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THORBECKE, Willem
RIETI

Research Institute of Economy, Trade & Industry, IAA
The Research Institute of Economy, Trade and Industry
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Weathering Safe Haven Capital Flows: Evidence from the Japanese transportation equipment industry[1]

Willem Thorbecke
RIETI

Abstract

When risk aversion increases, countries with safe haven currencies such as Japan and Switzerland can experience large appreciations. These appreciations may squeeze profit margins and lower export volumes. This paper investigates whether firms in these countries can weather appreciation periods by producing differentiated rather than commoditized products. To do this, it investigates different sectors within the Japanese transportation equipment industry. Results from estimating pricing-to-market (PTM) coefficients indicate that firms producing differentiated products can pass-through more of exchange rate appreciations into higher foreign currency prices and thus better preserve their profit margins. Results from estimating trade elasticities are consistent with the PTM results and indicate that the automobile industry has exported much less than predicted after the yen depreciated in 2012. Finally, estimates of the stock market exposure across sectors indicates that the profitability of firms producing differentiated products are less exposed to appreciations. Producing differentiated, knowledge-intensive goods can thus help firms survive risk-off periods.

Keywords: Differentiated products · Exchange rate pass-through · Exchange rate elasticities ·Safe haven capital flows

JEL classification: F14 · F17 · C22

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1. Introduction

When risk aversion increases, investors channel capital to safe haven currencies such as the Swiss franc and the Japanese yen. During the Global Financial Crisis (GFC) and the Eurozone Crisis, capital inflows caused the Swiss franc to appreciate by 30 percent between the third quarter of 2007 and the third quarter of 2011 and the Japanese yen to appreciate by more than 20 percent. These appreciations can squeeze profit margins if exporters must lower local currency export prices to remain competitive. They may also reduce the volume of exports. How can firms in countries with safe haven currencies weather large appreciations? How are they affected when exchange rates subsequently depreciate as risk aversion falls?

Producing differentiated products may help. Producers of commoditized products can face intense price competition, forcing firms to slash domestic currency export prices and compress profit margins when the exchange rate appreciates. Producers of differentiated products may not only be able to reduce domestic currency prices less during appreciations, they may be able to raise these prices more (price-to-market more) when the exchange rate depreciates (see Chen and Juvenal, 2016).

Ito, Koibuchi, Sato, and Shimizu (2018) highlighted a way to measure how differentiated a product is. They showed that, unlike for homogeneous goods, firms exporting differentiated products and firms having a large share of the global market tend to invoice in the exporter's currency. The Japanese Ministry of Finance provides detailed data on the invoice currencies of Japanese exports disaggregated by industry.

Examining the Japanese transportation equipment industry sheds light on this measure. At one extreme is passenger cars, with only 8 percent of exports over the 2000-2015 period invoiced in yen. Nguyen and Sato (2019) noted that cars have become commoditized. At the other extreme is bicycle parts, with 91 percent of exports invoiced in yen. Lewis and Morizono (2016) observed that Japan's Shimano Corporation produces 75 percent of the world's supply of bicycle brakes and gears.

Figures 1a shows the relationship between yen export prices and yen costs for Japanese passenger cars and Figure 1b shows this relationship for Japanese bicycle parts. Figure 1a shows that yen prices for cars fell logarithmically by 40 percent relative to yen costs (represented by the producer price index for passenger cars) after the yen began appreciating in June 2007. Figure 1b on the other hand shows that there was little change in yen export prices for bicycle parts relative to yen costs (represented by the producer price index for bicycle parts) during the yen appreciation period from June 2007 to September 2012.

The fact that yen export prices fell so much relative to yen costs for the automobile industry but not for the bicycle parts industry suggests that the profitability of the automobile industry suffered more during the strong yen period from June 2007 to September 2012 than the bicycle parts industry did. Stock prices provide one indicator of profitability, since they equal the expected present value of future cash flows. Figure 2 plots stock prices for the Japanese automobile sector and for Shimano Corporation. It shows that stock prices for automobile producers fell almost 90 percent during the strong yen period and only began recovering in September 2012 as the yen depreciated. On the other hand, stock prices for Shimano increased almost 30 percent during the *endaka* period.

This paper investigates whether Japanese transportation industry exports that are invoiced in yen – where yen invoicing is used to indicate whether the product is more differentiated or commands a larger share of the global market – are less exposed to exchange rate changes.

Focusing on the transportation industry rather than on all industries reduces variation across other dimensions that might affect pricing such as the skills and knowhow required to produce a certain good.[2] The paper examines whether long run exchange rate pass-through is larger (and long run pricing-to-market, PTM, smaller) for goods that are invoiced in yen. The results indicate that, the more firms invoice a product in yen, the more they pass-through exchange rate appreciations into foreign prices. This suggests that firms producing differentiated products or firms possessing more of the market are better able to maintain profit margins in the face of yen appreciations.

The paper then examines export elasticities for the transportation industry. Sectors such as auto parts and motorcycles that pass-through large shares of yen appreciations also have low exchange rate elasticities. The finding that exports in these sectors are not sensitive to exchange rates implies that firms producing these goods have more freedom to raise foreign currency prices when the exchange rate appreciates.

Finally the paper investigates the exposure of Japanese stocks in the transportation industry to exchange rates. Stock prices are the expected present value of future cash flows, so they should reflect profitability. The results indicate that the firms that pass-through more of their exchange rate changes to export prices such as makers of commercial vehicles, trucks, and bicycle parts are also less exposed to exchange rate changes than firms that price-to-market.

Nguyen and Sato (2019) employed a nonlinear autoregressive distributed lag model to investigate the PTM behavior of Japanese exporters. They specified yen appreciation and yen depreciation periods using predicted exchange rates from the Bank of Japan (BoJ) Tankan survey. They reported almost complete PTM behavior in the short run over the 1997-2018

[2] Hausmann, Hidalgo, Bustos, Coscia, Simoes, and Yildirim (2014) found that similar skills are required to produce goods in the same industry.

period. In addition, they found high but incomplete PTM in the long run for most industries during yen appreciation periods. They also found high PTM in the long run for competitive industries such as general machinery and transport equipment and lower PTM for less competitive industries such as textiles and chemicals during yen appreciation periods.

Ito, Koibuchi, Sato, and Shimizu (2016) investigated the exchange rate exposure of Japanese firms and the relationship between exposure and exchange rate risk management practices. They regressed monthly stock returns for 227 companies over the January 2005 to December 2009 period on the percentage change in the yen/dollar exchange rate and the nominal effective exchange rate. In one specification they also included the return on the overall Japanese stock market portfolio as a second independent variable. They found that firms producing transportation equipment, precision instruments, electrical machinery, and general machinery are highly exposed to exchange rate appreciations, indicating that these firms face intense competition from abroad. They also reported that firms with a higher ratio of foreign sales and firms with less yen invoicing are more exposed to appreciations. They did not find a statistically significant relationship between a firm's exchange rate exposure and its degree of exchange rate pass-through.

Iwaisako and Nakata (2017) used monthly vector autoregressions (VARs) over the January 1977 to September 2014 period to investigate how exchange rates, demand in the rest of the world, and other factors affect Japanese aggregate export. They included the real effective exchange rate, the growth of aggregate exports, two measures of global demand, crude oil prices, and world oil production growth in the VARs. They reported evidence from impulse response functions indicating that a yen appreciation reduces exports. They also reported evidence from variance decompositions indicating that exchange rate shocks explain less of the variance of export growth after 2000. They found that falls in global demand mattered much more than appreciating exchange rates for explaining decreases in exports following the 2008 Lehmann Brothers Crisis. Iwaisako and Nakata (2015) reported that even though the yen had less of an impact on export volumes after 2000, they substantially impacted the profitability of Japanese firms.

Shioji and Uchino (2012) investigated how external shocks affect the Japanese automobile industry. They estimated a monthly vector autoregression (VAR) over the 1980 to 2008 period. Their VAR included oil prices, the Japanese nominal effective exchange rate, measures of demand in the U.S. and the EU, real Japanese automobile exports, Japanese auto production, and industrial production. They assumed a recursive ordering to the variables and employed a Cholesky decomposition. They reported that over time positive shocks to U.S. demand increase Japanese automobile exports and positive exchange rate shocks (yen appreciations) reduce automobile exports. They also found that their model could not explain the huge fall in automobile exports during the GFC. They thus estimated another model using panel data on automobile production, sales, and inventories that are available by company and type of car. They reported a non-linear response, with Japanese automakers cutting production more quickly in response to accumulated inventories when output is falling rapidly than when output is falling slowly or rising.

Sato, Shimizu, Shrestha and Zhang (2013) examined how Japanese transport equipment exports responded to rest of the world output and to real exchange rates. They measured rest of the world output as a weighted average of trading partners' industrial production indices and exchange rates as industry-specific real effective exchange rates for the transport equipment industry. They employed a monthly VAR over the 2001 to 2013 period and assumed that industrial production in the rest of the world is strictly exogenous and that the exchange rate is not contemporaneously affected by shocks to exports. They reported that a positive shock to world output increases Japanese transport equipment exports in subsequent months and that a positive exchange rate shock (yen appreciation) decreases transport equipment exports. They did not report the exact magnitude of the effect of exchange rate changes on transport equipment exports.

This paper adds to the literature by using disaggregated data for the transportation industry. This allows us to investigate how similar products with different characteristics are affected by exchange rate changes.

The next section investigates the long run pass-through of exchange rates into export prices for goods in the transportation industry. Section 3 estimates exchange rate elasticities for these goods. Section 4 examines their exchange rate exposures. Section 5 concludes.

2. Long run pass-through of exchange rates into export prices

2.1 Data and methodology

Campa and Goldberg (2005) examined the microeconomic foundations of exporters' pricing behavior. They reported that export prices are a function of exporters' costs and of demand conditions in importing countries. They modelled export prices as the product of marginal costs and of firms' markups. Marginal cost depends on the cost of labor and other inputs and on demand in the importing countries. The markup is a function of industry-specific factors and of macroeconomic factors such as the exchange rate and of the prices of import-competing goods in the importing countries.

Ceglowski (2010) used this framework to study the short run pass-through from exchange rates to export prices in Japan. She modeled the first difference of Japanese export prices as a function of current and lagged values of the first difference of foreign prices, domestic costs, economic activity in the destination markets and exchange rates. She employed industry-specific yen-denominated export prices from the BoJ. She obtained the foreign price variable by multiplying the inverse of the BoJ real effective exchange rate series by the product of the nominal effective exchange rate and the Japanese corporate goods price index. She measured economic activity in destination markets by industrial production in industrialized countries. She calculated the exchange rate as the ratio in each industry of the yen-denominated export price to the contract-currency export price

Since this paper uses currency invoicing as an indicator of export competitiveness, it investigates long run exchange rate pass-through. As Ito et al. (2018) observed, over the medium and longer exporters can change prices and thus the choice of invoice currency has less influence on exchange rate pass-through.

Nguyen and Sato (2019) investigated long run pass-through from exchange rates to export prices in Japan. They first employed an autoregressive distributed lag (ARDL) model:

$$\Delta ex_t = \beta_0 + \beta_1 ex_{t-1} + \beta_2 e_{t-1} + \beta_3 dp_{t-1} + \beta_4 ipi_{t-1} + \sum_{i=1}^{k} \gamma_{1i} \Delta ex_{t-i} + \sum_{i=0}^{l} \gamma_{2i} \Delta e_{t-i} + \sum_{i=0}^{m} \gamma_{3i} \Delta dp_{t-i} + \sum_{i=0}^{n} \gamma_{4i} \Delta ipi_{t-i}, \quad (1)$$

where ex_t is the yen export price, e_t is the exchange rate, dp_t represents production costs, and ipi_t represents economic activity in the importing markets. The long run PTM coefficient is then given by β_2 / β_1. Bounds tests can be used to test the null hypothesis of no cointegration against the alternative of cointegration.

Nguyen and Sato (2019) also investigated whether exporters' pricing behavior differed during yen appreciation and yen depreciation periods. They characterized appreciation periods as times when the yen was stronger than forecasted by the BoJ Tankan survey of businesses and depreciations as times when the yen was weaker than forecasted. They then estimated a nonlinear autoregressive distributed lag (NARDL) model:

$$\Delta ex_t = \beta_0 + \beta_1 ex_{t-1} + \beta_2 e^{+}_{t-1} + \beta_3 e^{-}_{t-1} + \beta_4 dp_{t-1} + \beta_5 ipi_{t-1} + \sum_{i=1}^{k} \gamma_{1i} \Delta ex_{t-i} + \sum_{i=0}^{l} (\gamma^{+}_{2i} \Delta e^{+}_{t-i} + \gamma^{-}_{2i} \Delta e^{+}_{t-i}) + \sum_{i=0}^{m} \gamma_{3i} \Delta dp_{t-i} + \sum_{i=0}^{n} \gamma_{4i} \Delta ipi_{t-i}, \qquad (2)$$

where e^{+}_{t-1} is the partial sum of exchange rate changes for depreciation periods, e^{-}_{t-1} is the partial sum of exchange rate changes during appreciation periods, and the other variables are defined above. The long run PTM coefficient during yen depreciation periods is then given by β_2/β_1 and the coefficient during yen appreciation periods by β_3/β_1. The null hypothesis that the PTM coefficient is symmetric between depreciation and appreciation periods can be tested by using Wald tests of the null hypothesis that $\beta_2/\beta_1 = \beta_3/\beta_1$.

This paper estimates equations (1) and (2) for goods in the transportation industry. To do this it employs data on export prices in yen (ex_t) and the producer price index in yen (dp_t) for these goods that come from the BoJ. It also employs data on the nominal yen/dollar exchange rate (e_t) that come from the Federal Reserve Bank of St. Louis FRED database. Figure 1 suggests that there is a tight relationship between the yen/dollar exchange rate and export prices for passenger cars. Finally it uses data on industrial production in OECD countries (ipi_t) that come from the OECD.[3]

In calculating e^{+}_{t-1}, the change in the exchange rate is summed for all periods up to t-1 when the actual exchange rate was weaker than the value predicted by the Tankan survey. In calculating e^{-}_{t-1}, the change in the exchange rate is summed for all period up to t-1 when the actual exchange rate was stronger than the value predicted by the Tankan survey.

Data for the following goods are obtained: bicycle parts, buses, marine engines, motor vehicle parts, motorcycles, small cars, small trucks, standard cars, and standard trucks. The data extend from January 2000 to December 2018.

In almost every case augmented Dickey-Fuller tests indicate that the variables are integrated of order one (I(1)) and Bounds F-tests indicate that the variables are cointegrated. Exploratory analysis using the Schwarz Information Criterion (SIC) point to short lag lengths when estimating equations (1) and (2). The lag lengths in equations (1) and (2) are thus set equal to two.

2.2 Results

Column (2) of Table 1 presents the PTM coefficient from equation (1), column (3) the PTM coefficient from equation (2) during yen depreciation times, and column (4) the PTM coefficient from equation (2) during yen appreciation times. Column (5) presents the probability

[3] The websites for these databases are, respectively, www.boj.or.jp, www.fred.stlouisfed.ord and www.oecd.org.

value from Wald tests of the null hypothesis that the long run PTM coefficients are symmetric across exchange rate depreciation and appreciation periods. Column (6) lists the share of yen invoicing for each good. The table is ordered from the good with the smallest share of yen invoicing (small cars) to the good with the largest share of yen invoicing (bicycle parts).

Most of the PTM coefficients in columns (2), (3), and (4) are statistically significant. For small cars and standard cars, the PTM coefficients are larger during yen depreciation periods than during yen appreciation periods. For small cars but not for standard cars the difference is statistically significant. Nguyen and Sato (2019) also found that the PTM coefficients for passenger cars (i.e., small cars plus standard cars) are larger during yen depreciation periods, although the difference they reported was not statistically significant. For motor vehicle parts and motorcycles, the PTM coefficients are also smaller during yen appreciation times than during yen depreciation times. The PTM coefficients are close to zero for bicycle parts exports during both depreciation and appreciation periods.

Figure 3a plots the relationship between the PTM coefficients and the share of yen invoicing during depreciation periods, Figure 3b plots the relationship during appreciation periods, and Figure 3c plots the relationship over the whole sample period. Figure 3a shows a tight relationship between these two variables, with the t-statistic for the slope coefficient exceeding 10 in absolute value. Figure 3b also shows a tight relationship between the two variables, with the t-statistic for the slope coefficient close to 5. Motorcycles and motor vehicle parts are outliers, with producers of these goods lowering Japanese export prices only a little in response to yen appreciations. Figure 3c shows that there is a close relationship between the two variables over the whole sample, with the t-statistic for the slope coefficient is close to 10.

The important implication of these results is that more producers of competitive goods, where competitiveness is measured by the share of exports that are invoiced in yen, are better able to keep yen prices constant in the face of volatile exchange rates. The next section investigates exchange rate elasticities for exports in the transportation industry, and sheds light on why PTM coefficients during yen appreciation times are low for motorcycles and motor vehicle parts.

3. Estimating export elasticities

3.1 Data and Methodology

In theory export demand should depend on the real exchange rate and real GDP in the importing countries. To investigate the relationship between these variables, this section employs Japan's exports of cars, motorcycles, commercial vehicles (trucks and buses), and motor vehicle parts. For each of these categories, exports to the 20 leading importers over the 1990-2017 period are employed. These countries are listed in the Appendix. Including many countries over a long period of time provides cross sectional and time series variation in the independent variables. This should lead to more precise estimates of the effects of the real exchange rates and real GDP on exports.

Annual data for each of these categories are obtained from the CEPII-CHELEM database. Since these data are measured in U.S. dollars and since Japan's exports are imports in places like the U.S., exports are deflated using the U.S. Bureau of Labor Statistics import price deflator for goods from Japan.[4]

[4] These data are obtained from www.bls.gov.

Data on bilateral real exchange rates between Japan and each of the importing countries and real GDP in the importing countries are obtained from the CEPII-CHELEM database. An increase in the exchange rate variable represents an appreciation of the yen.

Panel unit root tests indicate that the variables are integrated of order 1 (I(1)). Kao (1999) residual cointegration tests permit rejection of the null hypothesis of no cointegration. Dynamic ordinary least squares, a technique for estimating cointegrating relations, is thus employed.

The Mark and Sul (2003) weighted dynamic ordinary least squares (DOLS) estimator is used. The model takes the form:

$$ex_{i,j,t} = \beta_0 + \beta_1 rer_{j,t} + \beta_2 y_{j,t}^{*} + \sum_{k=-p}^{p} \alpha_{1,j,k} \Delta rer_{j,t-k} + \sum_{k=-p}^{p} \alpha_{2,j,k} \Delta y_{j,t-k}^{*} + u_{i,j,t}, \quad t = 1,\cdots,T; \quad j = 1,\cdots,N. \qquad (3)$$

where $ex_{i,j,t}$ represents real exports of good *i* from Japan to country *j*, $rer_{j,t}$ represents the bilateral real exchange rate between Japan and importing country *j*, and $y_{j,t}^{*}$ represents real GDP in country *j*. The number of cross-section specific lags and leads is determined by the Schwarz Information Criterion. These variables are included to asymptotically remove endogeneity and serial correlation. Import country-specific fixed effects and time trends are also included.

3.2 Results

Table 2 present the results. Column (2) presents the exchange rate elasticity and column (3) the GDP elasticity.

All of the coefficients are of the expected signs and statistically significant. The results indicate that a 10 percent appreciation of the yen would reduce car exports by 7.5 percent, commercial vehicle exports by 6.5 percent, motorcycle exports by 3.0 percent, and motor vehicle parts exports by 1.7 percent.

The small exchange rate elasticities for motorcycles and motor vehicle parts shed light on the low PTM coefficients for these goods during yen appreciation periods that is evident in Figure 3b. Even as exchange rate appreciations in these industries are largely passed-through to higher foreign currency prices, the volume of exports does not decline much. Thus exporters of these products have more freedom to pass-through exchange rate appreciations.

Nguyen and Sato (2019) reported that there was a change in exporter pricing behavior after the yen appreciated during the Global Financial Crisis. They found, for instance, that PTM coefficients for passenger cars over the 2010-2108 period became very large during yen appreciation periods. They posited that this low exchange rate pass-through in recent years could explain why the 35 percent depreciation of the Japanese real effective exchange rate that began in September 2012 did not stimulate Japanese net exports.

It is possible to use equation (3) to investigate whether car exports increased less than expected after 2012. The model can be re-estimated over the 1990-2012 period, and then actual out-of-sample values of the exchange rate and of GDP in the importing countries can be used to forecast car exports over the 2013-2017 period.

The model forecasts exports of USD 410 billion to the 20 countries over the 2013-2017 period, while actual exports equaled USD 308 billion. The value of exports over this period was thus 30 percent less than predicted.

Some of this shortfall is due to Japanese automobile producers relocating production abroad. However, as Shimizu and Sato (2015) noted, the strong yen in 2011-2012 caused Japanese firms to relocate production of lower end goods abroad and concentrate production of highly differentiated goods in Japan. The PTM coefficients for the higher end cars still produced in Japan should be smaller than the PTM coefficients for the combination of higher end and lower end cars produced in Japan before the offshoring. The evidence that PTM coefficients remained large indicates that exchange rates exert a smaller effect on the foreign currency prices of exports and thus on the volume of exports after 2012. The next section investigates how exchange rates affect stock returns to shed light on how they affect the profitability of goods in the transportation industry.

4. The Exposure of Transportation Industry Stocks to Exchange Rates

4.1 Data and Methodology

Dominguez and Tesar (2006), Jayasinghe and Tsui (2008) and others have estimated exchange rate exposure equations to investigate how exchange rates affect profitability. Firm or industry stock returns ($R_{i,t}$) are regressed on changes in the log of the exchange rate (Δe_t) and the return on the country's aggregate stock market ($R_{M,t}$). The return on the world stock market ($R_{W,t}$) is also included here to control for conditions in the rest of the world. The regression estimated is thus:

$$R_{i,t} = \alpha_i + \beta_{i,yen}\Delta Yen_t + \beta_{i,M} R_{M,t} + \beta_{i,W}R_{W,t} + \varepsilon_{i,t} , \quad (4)$$

where $R_{i,t}$ is the return on firm or sector of the Japanese transportation industry, ΔYen_t is the change in the log of the yen/dollar exchange rate, $R_{M,t}$ is the return on the aggregate Japanese stock market, and $R_{W,t}$ is the return on the world stock market index. The data come from the Datastream database.

For $R_{i,t}$ the stock returns for automobiles, automobile parts, commercial vehicles and trucks, Shimano Corporation, and tires are employed. The sample period extends from 1 September 1993 to 29 August 2019. There are 6782 observations.

4.2 Results

Table 3 presents the exchange rate elasticities. The results for the other variables are available on request. The results are ordered from the sector most exposed to exchange rate appreciations to the sector least exposed.

The most exposed sector is tires. A 1 percent yen appreciation reduces the return on tire stocks by 0.387 percent. Automobiles are next, with a 1 percent appreciation reducing returns by 0.325 percent. For automobile parts, a 1 percent appreciation reduces returns by 0.241 percent and for commercial vehicles and trucks a 1 percent appreciation reduces returns by 0.118 percent. These coefficients are all significant at the 1 percent level.

For Shimano, on the other hand, the exchange rate coefficient is close to zero and not significant. This reflects the fact that Shimano produces differentiated products and is able to pass-through almost all of exchange rate appreciations into foreign currency prices.

Tires are the closest to a pure commodity. This industry is most exposed to appreciations. Automobiles are also highly exposed, reflecting the findings in Section 2 that automobile producers can only pass-through a small portion of exchange rate appreciations into foreign currency prices.

The exposure for automobile parts producers remains high. This might seem puzzling in light of the findings in Section 2 that they can pass-through most of an exchange rate appreciation into foreign currency prices. However, there is another channel through which exchange rates affect Japanese automobile parts firms. Li, Wei, and Zhang (2018) reported that the profits and sales of upstream Japanese producers such as automobile parts makers are highly exposed to exchange rate appreciations that reduce exports of downstream companies such as automobile manufacturers. Since yen appreciations cause large decreases in profits and exports of automobile manufacturers, they also reduce their demand for automobile parts.

The finding that commercial vehicles and truck producers are much less exposed to exchange rates than automobile producers are reflects the findings in Section 2 that bus and truck makers are able to pass-through more of exchange rate appreciations than auto makers can.

The important implication of these findings is that producers of commoditized products are highly exposed to exchange rates while producers of differentiated products are not.

5. Conclusion

This paper has investigated how exchange rates affect different subsets of the transportation equipment industry in Japan. The results indicate that exporters of commoditized products such as cars can pass-through little of exchange rate appreciations into foreign currency prices. Instead they must compress their profit margins. Exporters of differentiated products such as bicycle parts, on the other hand, can pass-through almost all of the appreciations. These conflicting effects on profitability are confirmed by examining the stock market exposure of different sectors. Stocks of sectors such as automobiles are severely harmed by appreciations while the stock of Shimano Corporation, the leading maker of bicycle parts, is unaffected by exchange rates. Thorbecke and Kato (2018) reported that medium-high technology Swiss sectors such as machinery and capital goods are highly exposed to appreciations, while the highest-level sectors such as pharmaceuticals and watches are not.

Countries such as Japan and Switzerland could try to keep their currencies weaker to shield their industries from appreciations. However, exogenous sources of risk are likely to arise in the world economy and generate safe haven inflows that will appreciate their currencies. During risk-on periods when their exchange rates are weaker, they should use R&D policy to promote technological upgrading so that firms can develop knowledge-intensive, differentiated products. They should also nurture startups. These companies can help by promoting entrepreneurship and introducing new products. Safe haven countries should thus pursue a favorable business climate for startups. One way to do this is to survey them to better understand the challenges and obstacles they face. Finally, they should invest in human capital so that workers can innovate in order to confront the challenges that arise from volatile exchange rates.

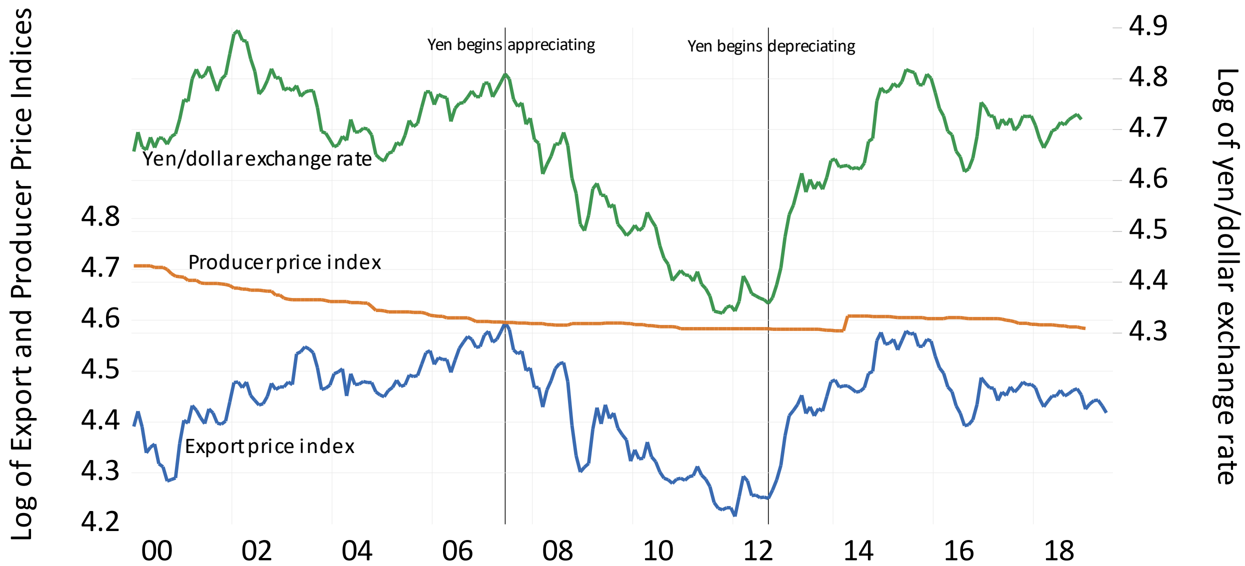

Fig. 1a The relationship between yen export prices, yen costs, and exchange rates for Japanese passenger cars
Source: Bank of Japan and Federal Reserve Bank of St. Louis FRED database.
Note: Yen costs are represented by the producer price index for passenger cars.

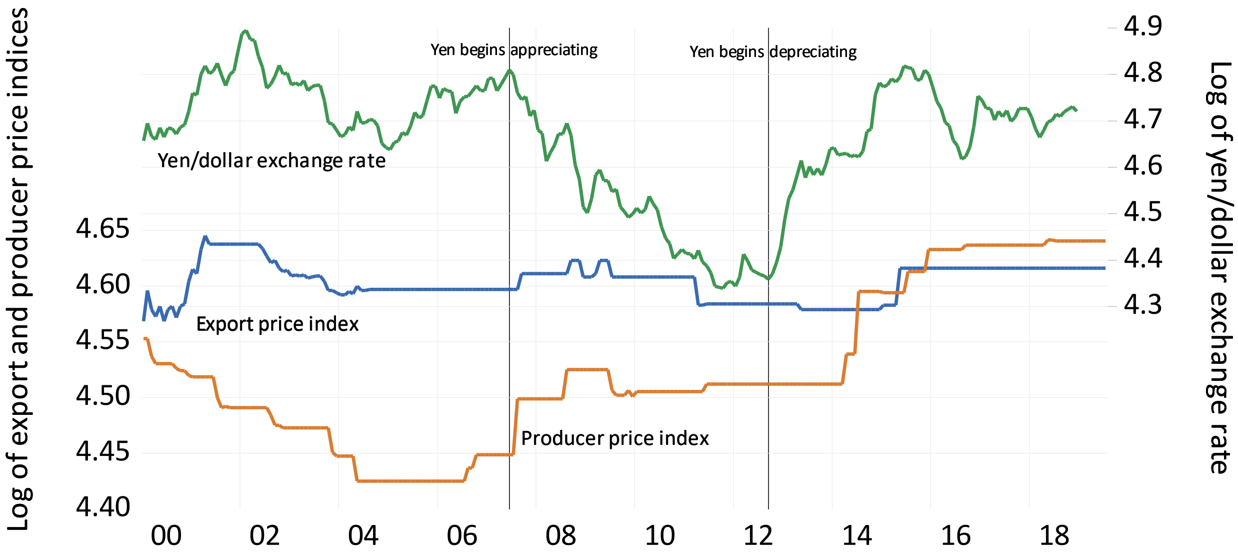

Fig. 1b The relationship between yen export prices, yen costs, and exchange rates for Japanese bicycle parts
Source: Bank of Japan and Federal Reserve Bank of St. Louis FRED database.
Note: Yen costs are represented by the producer price index for bicycle parts.

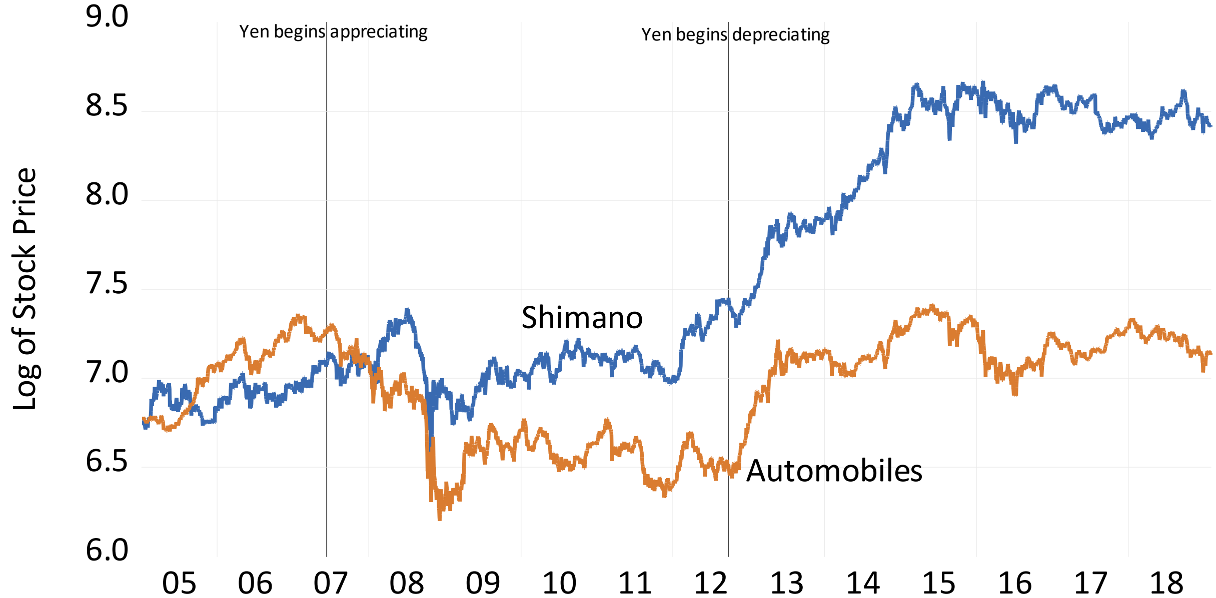

Fig. 2 Stock prices for Japanese automobile companies and for Shimano Corporation.
Source: Datastream database
Note: Shimano Corporation is the leading producer of bicycle parts.

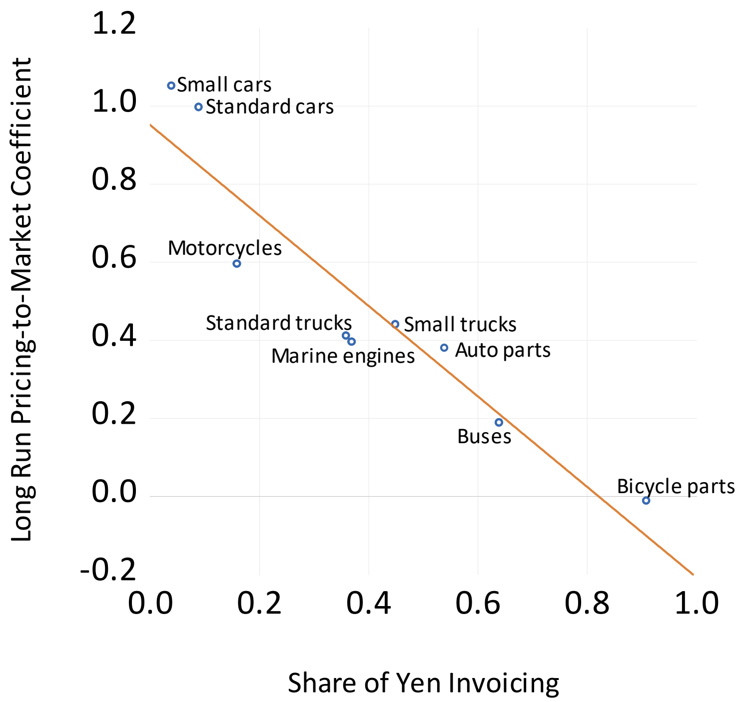

Fig. 3a The relationship between the long run pricing-to-market coefficient and the share of yen invoicing during yen depreciation episodes

Source: Bank of Japan, Organization for Economic Cooperation and Development, Federal Reserve Bank of St. Louis FRED database, Japanese Ministry of Finance, and calculations by the author.

Note: The long run pricing-to-market coefficient comes from a nonlinear autoregressive distributed lag regression of the change in the yen export price on the lagged value of the yen export price, the lagged value of the producer price index, the lagged value of industrial production in OECD countries, the sum of the change in the yen/dollar rate for all periods up to t-1 when the actual exchange rate was weaker than the value predicted by the Tankan survey, the sum of the change in the yen/dollar rate for all periods up to t-1 when the actual exchange rate was weaker than the value predicted by the Tankan survey, and lagged values of the first differences of all of these variables.

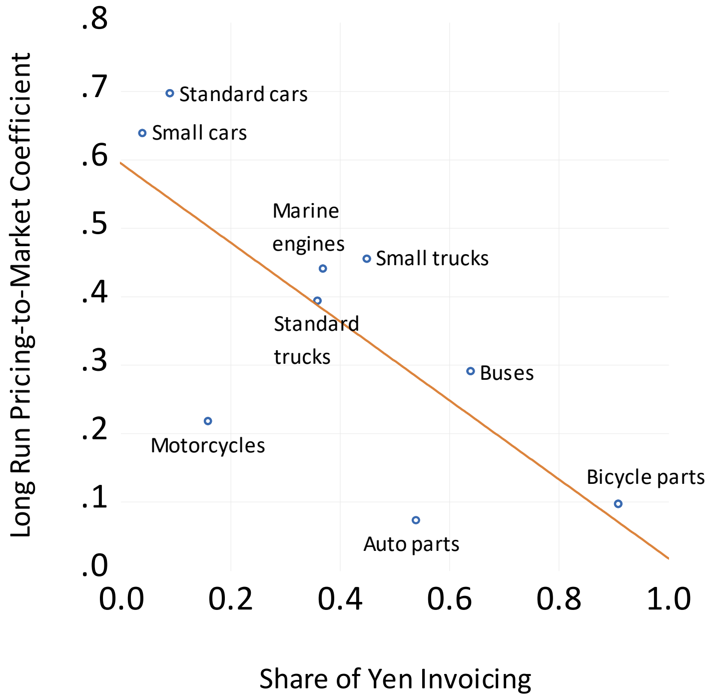

Fig. 3b The relationship between the long run pricing-to-market coefficient and the share of yen invoicing during yen appreciation episodes

Source: Bank of Japan, Organization for Economic Cooperation and Development, Federal Reserve Bank of St. Louis FRED database, Japanese Ministry of Finance, and calculations by the author.

Note: The long run pricing-to-market coefficient comes from a nonlinear autoregressive distributed lag regression of the change in the yen export price on the lagged value of the yen export price, the lagged value of the producer price index, the lagged value of industrial production in OECD countries, the sum of the change in the yen/dollar rate for all periods up to t-1 when the actual exchange rate was weaker than the value predicted by the Tankan survey, the sum of the change in the yen/dollar rate for all periods up to t-1 when the actual exchange rate was weaker than the value predicted by the Tankan survey, and lagged values of the first differences of all of these variables.

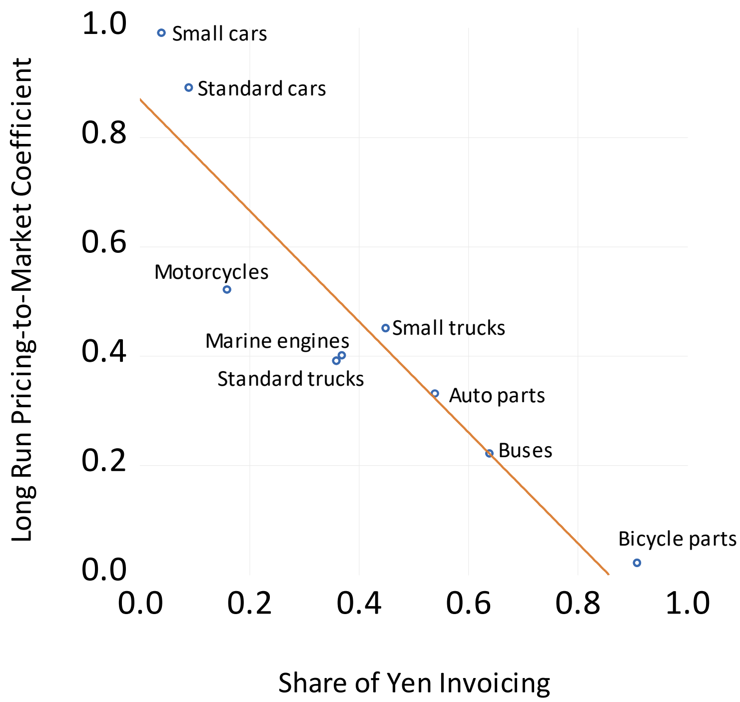

Fig. 3c The relationship between the long run pricing-to-market coefficient and the share of yen invoicing

Source: Bank of Japan, Organization for Economic Cooperation and Development, Federal Reserve Bank of St. Louis FRED database, Japanese Ministry of Finance, and calculations by the author.

Note: The long run pricing-to-market coefficient comes from an autoregressive distributed lag regression of the change in the yen export price on the lagged value of the yen export price, the lagged value of the yen/dollar exchange rate, the lagged value of the producer price index, the lagged value of industrial production in OECD countries, and lagged values of the first differences of all of these variables.

Table 1 Long Run Pricing-to-Market Coefficients for Japanese Transportation Equipment Industries

(1)	(2)	(3)	(4)	(5)	(6)
Sector	Long Run Pricing-to-Market Coefficient	Long Run Pricing-to-Market Coefficient in Exchange Rate Depreciation Periods	Long Run Pricing- to-Market Coefficient in Exchange Rate Appreciation Periods	Probability Value of Null Hypothesis that the PTM Coefficients Are Equal in Appreciation and Depreciation Period	Share of Yen-invoicing
Small cars	0.994*** (0.108)	1.05*** (0.088)	0.638*** (0.122)	0.002	0.04
Standard cars	0.887*** (0.211)	0.996*** (0.256)	0.696*** (0.197)	0.336	0.09
Motorcycles	0.516*** (0.150)	0.594*** (0.129)	0.217 (0.189)	0.064	0.16
Standard trucks	0.394*** (0.029)	0.410*** (0.049)	0.393*** (0.056)	0.832	0.36
Marine engines	0.395*** (0.030)	0.394*** (0.039)	0.440*** (0.080)	0.492	0.37
Small truck	0.454*** (0.072)	0.439*** (0.082)	0.454*** (0.106)	0.904	0.45
Auto parts	0.330*** (0.066)	0.379*** (0.042)	0.072 (0.081)	0.000	0.54
Bus	0.219*** (0.041)	0.188*** (0.036)	0.290*** (0.054)	0.000	0.64
Bicycle parts	0.022 (0.046)	-0.013 (0.056)	0.096** (0.046)	0.03	0.91

Source: Bank of Japan, Organization for Economic Cooperation and Development, Federal Reserve Bank of St. Louis FRED database, Japanese Ministry of Finance, and calculations by the author.
Note: The long run pricing-to-market coefficient in column (2) comes from an autoregressive distributed lag regression of the change in the yen export price on the lagged value of the yen export price, the lagged value of the yen/dollar exchange rate, the lagged value of the producer price index, the lagged value of industrial production in OECD countries, and lagged values of the first differences of all of these variables. The long run pricing-to-market coefficients in columns (3) and (4) come from a nonlinear autoregressive distributed lag regression of the change in the yen export price on the lagged value of the yen export price, the lagged value of the producer price index, the lagged value of industrial production in OECD countries, the sum of the change in the yen/dollar rate for all periods up to t-1 when the actual exchange rate was weaker than the value predicted by the Tankan survey, the sum of the change in the yen/dollar rate for all periods up to t-1 when the actual exchange rate was weaker than the value predicted by the Tankan survey, and lagged values of the first differences of all of these variables. Monthly data over the 2000M01-2018M12 period are used.
Heteroskedasticity and autocorrelation consistent standard errors are in parentheses.
*** (**) denotes significance at the 1% (5%) levels.

Table 2 Panel DOLS Estimates of Trade Elasticities for Japanese Transportation Equipment Exports to 20 Countries

(1)	(2)	(3)	(4)	(5)	(6)
Sector	Exchange Rate Elasticity	GDP Elasticity	Adjusted R-squared	Standard Error of Regression	Number of Observations
Cars	-0.75*** (0.08)	1.84*** (0.29)	0.954	0.269	533
Commercial vehicles	-0.65*** (0.16)	3.70*** (0.69)	0.842	0.660	531
Motorcycles	-0.30** (0.12)	5.00*** (0.50)	0.865	0.453	530
Motor vehicle parts	-0.17** (0.08)	1.43*** (0.23)	0.961	0.223	536

Source: CEPII-Chelem database, U.S. Bureau of Labor Statistics, and calculations by the author.
Note: The coefficients come from a panel dynamic ordinary least squares regression of Japan's exports in each sector to the 20 leading importing countries. The right hand side variables are the bilateral real exchange rate between Japan and each importing country and real GDP in the importing countries. Import country-specific fixed effects and time trends are included in the regressions. Annual data over the 1990-2017 period are used.
*** (**) denotes significance at the 1% (5%) levels.

Table 3 The Exposure of Stock Returns in the Japanese Transportation Equipment Industry to the yen/dollar Exchange Rate

(1)	(2)	(3)	(4)	(5)	(6)
Sector or firm	Exchange Rate Elasticity	Standard Error	Adjusted R-squared	Standard Error of Regression	Number of Observations
Tires	0.387***	0.042	0.401	0.0148	6782
Automobiles	0.325***	0.027	0.669	0.0096	6782
Automobile parts	0.241***	0.025	0.722	0.0086	6782
Commercial vehicles & trucks	0.118***	0.032	0.630	0.0117	6782
Shimano	0.007	0.051	0.000	0.0215	6782

Source: Datastream database, Federal Reserve Bank of St. Louis FRED database, and calculations by the author.
Note: The exchange rate coefficients come from a regression of stock returns in each sector on the change in the yen/dollar exchange rate, the return on the Japanese stock market, and the return on the world stock market. Daily data over the 1 September 1993 to 29 August 2019 are used. There are 6782 observations.
Heteroskedasticity and autocorrelation consistent standard errors are reported.
*** denotes significance at the 1% level.

Appendix Importing countries for the dynamic ordinary least squares estimation

Cars	Commercial vehicles	Motorcycles	Motor Vehicle Parts
Australia	Australia	Australia	Australia
Austria	Canada	Belgium	Belgium
Belgium	China, People's Rep.	Canada	Canada
Canada	Finland	China, People's Rep.	China, People's Rep.
Finland	France	France	France
France	Germany	Germany	Germany
Germany	Greece	Greece	India
Hong Kong	Hong Kong	Hong Kong	Indonesia
Ireland	Malaysia	Indonesia	Malaysia
Israel	Netherlands	Italy	Mexico
Malaysia	New Zealand	Malaysia	Philippines
Netherlands	Pakistan	Netherlands	Portugal
New Zealand	Philippines	Singapore	Saudi Arabia
Norway	Saudi Arabia	Spain	Singapore
Saudi Arabia	Singapore	Switzerland	South Korea
Sweden	Sweden	Taiwan	Spain
Switzerland	Taiwan	Thailand	Taiwan
Taiwan	Thailand	United Kingdom	Thailand
United Kingdom	United Kingdom	United States	United Kingdom
United States	United States	Viet Nam	United States

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