the 1% (5%) [10%] level.

Table 3. The Exposure of Machinery Sectors to the Yen/dollar Exchange Rate.

	Sample Period			
	1 January 2000 to December 31 2010		1 January 2010 to December 31 2020	
Sector	Beta to the Yen/dollar Exchange Rate	Standard Error	Beta to the Yen/dollar Exchange Rate	Standard Error
(1)	(2)	(3)	(4)	(5)
Agricultural Machinery	0.221***	0.074	0.150**	0.064
Automobiles	0.420***	0.042	0.307***	0.035
Construction Machinery	0.115**	0.048	0.101*	0.061
Electronic Instruments (Gauges)	0.151***	0.028	0.020	0.044
Machine Tools	0.089	0.055	0.124**	0.058
Office Equipment	0.362***	0.048	0.191***	0.048
Specialized Machinery	0.132**	0.049	0.025	0.039

Notes: The table presents exchange rate coefficients from regressions of stock market returns for the Japanese machinery sectors listed in column (1) on the return on the world stock market, the change in the log of the spot price for Dubai crude oil, the return on the Japanese aggregate stock market, and the change in the log of the Japanese yen/U.S. dollar nominal exchange rate (columns (2) and (4)). Heteroscedasticity and autocorrelation consistent standard errors are reported in columns (3) and (5). An increase in the yen/dollar exchange rate represents a depreciations of the yen. The sample period in columns (2) and (3) extend from 1 January 2000 to 31 December 2010. The sample period in columns (4) and (5) extend from 1 January 2010 to 31 December 2019. There are 2609 observations for the results in columns (2) and (3) and 2608 observations for the results in columns (4) and (5). When return data are not available on 1 January 2001, the sample begins on the first date when return data become available.
*** (**) [*] denotes significance at the 1% (5%) [10%] level.

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