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Why Japan Lost Its Comparative Advantage in Producing Electronic Parts and Components[1]

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Abstract

Japanese electronic parts and components (ep&c) exports fell in value after the Global Financial Crisis (GFC) while Taiwan and South Korea's ep&c exports soared. This paper reports that the yen appreciation between 2007 and 2011 reduced yen ep&c export prices by 28 percent. This paper also finds that yen appreciations led to small declines in ep&c export volumes and, together with NT dollar depreciations, to large decreases in Japanese semiconductor stock prices. The strong yen caused yen export prices after the GFC to tumble relative to yen production costs, decimating profits. Plummeting profits in turn hindered Japanese ep&c firms from investing enough in capital and innovation to compete with nimble rivals.

JEL classification: F32, F41

Keywords: Electronic parts and components; Exchange rate pass-through; Exchange rate elasticities

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1. Introduction

Japan is upstream in global value chains and exports parts and components and capital goods to downstream producers. In every year since 1994 electronic parts and components (ep&c) has been Japan's second leading export category at the International Standard Industrial Classification (ISIC) 4-digit level. However Japan's comparative advantage in ep&c, as measured by Baldwin and Okubo's (2019) method, tumbled after the Global Financial Crisis (GFC) while Korea and Taiwan's soared (see Figure 1). Japan was the world's largest exporter of ep&c before the GFC, but by 2017 Taiwan and South Korea each exported more than twice the value of ep&c as Japan did (Figure 2). How did Japan lose its comparative advantage in producing microprocessors, flat-panel displays, integrated circuits, and other parts and components?

Katz (2012) noted that integrated circuits and similar goods have become commoditized and that Japanese firms compete in these products based on price. Facing fierce competition from Korea and Taiwan, Japanese firms may lack pricing power. If they cannot raise prices, they may suffer compressed profit margins when confronting adverse shocks.

Japanese companies faced a negative shock in the form of an appreciating yen beginning in June 2007 (see Figure 3). The GFC generated safe haven capital inflows that caused the yen to appreciate 45 percent against the U.S. dollar between June 2007 and September 2012. Figure 3 shows that the yen price of ep&c exports over this period fell 35 percent relative to yen production costs, where production costs are measured using the producer price index for ep&c. Figures 4a and 4b show that, while both the volume and the yen value of Japan's ep&c exports tumbled during the GFC, the volume recovered and exceeded pre-GFC levels but the yen value never did.

This paper investigates whether the strong yen caused yen export prices and thus the value of ep&c exports to fall. Results from exchange rate pass-through equations indicate that yen appreciations led to one-for-one decreases in yen export prices. This implies that exporters followed a pricing-to-market strategy.

The paper then examines whether the appreciating yen caused export volumes to fall by estimating export elasticities using a panel of Japan's exports to major importing countries. The results indicate that yen appreciations caused only small decreases in export volumes. This is what one would expect given that Japanese firms kept foreign currency prices constant in the face of yen appreciations.

Since an appreciation causes yen export prices to fall relative to yen production costs, exchange rate changes should affect the profitability of ep&c producers. To examine this issue the paper estimates exchange rate exposure equations for Japanese semiconductor stocks. Theory implies that stock prices equal the expected present value of future net cash flows. Thus these prices provide information about future profitability. The results indicate that yen appreciations lead to large decreases in semiconductor stocks and that New Taiwan dollar depreciations also lead to large decreases in semiconductor stocks. With the advent of the GFC, not only did the yen appreciate but the NT dollar depreciated. Both of these currency movements acted as negative shocks that lowered the profitability of Japanese ep&c producers.

Sato, Shimizu, Shrestha and Zhang (2013) investigated how industry-specific exchange rate shocks for the electrical machinery industry affected Japanese communication equipment exports. Communications equipment comes from ISIC code 32 and includes ep&c, televisions, and mobile devices. Sato *et al.* estimated impulse-response functions from a monthly vector autoregression (VAR) over the January 2001 to February 2013 period. Their VAR included world output, the nominal exchange rate for electrical machinery goods, the price of Japanese electrical machinery goods, the price of foreign electrical machinery goods, and real exports. They reported that an appreciation of the yen nominal effective exchange rate caused Japanese real communications equipment exports to fall. They also found that an increase in Japanese electrical machinery goods prices was associated with a drop in communication equipment exports. Surprisingly, they reported that an increase in foreign electrical machinery goods prices was also associated with a drop in Japanese communications goods exports.

Nishimura and Hirayama (2013) investigated Japan's exports to China using an autoregressive distributed lag model over the January 2002 to December 2011 period. They noted that 70 percent of Japan's exports to China are intermediate goods and that the lion's share of these are used to produce goods for re-export. When they employed Chinese income as the scale variable, they found that the coefficients on the exchange rate took on the wrong sign (i.e., an appreciation of the yen relative to the renminbi was associated with an increase in Japanese exports). They observed that this could be because an appreciation of the yen/renminbi rate implies a weaker renminbi. A weaker renminbi allows China to export more, and thus to import more intermediate goods from Japan. To control for this effect, they included China's real exports as an explanatory variable. They found that the exchange rate coefficient then took on the correct sign. They also reported that the coefficient on China's real exports was positive and large for Japan's electrical machinery exports, implying that the re-export effect was important for Japan's exports of electrical machinery to China.

Iwaisako and Nakata (2017) investigated how exchange rates, global demand, and other factors affected Japanese aggregate exports using monthly VARs over the January 1977 to September 2014 period. Their VARs included the real effective exchange rate, the growth rate of aggregate exports, two measures of global demand, the price of crude oil and growth rate of world oil production. Impulse response functions indicate that exports fall in response to a yen appreciation. However, variance decompositions indicate that exchange rate shocks explain less of the variance of export growth over the 2000-2014 period than over earlier periods. They also found that global demand shocks were much more important than exchange rate shocks in explaining falling exports after the 2008 Lehmann Brothers Crisis. Iwaisako and Nakata (2015) reported that, though yen depreciations have a muted effect on exports after 2000, they still matter because they increase the profitability of Japanese firms.

The research discussed above investigated how exchange rates affect electric machinery exports more generally or aggregate variables. This paper focuses specifically on Japan's ep&c exports. Given its prominence in Japan's export structure, it is important to understand why Japan's comparative advantage in producing these goods has fallen.

The next section examines the pass-through of exchange rates into ep&c export prices. Section 3 investigates the effect of exchange rate changes on the volume of ep&c exports. Section 4 tests for the exposure of Japanese semiconductor stocks to the yen, the Korean won, and the New Taiwan dollar. Section 5 discusses the findings and Section 6 concludes.

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

Campa and Goldberg (2002, 2005) highlighted the microeconomic foundations of exporters' pricing behavior. Export prices should depend on exporters' costs and on demand conditions in the importing country. Export prices can be represented as the product of firms' marginal costs and their markups. Marginal cost depends on wages and other input costs and on the level of demand in the importing country. The markup depends on industry-specific factors and on macroeconomic variables such as the exchange rate and the prices of import-competing goods in the importing country.

2.1 Data and methodology

Ceglowski (2010) applied this framework to Japanese export prices. She modeled the first difference of Japanese export prices as a function of current and lagged values of the first difference of the exchange rate, foreign prices, domestic costs, and economic activity in the destination market:

$$\Delta p_{jt}^{x} = \beta_0 + \sum_{i=0}^{p} \beta_{1i} \Delta e_{jt-i} + \sum_{i=0}^{p} \beta_{2i} \Delta p_{t-i}^{f} + \sum_{i=0}^{p} \beta_{3i} \Delta c_{jt-i} + \sum_{i=0}^{q} \beta_{4i} \Delta y_{t-i}^{f} + u_t , \quad (1)$$

where p_j^x is the yen price of ep&c exports, e_j is the exchange rate, p^f measures foreign prices, c_j represents costs for the ep&c industry, and y^f represents economic activity in the export market.

The yen price of electronic component and devices exports comes from the Bank of Japan (BoJ). The exchange rate is the ratio of the yen-denominated export price to the contract-currency export price for electronic components and devices. As Ceglowski (2010) discussed, this exchange rate measure captures the composition of invoice currencies. The foreign price variable is obtained 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. Costs are measured by the producer price index for electronic components and devices. Finally, economic activity in export markets is captured by the OECD measure for industrial production in OECD countries.[3]

A time series for the yen price of electronic component and devices exports is available from the BoJ starting in January 2005. The OECD data on industrial production are available until January 2018. The sample period for the estimation thus extends from January 2005 to January 2018. The estimation begins with six lags of e_j , p^f, and c_j and y^f . To avoid overfitting the lag length is progressively reduced by one up to a minimum of two lags and the Schwarz Information Criterion (SIC) is used to choose between the models. The SIC selects two lags.

As a robustness check, a model with six lags is estimated. As a second robustness check, a model is estimated with real wages in Japan included as an additional explanatory variable. Nominal wage data are obtained from the CEIC database and are deflated using the BoJ domestic corporate goods price index.

2.2 Results

Table 1 presents the results from estimating equation (1) with the first difference of the yen export price for electronic components and devices as the dependent variable and with current values and two lags of the first difference of exchange rates, foreign prices, domestic costs, and foreign industrial production as independent variables.

The coefficient on the contemporaneous first difference of the exchange rate is significant at the one percent level. It takes on a value of 0.974. The sum of the coefficients on the

[3]All of the data mentioned in this paragraph come from the Bank of Japan, except the industrial production data that come from the OECD. The associated websites are www.boj.or.jp/en/index.htm/ and www.oecd.org.

exchange rates in Table 1 equals 1.117 and the associated standard error equals 0.008. These findings indicate that there is even more than a one-for-one response of export prices for electronic components and devices to exchange rate changes. Since the exchange rate measure (the ratio of the yen-denominated export price to the contract-currency export price for the industry) appreciated 25 percent between June 2007 and September 2012, these results imply that the exchange rate appreciation led to almost a 28 percent increase in ECD export prices.

The sum of the coefficients on current and lagged Δc_j equals 0.937 and the associated standard error is 0.096. There is thus a statistically significant relationship between yen export prices and costs in the electronic components and devices industry. There does not appear to be a robust relationship between export prices and the other variables in Tables 1. Results including the real wage rate and results including six lags of the explanatory variables, available on request, corroborate the findings in Table 1.

The important implication of the results presented in this section is that yen export prices are very sensitive to exchange rate changes. These findings imply that the appreciation of the yen between June 2007 and September 2012 caused yen export prices for ep&c to fall by almost 28 percent.

3. Investigating the effect of exchange rate changes on export volumes

3.1 Data and methodology

According to the imperfect substitutes model of Goldstein and Khan (1985), exports can be represented as:

$$ex_t = \alpha_{10} + \alpha_{11}\, rer_t + \alpha_{12}\, rgdp_t + \varepsilon_t \quad , \qquad (2)$$

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

As discussed above, Nishimura and Hirayama (2013) found that employing GDP to explain Japan's intermediate goods exports to China produced exchange rate coefficients that took on the wrong sign. When they used China's exports as the scale variable, the exchange rate elasticities took on the right sign. Many other researchers have also found that the relationship in Asia between parts and components imports into a country and subsequent re-exports is so strong that they need to include exports as an explanatory variable in order to explain intermediate goods imports. These authors include Ahuja, Chalk, Nabar, N'Diaye, and Porter (2012), Baak (2013), Baak (2013), Cheung, Chinn, and Qian (2012), and Kamada and Takagawa (2005). A theoretical rationale for employing exports as a right-hand-side variable in East Asian supply chains, as the IMF (2005) discussed, is that imports for re-export may flow elastically into downstream countries in response to these countries' re-exports. This would imply a recursive relationship, where re-exports depend on demand in the rest of the world and imported parts and components depend on re-exports.

Electronics exports from the countries importing Japanese electronic parts and components are thus used as the scale variable. Data on electronics exports come from the CEPII-CHELEM database and include the following goods: telecommunications equipment, computer equipment, consumer electronics, electronic components, precision instruments, clockmaking, and optics.

Data on Japan's ep&c exports are obtained from the CEPII-CHELEM database and come from ISIC category 3210. The data are measured in US dollars. They are deflated using the yen export price index for electric components and devises from the Bank of Japan converted to dollar values using the yen/dollar nominal exchange rate obtained from the CEIC database.

Japanese ep&c exports to the major importers of these goods are examined. These are Canada, China, France, Germany, Hong Kong, Malaysia, Mexico, the Netherlands, the Philippines, Singapore, South Korea, Taiwan, Thailand, the United Kingdom, the United States, and Vietnam.

Data on the real exchange rate between Japan and the importing countries (rer_t) are also obtained from the CEPII-CHELEM database. Higher values of rer represent a stronger yen.

A battery of panel unit root tests on the levels and first differences of the variables provide some evidence that the variables are integrated of order 1 (I(1)). Kao residual tests for cointegration indicate that the null hypothesis of no cointegration can be rejected. Mark and Sul (2003) panel dynamic ordinary least squares (DOLS) estimation, a technique for estimating cointegrating relations, is thus employed.

The estimated model takes the form:

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

Here $ex_{j,t}$ represents real ep&c exports from Japan to country *j*, $rer_{j,t}$ represents the bilateral real exchange rate between Japan and country *j*, and $EL^*_{j,t}$ represents electronics exports from country *j* to the world. Cross-section specific lags and leads of the first differenced independent variables are employed to asymptotically remove endogeneity and serial correlation. The number of lags and leads are determined by the Schwarz Information Criterion. A sandwich estimator is used to allow for heterogeneity in the long-run residual variances. Individual specific fixed effects are included and individual specific time trends are included in one specification. The data extend from 2002 to 2017.

3.2 Results

Table 2 presents the results from estimating equation (3). Column (1) shows the results without a heterogeneous time trend and column (2) shows the results including the trend.

The results are similar with and without the trend term. There is a tight link between electronics exports from downstream countries and their imports of ep&c. A 10 percent increase in electronics exports is associated with an increase of ep&c imports from Japan of between 5.7 and 6.5 percent. A slowdown in electronics exports in downstream countries, due for example to a trade war, would thus cause a large decrease in Japanese ep&c exports.

The exchange rate elasticities equal -0.27 when the trend term is excluded and -0.21 when it is included. This implies a 10 percent appreciation would reduce ep&c exports by between 2.1 and 2.7 percent. Exchange rates thus exert only a small effect on export volumes. An implication of these results is that Japan's loss in comparative advantage in ep&c exports cannot be attributed to the impact of the yen on export volumes.

4. The Exposure of Electronic Components Stocks to Exchange Rates

4.1 Data and Methodology

Chamberlain, Howe, and Popper (1997), Dominguez and Tesar (2006), and many others have estimated exchange rate exposure equations to investigate how exchange rates affect industry profitability. This involves regressing industry stock returns ($R_{i,t}$) on changes in the country's exchange rate (ΔYen_t), the return on the country's aggregate stock market ($R_{M,t}$), and other variables. The return on the world stock market ($R_{W,t}$) is included to control for conditions in the rest of the world and changes in the New Taiwan dollar (ΔNT_t) and South Korean won (ΔWon_t) are included to control for price competition with neighboring countries:

$$R_{i,t} = \alpha_i + \beta_{i,yen}\Delta Yen_t + \beta_{i,M} R_{M,t} + \beta_{i,W}R_{W,t} + \beta_{i,NT}\,\Delta NT_t + \beta_{i,Won}\,\Delta Won_t + \varepsilon_{i,t}\,. \qquad (4)$$

$R_{i,t}$ is the return on Japanese electronic components stocks, $R_{M,t}$ is the return on the aggregate Japanese stock market, $R_{W,t}$ is the return on the world stock market index, Yen_t is the yen/ U.S. dollar exchange rate, NT_t, is the New Taiwan dollar/U.S. dollar exchange rate, and Won_t is the won/U.S. dollar exchange rate. All of the data come from the Datastream database and stock returns and exchange rate changes are calculated as the daily change in the natural log of the level of stock prices or exchange rates.

For the dependent variable the returns of semiconductor stocks are used.[4] In addition, there are Japanese ep&c companies that do not produce commoditized products such as semiconductors but occupy higher-end niches. One example is Murata Manufacturing. Murata produces ceramic components such as multi-layer ceramic capacitors (MLCC). It abandoned the low-end of the MLCC market to Taiwanese firms so that it could focus on high-end MLCC's (*Electronic Components News*, 2018). It also dominates the market in certain parts and sensors. The returns on Murata stocks are also investigated.

The sample period extends from 4 January 2005 to 31 January 2019. There are 3673 observations.

4.2 Results

[4]The semiconductor index includes stocks from the following companies: Advantest, Sumco, Tokyo Electron, Hitachi High Technologies, Lasertec, Macnica Fuji Electronics Holdings, Renesas Electronics, Rohm, Ryosan, Screen Holdings, Shinko Electric Industries, Tokyo Ohka Kogyo, Tokyo Seimitsu, and UT Group.

Table 3 presents the results. The adjusted R-squared equals 0.67 for semiconductor stocks and 0.47 for Murata Manufacturing stocks. These are high values since daily stock market data are noisy.

The results for semiconductor stocks in column (1) indicate that a 10 percent appreciation of the yen would reduce returns on Japanese semiconductor stocks by 3.1 percent and that a 10 percent appreciation of the New Taiwan dollar would increase returns on Japanese semiconductor stocks by 3.5 percent. The opposite signs on the yen/U.S. dollar exchange rate and the NT dollar/U.S. dollar exchange rate point to significant price competition between Japanese and Taiwanese semiconductor producers. The coefficient on the Korean won is not statistically significant.

The coefficient on the returns on the Japanese stock market and the world stock market are both positive and statistically significant. These findings indicate that semiconductor producers are sensitive to conditions in the Japanese and world economies.

The results for Murata Manufacturing in column (2) indicate that the yen does not affect the returns on Murata stocks. Since Murata produces high-end products and dominates the market share in several product categories, it faces less pressure to reduce yen prices to keep U.S. dollar prices constant in response to yen appreciations. Thus yen appreciations do less to damage its profitability. The NT dollar also does not affect Murata stocks. For products such as multi-layer ceramic capacitors, Murata produces the higher-end items and Taiwanese firms produce the lower-end items. Thus there is less price competition between Murata and Taiwanese firms. The positive coefficient on the Korean won could reflect the phenomenon that Patel and Wei (2019) highlighted. They noted that there can be a complementary relationship between Japanese parts and components makers and downstream producers. A depreciation of the won can increase the demand for Korean final goods exports and thus increase the demand for Japanese parts and components that go into these goods.

The important implication of these findings is that, when the yen appreciates and the NT dollar depreciates, the profitability of Japanese semiconductor makers suffers. This combination occurred for more than two years after the Lehmann Brothers shock in 2008. On the other hand Murata Manufacturing produces advanced products rather than commoditized goods and is not exposed to either the Japanese yen or the NT dollar.

5. Discussion

When the yen appreciated between June 2007 and September 2012, yen export prices for Japanese electronic parts and components exports fell 35 percent relative to yen production costs (Figure 3). Results from estimating pass-through equations indicate that the appreciation of the yen led to the lion's share of the fall in export prices. The evidence that yen export prices adjust one-for-one with exchange rates suggests that the effect of exchange rates on the volume of ep&c exports should be small. Results from estimating export equations bear this out. Results from estimating exchange rate exposure equations, on the other hand, indicate that an appreciation of the yen and a depreciation of the NT dollar cause large declines in semiconductor stock prices.

The appreciating yen and weakening NT after the GFC thus impaired the profitability of Japanese parts and components makers. While the yen subsequently depreciated and the NT dollar appreciated, however, Japanese ep&c makers never regained their competitiveness relative to Korean and Taiwanese producers. This is clear from Figure 1 that shows that Japan's comparative advantage in ep&c fell while Taiwan and Korea's comparative advantage rose. It is also seen in Figure 2, that shows that the value of Japan's ep&c exports has fallen since the GFC while Korea and Taiwan's have soared.

Why did Japan's electronic parts exports not recover after the yen depreciated in 2012? Maintaining competitiveness in this industry requires massive investment in physical capital and in research and development (see, e.g., Rastogi *et al*., 2011). Following the profitability shock, Japanese firms were unable to sustain investment at pre-GFC levels. This is clear in Figure 5. It shows investment in tangible fixed assets by Japanese electronic parts and components makers. The data come from the Census of Manufacture collected by the Ministry of Trade and Industry. They show that investment by Japanese ep&c firms tumbled after the GFC and never recovered. The *endaka* shock thus triggered hysteresis effects that contributed to a long-term decline in the industry.[5]

By contrast, Taiwanese and Korean ep&c firms have seen their profitability increase. This is seen in Figure 6. It shows that stock prices for Taiwanese and Korean semiconductor producers have soared, while prices for Japanese producer in 2019 remain below their values from 2005. Rising profits at firms in Taiwan and Korea have enabled them to invest heavily and maintain their comparative advantage in producing ep&c.

Not all Japanese electronic parts producers have fared badly since the GFC though. The results above indicate that Murata Manufacturing is not exposed to exchange rates. Figure 7 shows that Murata's stock price in 2019 far exceeds its pre-Crisis values.

6. Conclusion

[5] I am indebted to Dr. Masayuki Morikawa for this insight.

The strong yen after the Global Financial Crisis decimated the profitability of the Japanese electronic parts and components industry. These products face short lifecycles and volatile demand. Continual investment is needed to remain competitive. As the strong yen shook the Japanese electronics sector, its ability to sustain investment fell.

This experience offers a couple of lessons. First, unexpected shocks can cause an industry's outlook to turn on a dime. Japanese companies should save during good times to be prepared for downturns. During the bad times they should focus on long-term viability and resist hysteresis effects. Second, competing based on price in commoditized industries is onerous. Japanese companies should focus on products where craftsmanship is valued. Examples of this are the ceramic filters that Murata produces or the image sensors that Sony makes. By finding niches where they have market power, firms will be less exposed to volatile exchange rates.

Sato, Shimizu, Shrestha and Zhang (2013) found that the Japanese yen and the Korean won moved in opposite directions between 2003 and 2013 and that as the yen appreciated relative to the won, Japanese electronics firms faced severe competition from Korean firms. It is thus puzzling that Japanese semiconductor stocks are not exposed to the Korean won along with the New Taiwan dollar. It is also notable that Murata Manufacturing may benefit from a weaker won, suggesting that there may be a complementary relationship between Murata and Korean firms. Future research should investigate the nexus of competitive and cooperative relationships between Japanese, Taiwanese, and Korean firms. This evidence could assist in formulating regional exchange rate policies that relieve pressure for beggar-thy-neighbor outcomes and promote Asian value chains.

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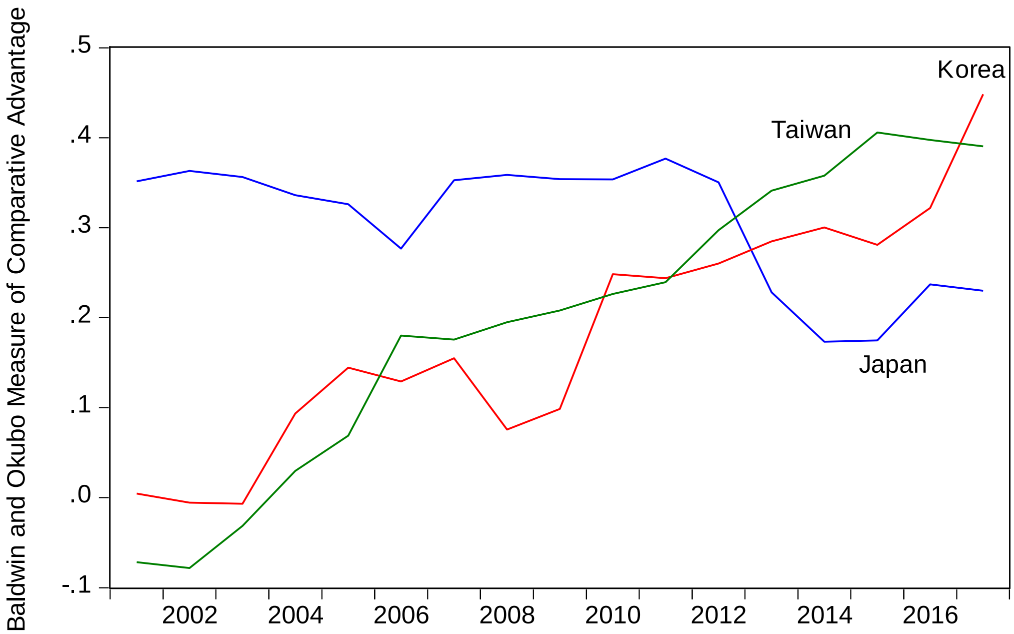

Figure 1. The Comparative Advantage of Japan, South Korea, and Taiwan in exporting electronic parts and components.
Note: Comparative advantage is calculated using the method of Baldwin and Okubo (2019)
Source: CEPII-CHELEM database and calculations by the author.

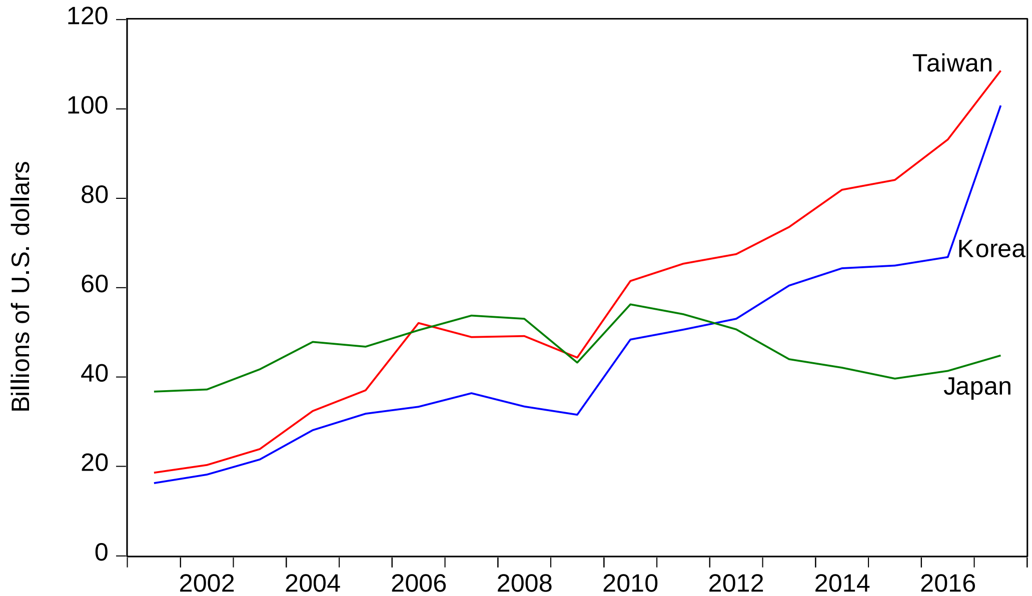

Figure 2. The value of electronic parts and components exports from Japan, South Korea, and Taiwan.
Note: Electronic parts and components come from International Standard Industrial Classification code 3210.
Source: CEPII-CHELEM database.

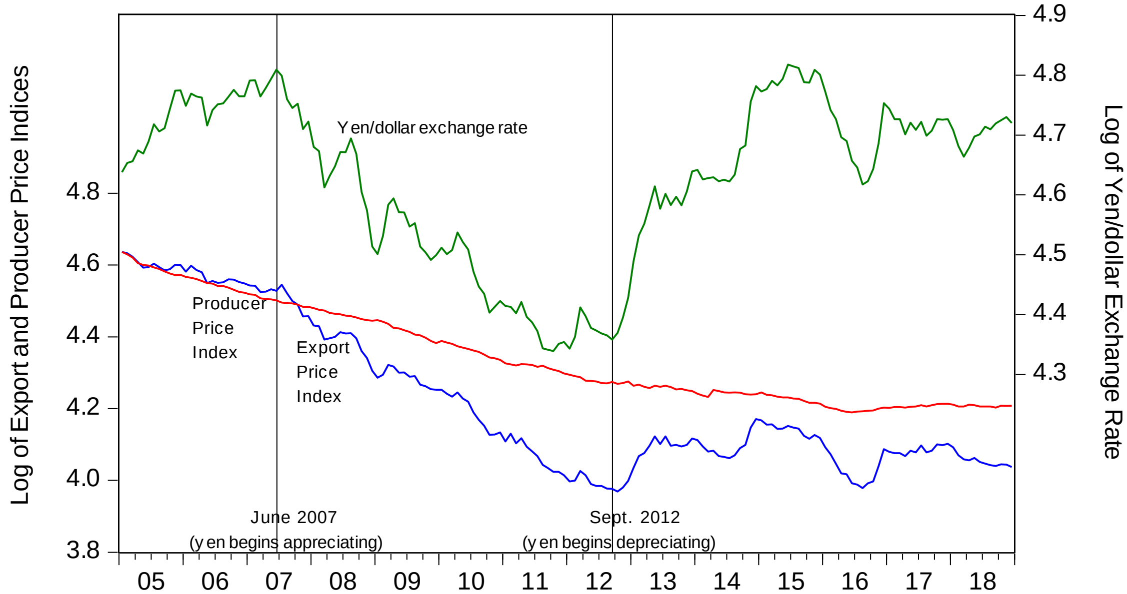

Figure 3. The yen/dollar exchange rate and the producer price index and export price index for Japanese electronic components and devices.
Source: Bank of Japan and CEIC Database.

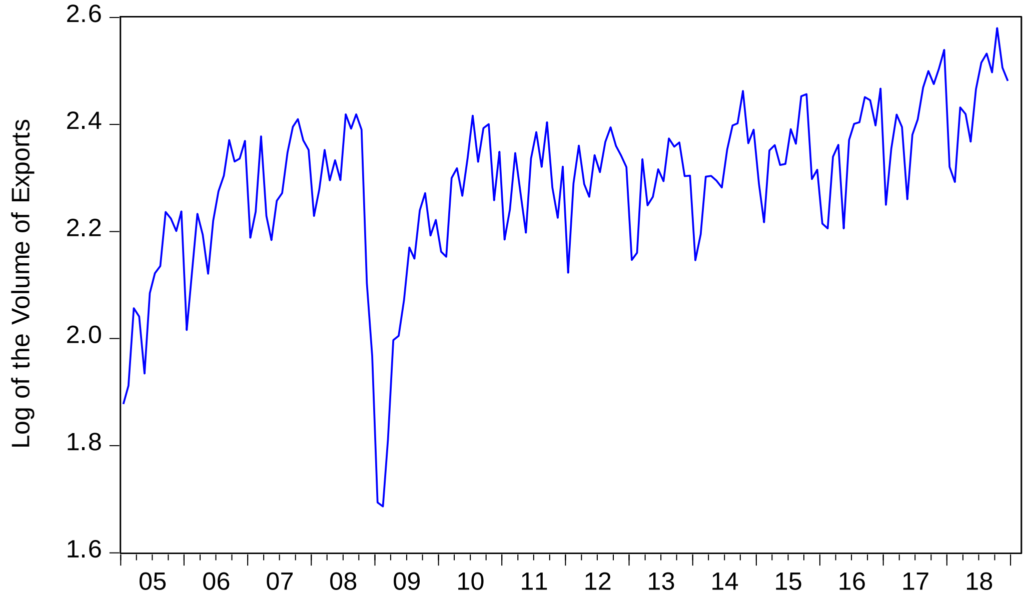

Figure 4b. The volume of Japanese electronic components and devices exports.
Source: Bank of Japan and CEIC Database.

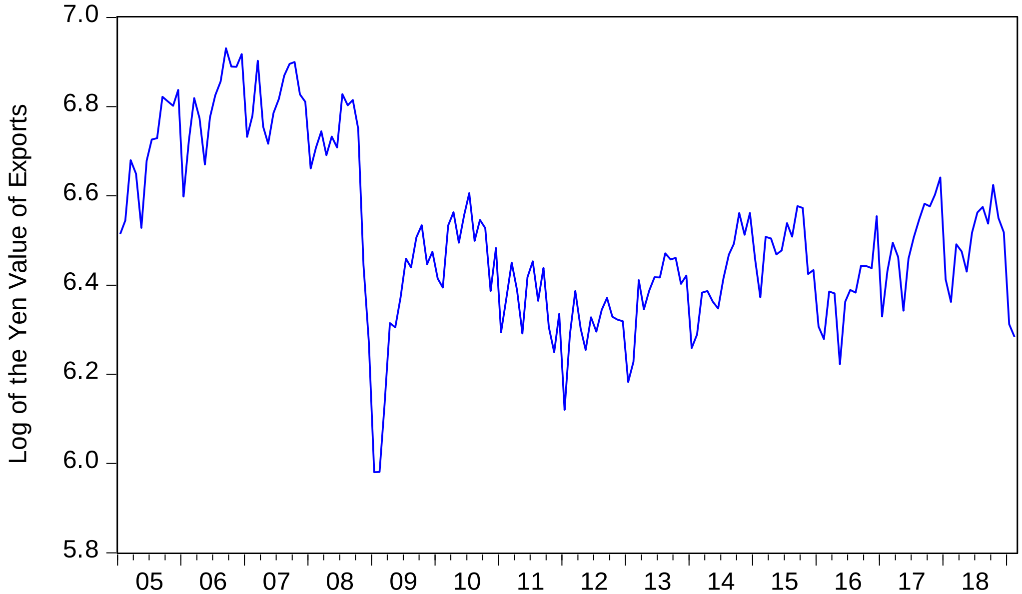

Figure 4a. The yen value of Japanese electronic components and devices exports.
Source: Bank of Japan and CEIC Database.

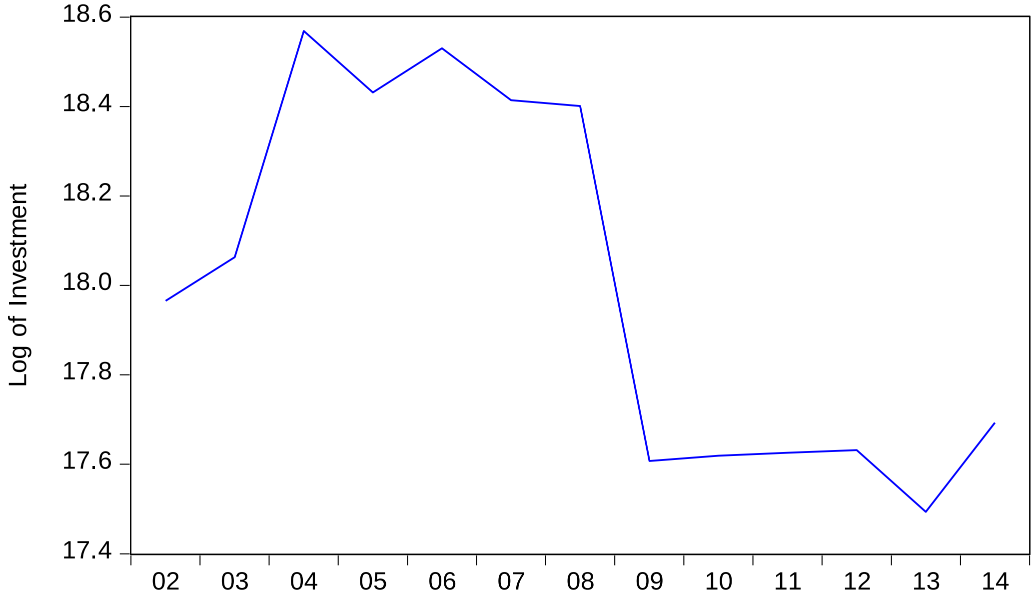

Figure 5. Investment in tangible fixed assets by Japanese electronic parts and components makers.

Note: The figure includes makers of electronic tubes, semiconductor devices, integrated circuits, resistors, capacitors, transformers, electroacoustic transducers, magnetic heads and small motors, connectors, switches and relays. The data are available between 2002 and 2014, except for 2011. The value for 2011 in the figure is the average of the values for 2010 and 2012.

Source: Census of Manufacture, Ministry of Trade and Industry.

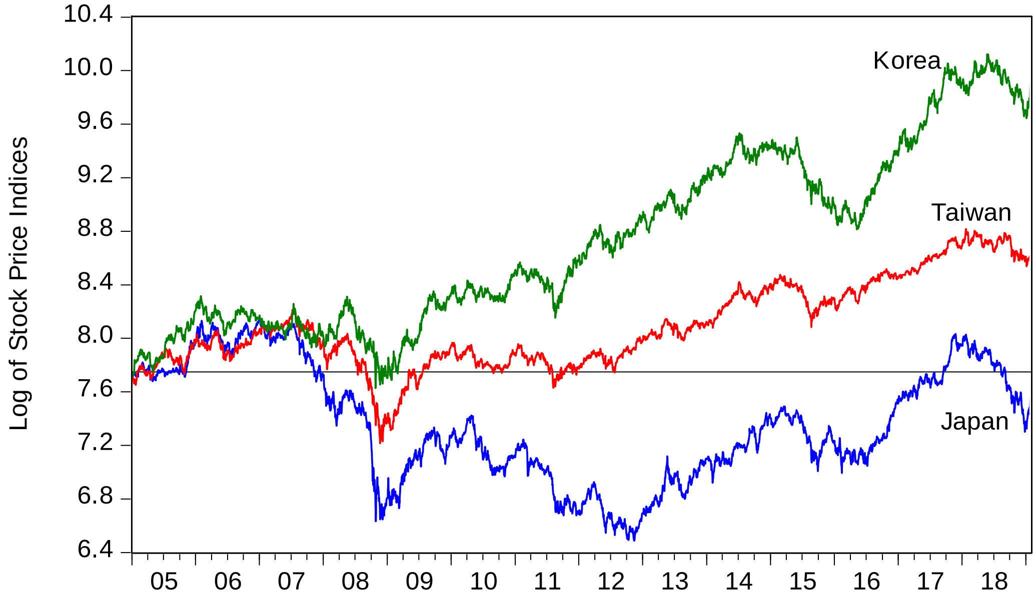

Figure 6. Semiconductor stock prices in Japan, South Korea, and Taiwan.
Source: Datastream database.

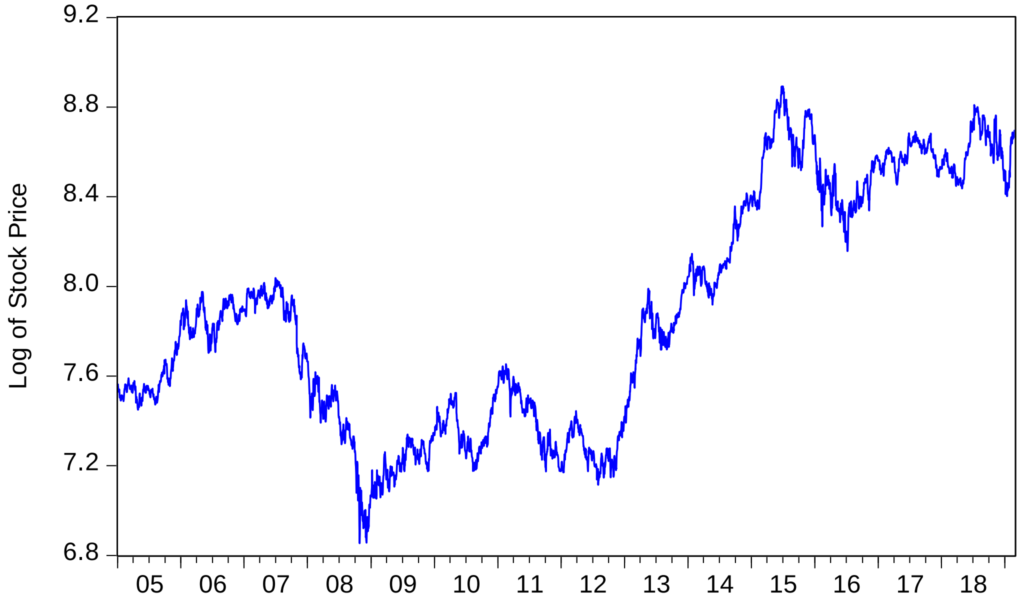

Figure 7. Stock prices for Murata Manufacturing.
Source: Datastream database.

Table 1. Regression estimates of the change in the yen export price for Japanese electronic components and devices, 2005:01-2018:01.

Independent Variable	Coefficient	Standard Error
ΔExchange Rate	0.974***	0.033
ΔExchange Rate$_{-1}$	0.089**	0.041
ΔExchange Rate$_{-2}$	0.054	0.044
ΔForeign PPI	0.074	0.092
ΔForeign PPI$_{-1}$	-0.044	0.083
ΔForeign PPI$_{-2}$	-0.136	0.119
ΔECD PPI	0.568***	0.150
ΔECD PPI$_{-1}$	0.107	0.138
ΔECD PPI$_{-2}$	0.261**	0.111
ΔForeign IP	-0.011	0.071
ΔForeign IP$_{-1}$	0.070	0.090
ΔForeign IP$_{-2}$	0.068	0.084
Constant	-0.001	0.001
Adjusted R-squared	0.846	
Standard Error of Regression	0.006	
Durbin-Watson Statistic	2.14	

Table 2. Panel DOLS Estimates of Japanese Electronic Parts and Components Exports to 16 Countries

	(1)	(2)
Electronics Exports	0.57*** (0.04)	0.65*** (0.05)
Bilateral Real Exchange Rate	-0.27*** (0.08)	-0.21*** (0.08)
Adjusted R-squared	0.974	0.989
S.E. of regression	0.219	0.143
Country Fixed Effects	Yes	Yes
Heterogeneous Linear Trend	No	Yes
Sample Period	2002-2017	2002-2017
No. of Observations	256	256

Notes: The number of lags and leads of the first differences of the independent variables are determined by the Schwartz Information Criterion. An increase of the bilateral real exchange rate implies an appreciation of the Japanese yen. The predicted sign of the coefficient is negative. Electronics Exports refers to exports from the countries that import electronic parts and components from Japan and includes exports in the following categories: telecommunications equipment, computer equipment, consumer electronics, electronic components, precision instruments, clockmaking, and optics.
*** denotes significance at the 1% level.

Table 3. The Exchange Rate Exposure of the Japanese Semiconductor Stocks and Murata Manufacturing's Stock

	(1) Returns on Semiconductor Stocks	(2) Returns on Murata Manufacturing's Stock
Yen/U.S. dollar exchange rate	0.31*** (0.04)	0.09 (0.06)
NT dollar/ U.S. dollar exchange rate	-0.35*** (0.09)	-0.07 (0.04)
Korean won/ U.S. dollar exchange rate	0.00 (0.04)	0.12* (0.07)
Return on Japanese stock market	1.08*** (0.03)	1.16*** (0.04)
Return on world stock market	0.11*** (0.03)	0.02 (0.04)
Adjusted R-squared	0.67	0.47
S.E. of regression	0.011	0.016
Durbin-Watson Statistic	1.95	1.94
Sample Period	4 January 2005-31 January 2019	4 January 2005-31 January 2019
No. of Observations	3673	3673

Notes: An increase of the yen/U.S. dollar, NT dollar/ U.S. dollar, Korean won/ U.S. dollar exchange rates implies a depreciation of the yen, NT dollar, or won relative to the U.S. dollar. Heteroskedasticity and autocorrelation consistent standard errors in parentheses.

*** (*) denotes significance at the 1%(10%) levels.