Asymmetric Exchange Rate Pass-Through between Unexpected Yen Appreciation and Depreciation: The Case for Japanese Machinery Exports*

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Abstract

This paper investigates whether Japanese exporters adjusted their exchange rate pass-through (ERPT) behavior in response to significant yen fluctuations from January 2000 to December 2022. A novel aspect of our study is the integration of exchange rate prediction errors into a nonlinear autoregressive distributed lag (NARDL) model with multiple thresholds. This approach allows us to rigorously differentiate between strong and weak yen levels and between unexpected yen appreciation and depreciation. We discover an asymmetric ERPT pattern during strong and weak yen levels. Particularly interesting is the strategic shift in pricing behavior by Japanese machinery exporters, alternating between ERPT and pricing-to-market (PTM) strategies in response to unexpected yen appreciation and depreciation, without changing the invoice currency choice. This finding is further supported by our analysis of disaggregated sectoral data. The practical implications of our empirical findings are significant, providing valuable insights for Japanese export firms in devising effective pricing strategies in the face of unanticipated, large exchange rate changes.

Keywords: Exchange rate pass-through (ERPT); pricing-to-market (PTM); invoice currency; nonlinear autoregressive distributed lag model; multiple thresholds; expected exchange rate

JEL classification: F31; F36; F23

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1. Introduction

Exporters' pricing behavior has been empirically investigated in the exchange rate pass-through (ERPT) literature. In the 1980s, Japanese exporters' pricing strategy gained much attention since Japan's trade surplus against the United States continued to increase even though the yen appreciated substantially against the US dollar (USD) from 254.2 in January 1985 to 123.6 in December 1988.[1] Seminal empirical works in the ERPT literature, such as Giovannini (1988), Marston (1990), and Knetter (1989, 1993), demonstrated that Japanese exporters stabilized their selling price in the destination market in terms of the local currency, which is typically called "pricing-to-market (PTM)" behavior.

Recent studies have paid renewed attention to an empirical analysis of ERPT and invoice currency choice using the unpublished Customs data at a highly disaggregated transaction level. Among others, Amiti *et al*. (2022) use Belgian Customs data on export and import transactions, Devereux *et al*. (2017) and Goldberg and Tille (2016) use Canadian import transaction data obtained from the Canadian Border Service Agency (CBSA), Berthou *et al*. (2022) use French Customs data of firm-level French exports, and Chung (2016) and Corsetti *et al*. (2022) use the UK's non-EU trade statistics, recorded by Her Majesty's Revenue and Customs (HMRC). While highly disaggregated transaction-level or firm-level data are necessary for rigorous empirical investigation, most studies employ a relatively short sample period, such as seven or eight years.[2]

In contrast, this paper empirically investigates whether Japanese exporters changed the degree of ERPT or PTM across different levels and phases (directions) of the yen's exchange rate for a more extended sample period from 2000 to 2022. For instance, Japanese exporters experienced considerable appreciation and depreciation from 2007 to 2015. After the yen's appreciation against the USD from 122.6 in June 2007 to 76.8 in October 2011, the yen depreciated sharply to 123.8 in June 2015 (Figure 1). This arouses our strong interest in possible asymmetric ERPT or PTM in Japanese exports between yen appreciation and depreciation periods. In addition, Japan experienced substantial yen depreciation again, from 103.7 in January 2021 to 147.0 in October 2022. This excites another interest in the possible difference in ERPT or PTM between yen depreciation in

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[1] This paper shows data on the nominal exchange rate (monthly average) of the yen vis-à-vis the US dollar (USD) taken from the IMF's International Financial Statistics, which is available online.

[2] See Yoshimi *et al*. (2024) and Yoshida *et al*. (2024), which used Japanese Customs data at a highly disaggregated transaction level from 2014 to 2020 to analyze ERPT and the choice of invoice currency. Ito *et al*. (2012, 2018) used Japanese firm-level data obtained from a large-scale questionnaire survey to examine the firms' invoice currency choice and its determinants.

2013–2015 and the subsequent depreciation in 2021–2022 because the yen level is considerably different between the two depreciation periods.

Existing empirical studies such as Knetter (1994), Delatte and López-Villavicencio (2012), Baharumshah *et al*. (2017), and Jammazi *et al*. (2017) examined possible nonlinearity or asymmetry in exporters' pricing behavior, employing a "zero-threshold" approach. For example, in Japanese exports, the nominal exchange rate of the yen against the USD (S_t) is decomposed into two series of exchange rates. A positive change in the nominal exchange rate of the yen ($\Delta \ln S_t > 0$) is considered a yen depreciation period, while a negative change ($\Delta \ln S_t < 0$) is assumed to indicate a yen appreciation period. With the two decomposed exchange rate series, an autoregressive distributed lag (ARDL) model is widely used for the nonlinear estimation of ERPT.[3]

As demonstrated by Nguyen and Sato (2019), however, the zero-threshold approach does not necessarily work as an appropriate threshold to distinguish between currency appreciation and depreciation periods. Given the volatile nature of nominal exchange rates, for instance, short-run positive changes in the exchange rate (i.e., currency depreciation) are often observed even during the continuous and substantial currency appreciation period. As shown in Figure 1, even though we observe a strong yen period from June 2007 to October 2011, several months show small positive changes in the yen, which are incorrectly categorized by the zero-threshold approach into the yen "depreciation" period.

[Insert Figure 1 around here.]

A novel development of this study is that we incorporate exchange rate prediction errors into a nonlinear autoregressive distributed lag (NARLD) model with multiple thresholds to overcome the limitation of the zero-threshold approach.[4] Specifically, we compute prediction errors by comparing the actual (realized) exchange rates with the *survey-based* expected exchange rates collected by the Bank of Japan (BOJ). The expected yen exchange rates against the USD by industry are compiled from the BOJ's questionnaire survey with more than 9,000 Japanese firms. Although the expected exchange rates of individual firms are not disclosed, the BOJ publishes the industry-averaged expected exchange rates.

[3] Whereas most existing studies perform nonlinear estimation of an ARDL model, Nguyen and Sato (2020) employ a structural near-VAR model to investigate possible asymmetry in the ERPT of Japanese exports.

[4] For empirical studies using the multiple threshold NARDL model, see Verheyen (2013), Pal and Mitra (2016), and Jalal and Gopinathan (2022).

This paper proposes employing the multiple-threshold NARDL model with prediction errors (MT-NARDL-PE), which has two distinctive features. First, as benchmark thresholds for estimation of the MT-NARDL model, we choose 40% and 60% quantiles of the monthly series of the nominal effective exchange rate (NEER) of the yen and distinguish between "weak yen (depreciation)," "neutral," and "strong yen (appreciation)" periods in terms of the *level* of exchange rates.[5] Second, using the survey-based expected exchange rates, we divide the strong yen period into *unexpected* yen appreciation and depreciation phases. We also split the weak yen period into unexpected yen appreciation and depreciation phases. Then, we estimate the degree of ERPT or PTM for both phases of unexpected yen appreciation and depreciation in the strong and weak yen periods to reveal whether there is an asymmetry in pricing behavior across different levels and phases of the yen exchange rates. We conduct additional estimations with various threshold choices to check the robustness of our benchmark results.

This paper finds that while PTM behavior becomes evident during the strong yen period, the degree of ERPT (PTM) is larger (smaller) in the unexpected yen appreciation phase than in the unexpected yen depreciation phase. More intriguingly, the degree of PTM in the unexpected yen depreciation phase is larger during the strong yen levels than the weak yen levels, likely because Japanese exporters sacrificed their foreign exchange gains to lower the export price during the weaker yen levels. Thus, Japanese exporters strategically shift their pricing behavior, alternating between ERPT and PTM strategies in response to unexpected yen appreciation and depreciation, without changing the invoice currency choice. The above findings obtained from the benchmark thresholds are supported by different threshold values and the time-varying estimates of the Japanese exporters' invoice currency choice. The practical implications of our empirical findings are significant, providing valuable insights for Japanese export firms in devising effective pricing strategies in the face of unanticipated, large exchange rate changes.

The remainder of the paper is organized as follows. Section 2 elaborates on our empirical model. Section 3 describes the data. Section 4 presents and discusses empirical results. Finally, Section 5 concludes this study.

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[5] As discussed in later sections, we use the Japanese export price index for an ERPT analysis, and destination breakdown data for the export price index is unavailable. Thus, we do not use the bilateral nominal exchange rate but the NEER to estimate the MT-NARDL-PE model. It must be noted that the bilateral nominal exchange rate of the yen vis-à-vis the USD is used to obtain exchange rate prediction errors since expected exchange rates are available only for the bilateral nominal exchange rate against the USD.

2. Empirical Model

2.1 ARDL Approach to ERPT

This paper employs the following empirical model that is typically used in the ERPT literature:[6]

$$p_t^x = \beta_0 + \beta_1 neer_t + \beta_2 dp_t + \beta_3 ipi_t^w + \varepsilon_t \qquad (1)$$

where p^x denotes the natural log of yen-based export price; *neer* denotes the natural log of the yen's NEER; *dp* denotes the natural log of domestic input price as a proxy for production costs; ipi^w denotes the natural log of world industrial production index as a proxy for global demand; and ε denotes error term.

Our primary interest is in the coefficient β_1 that measures the degree of ERPT or PTM. We do not use the bilateral nominal exchange rate but the NEER because destination-specific export prices are unavailable from the BOJ database.[7] Note that our NEER of the yen (*neer*) is a reciprocal of the NEER obtained from the Bank for International Settlements (BIS), which means that an increase (decrease) in the yen's NEER is defined as depreciation (appreciation) of the yen in this paper. Given our definition of the yen's NEER, the coefficient β_1 is equal to one and statistically significant when the degree of ERPT (PTM) is zero (100%). When the coefficient β_1 is equal to zero and/or not statistically significant, the degree of ERPT (PTM) is 100% (zero). Usually, the estimated coefficient β_1 lies between zero and one, which is called incomplete ERPT or PTM.

The ARDL modeling approach, developed by Pesaran *et al*. (2001), is widely used in recent empirical studies on ERPT, which can estimate both short-run and long-run ERPT behavior. Specifically, we estimate a conditional error-correction model (ECM) to perform the bounds test for cointegration:

$$\begin{aligned}\Delta p_t^x &= \rho_0 + \rho_1 p_{t-1}^x + \rho_2 neer_{t-1} + \rho_3 dp_{t-1} + \rho_4 ipi_{t-1}^w \\ &\quad + \sum_{i=1}^{k} \gamma_{1i} \Delta p_{t-i}^x + \sum_{i=0}^{l} \gamma_{2i} \Delta neer_{t-i} + \sum_{i=0}^{m} \gamma_{3i} \Delta dp_{t-i} + \sum_{i=0}^{n} \gamma_{4i} \Delta ipi_{t-i}^w + v_t \end{aligned} \qquad (2)$$

[6] This empirical specification is widely used in the literature on ERPT, such as Goldberg and Knetter (1997), Campa and Goldberg (2005), and Nguyen and Sato (2019). It is applied to panel estimation with cross-section and time-fixed effects. See, for instance, Knetter (1989, 1993), Takagi and Yoshida (2001), and Yoshida (2010).

[7] The BOJ publishes the yen-based export price index not by destination but by industry.

Pesaran *et al*. (2001) proposed to conduct the bounds F-test, the joint null hypothesis of which is H_0: $\rho_1 = \rho_2 = \rho_3 = \rho_4 = 0$. If the null hypothesis is rejected, we may say that a long-run equilibrium relationship is found between the variables, which is equivalent to Equation (1). Specifically, in Equation (2), the long-run ERPT or PTM coefficient is calculated as $\beta_1 = -\rho_2 / \rho_1$ and ρ_1 is called the error-correction term (ECT), which represents the speed of adjustment to equilibrium. To ascertain a level relationship between the variables, Pesaran *et al*. (2001) also proposed to perform another bounds test for cointegration, i.e., the bounds t-test, where the null hypothesis is H_0: $\rho_1 = 0$. We conduct both bounds testing procedures in the following nonlinear ARDL approach.

2.2 Nonlinear ARDL Approach

The conventional ARDL model can be extended to investigate the possible asymmetric impact of exchange rate changes on export prices. Knetter (1994), Delatte and López-Villavicencio (2012), Shin *et al*. (2014), Baharumshah *et al*. (2017), and Jammazi *et al*. (2017) employ the following decomposition approach to distinguish between exchange rate depreciation and appreciation periods:

$$s_t^+ = \sum_{j=1}^{t} \Delta s_j^+ = \sum_{j=1}^{t} \max(\Delta s_j, 0) \quad (3)$$

$$s_t^- = \sum_{j=1}^{t} \Delta s_j^- = \sum_{j=1}^{t} \min(\Delta s_j, 0) \quad (4)$$

where s_t denotes the natural log of the nominal exchange rate of the home currency against the foreign currency. This decomposition approach utilizes the information on the short-run exchange rate changes, i.e., log differences of the nominal exchange rate series. Specifically, a positive change in the nominal exchange rate of the home currency ($\Delta s_t > 0$) is considered a home currency depreciation, while a negative change ($\Delta s_t < 0$) is assumed to indicate a home currency appreciation. This zero-threshold approach has been widely used as the NARDL model to examine possible asymmetric ERPT or PTM in exports and imports.

The zero-threshold approach, however, does not necessarily work as an appropriate threshold to distinguish between currency appreciation and depreciation periods. Figure 1 illustrates a significant drawback of the zero-threshold approach. From early 2010 to late 2011, the yen appreciated substantially from around 90 to 77 against the USD, which is widely recognized as a historically high level of yen appreciation. In Figure 1, however, we observe small positive changes in the yen several times during the yen appreciation period. As shown by Nguyen and Sato (2019), if we rely on the zero-threshold approach, positive changes in the yen during the yen appreciation period would be categorized into the yen depreciation period, which prevents us from making a rigorous and correct distinction between yen appreciation and depreciation periods.[8]

2.3 Multiple Threshold Nonlinear ARDL Approach

To overcome the drawback of the zero-threshold approach, previous studies employ the multiple-threshold approach, such as Verheyen (2013), Pal and Mitra (2016), and Jalal and Gopinathan (2022), although these studies do not analyze the ERPT or PTM behavior.[9] By applying the multiple-threshold approach to Equation (2), we may set up the following conditional ECM by using 40% and 60% quantile of the NEER series as benchmark thresholds q_a and q_b, respectively:

$$\begin{aligned}\Delta p_t^x &= \rho_0 + \rho_1 p_{t-1}^x + \rho_2 neer_{t-1}^+ + \rho_3 neer_{t-1}^\pm + \rho_4 neer_{t-1}^- + \rho_5 dp_{t-1} + \rho_6 ipi_{t-1}^w \\ &+ \sum_{i=1}^{k} \gamma_{1i} \Delta p_{t-i}^x + \sum_{i=0}^{l_2} \gamma_{2i} \Delta neer_{t-i}^+ + \sum_{i=0}^{l_3} \gamma_{3i} \Delta neer_{t-i}^\pm + \sum_{i=0}^{l_4} \gamma_{4i} \Delta neer_{t-i}^- \\ &+ \sum_{i=0}^{m} \gamma_{5i} \Delta dp_{t-i} + \sum_{i=0}^{n} \gamma_{6i} \Delta ipi_{t-i}^w + v_t\end{aligned} \quad (5)$$

where three partial sums of the NEER series are:

$$neer_t^+ = neer_{t-1}^+ + \Delta neer_t \cdot I\{neer_t > q_b\} \quad (6)$$

$$neer_t^\pm = neer_{t-1}^\pm + \Delta neer_t \cdot I\{q_a \le neer_t \le q_b\} \quad (7)$$

$$neer_t^- = neer_{t-1}^- + \Delta neer_t \cdot I\{neer_t < q_a\} \quad (8)$$

$I\{\cdot\}$ denotes an indicator function that takes the value of one if the condition in the bracket is satisfied; otherwise, the indicator function takes the value of zero. It must be noted that this approach using Equations (6) – (8) differs distinctly from the previous studies such as Verheyen (2013), Pal and Mitra (2016), and Jalal and Gopinathan (2022) that used not $neer_t$ but $\Delta neer_t$ in the above indicator functions as a straightforward extension of the zero-threshold approach. This paper uses the information on a level of NEER ($neer_t$) for the decompositions, motivated by Figures 1 and 2.

[Insert Figure 2 around here.]

[8] See Figure 4 of Nguyen and Sato (2019), which graphically illustrates that the zero-threshold approach fails to distinguish between yen appreciation and depreciation periods correctly.

[9] For empirical studies using the multiple-threshold approach, see also Jammazi *et al*. (2017), Asad *et al*. (2020), Kisswani (2021), and Hashmi *et al*. (2022).

To illuminate our understanding, let us look at the bilateral nominal exchange rate of the yen against the USD (i.e., JPY/USD) in Figures 1 and 2. On a monthly average basis, the JPY/USD changed from the bottom (76.77) in October 2011 to a peak (147.01) in October 2022. Japanese exporters' pricing behavior may be different between the yen depreciation period in 2013–2014 (i.e., (ii) in Figure 2) and another yen depreciation period in 2022 (i.e., (iv) in Figure 2) because the level of JPY/USD differs substantially. Specifically, the former depreciation occurred in 2013–2014, when the JPY/USD reached around 100 in 2014, which was welcomed by Japanese exporters that had suffered from foreign exchange losses arising from historically strong appreciation in 2010–2012. In contrast, the latter depreciation occurred in 2022, when the JPY/USD reached 147 in October 2022. Japanese firms were concerned about the inflationary side effects of the substantial yen depreciation. These possibly different level effects of the exchange rate will neither be captured nor considered by the multiple-threshold approach using $\Delta neer_t$ in the indicator function.

2.4 Multiple Threshold Nonlinear ARDL Approach with Prediction Errors

The MT-NARDL approach in Equations (5) – (8) we proposed is insufficient in practice to consider the different impacts of exchange rate changes. Specifically, in Figure 2, we divide the whole sample period into three sub-samples: "strong yen period" with the exchange rate level below 107.36, "neutral period" with the exchange rate level between 107.36 and 111.21, and "weak yen period" with the exchange rate level above 111.21. The threshold values, 107.36 and 111.21, are chosen by 40% and 60% quantiles as the benchmark case.

Even in the strong yen period, for instance, there are two different exchange rate movements: one is the continuous appreciation of the yen from around 2007 to 2012 (i.e., (i) in Figure 2), and the other is the sharp and substantial depreciation from 2013 to 2014 (i.e., (ii) in Figure 2). The Japanese exporter's pricing behavior will likely differ between the two movements in the opposite direction.

To consider two different aspects, i.e., levels and changes in the exchange rate, we propose a new approach, the multiple-threshold nonlinear ARDL approach with prediction errors (MT-NARDL-PE). Specifically, we identify unexpected yen appreciation or depreciation by using the prediction errors obtained from differences between the actual (realized) nominal exchange rate and the survey-based expected exchange rate, developed by Nguyen and Sato (2019).

Unexpected yen appreciation if $S_{t+1} < E_t S_{t+1}$ holds.

Unexpected yen depreciation if $S_{t+1} > E_t S_{t+1}$ holds.

S_{t+1} can be considered as the nominal exchange rate of the yen against the USD "realized" at $(t + 1)$. E_t is an expectation operator using all information available at time t, and $E_t S_{t+1}$ denotes the expected exchange rate for time $(t + 1)$, for which we use the survey-based expected exchange rate.

By using the above prediction errors, we set up the following decomposition of the NEER series of the strong yen ($neer_t^-$) to obtain the unexpected yen appreciation ($neer_t^{--}$) and unexpected yen depreciation ($neer_t^{-+}$) in the period of strong yen in levels:

$$neer_t^{--} = neer_{t-1}^{--} + \Delta neer_t^- \cdot I\{S_t < E_{t-1} S_t\} \quad (9)$$

$$neer_t^{-+} = neer_{t-1}^{-+} + \Delta neer_t^- \cdot I\{S_t > E_{t-1} S_t\} \quad (10)$$

Similarly, we decompose the NEER series of the weak yen ($neer_t^+$) to obtain the unexpected yen appreciation ($neer_t^{+-}$) and unexpected yen depreciation ($neer_t^{++}$) in the period of the weak yen in levels:

$$neer_t^{+-} = neer_{t-1}^{+-} + \Delta neer_t^+ \cdot I\{S_t < E_{t-1} S_t\} \quad (11)$$

$$neer_t^{++} = neer_{t-1}^{++} + \Delta neer_t^+ \cdot I\{S_t > E_{t-1} S_t\} \quad (12)$$

The MT-NARDL-PE model can be set up as the following conditional ECM by using 40% and 60% quantile of the NEER series as the benchmark thresholds:

$$\begin{aligned} \Delta p_t^x = {} & \rho_0 + \rho_1 p_{t-1}^x + \rho_2 neer_{t-1}^{++} + \rho_3 neer_{t-1}^{+-} + \rho_4 neer_{t-1}^{\pm} + \rho_5 neer_{t-1}^{-+} + \rho_6 neer_{t-1}^{--} \\ & + \rho_7 dp_{t-1} + \rho_8 ipi_{t-1}^w + \sum\nolimits_{i=1}^{k} \gamma_{1i} \Delta p_{t-i}^x + \sum\nolimits_{i=0}^{l_2} \gamma_{2i} \Delta neer_{t-i}^{++} + \sum\nolimits_{i=0}^{l_3} \gamma_{3i} \Delta neer_{t-i}^{+-} \\ & + \sum\nolimits_{i=0}^{l_4} \gamma_{4i} \Delta neer_{t-i}^{\pm} + \sum\nolimits_{i=0}^{l_5} \gamma_{5i} \Delta neer_{t-i}^{-+} + \sum\nolimits_{i=0}^{l_6} \gamma_{6i} \Delta neer_{t-i}^{--} \\ & + \sum\nolimits_{i=0}^{m} \gamma_{7i} \Delta dp_{t-i} + \sum\nolimits_{i=0}^{n} \gamma_{8i} \Delta ipi_{t-i}^w + v_t \end{aligned} \quad (13)$$

where an appropriate lag length is chosen based on the Akaike information criterion (AIC). After estimating the conditional ECM, we conduct the bounds F-test for cointegration, the joint null hypothesis of which is H_0: $\rho_1 = \rho_2 = \rho_3 = \rho_4 = \rho_5 = \rho_6 = \rho_7 = \rho_8 = 0$.[10] If the null hypothesis is rejected, we conclude that a long-run equilibrium relationship exists between the variables. We also perform the bounds *t*-test for cointegration to ascertain the long-run equilibrium relationship, where the null hypothesis is H_0: $\rho_1 = 0$.

We conduct the test for (a)symmetric ERPT or PTM in both the short and long run. The null hypothesis of long-run symmetry in the strong yen period is H_0: $-\rho_5 / \rho_1 = -\rho_6 / \rho_1$ in Equation (13), i.e., whether the long-run ERPT (or PTM) coefficients are identical between phases of the unexpected yen depreciation and appreciation in the period of strong yen in levels. Similarly, we can test for the long-run symmetry in ERPT or PTM between the unexpected yen depreciation in the weak yen period and the corresponding yen depreciation in the strong yen period, $-\rho_2 / \rho_1 = -\rho_5 / \rho_1$ in Equation (13).

3. Data

3.1 Data for ERPT

This study uses the monthly series of the Japanese export price index (on a yen basis) by industry, the NEER of the yen, domestic input prices by industry, the world industrial production index, the bilateral nominal exchange rate of the yen vis-à-vis the USD, and the corresponding expected exchange rate of the yen by industry. The sample period ranges from January 2000 to December 2022.

The Japanese export price index by industry and the domestic input price index by industry are obtained from the BOJ website. We use four industries for the export price index: one is (i) All Manufacturing, and the other three are (ii) General Machinery (i.e., General Purpose, Production, and Business-Oriented Machinery), (iii) Electric Machinery (i.e., Electric and Electronic Products), and (iv) Transport Equipment.[11] We use the corresponding domestic input price index for each industry.

The domestic input price index published by the BOJ is constructed using input coefficients obtained from the latest version of Japan's input-output table. However, the data is available only up to April 2022. From then on, the BOJ publishes a similar input

[10] Previous studies using the multiple-threshold for NADL estimation used the bounds *F*-test for cointegration developed by Pesaran *et al*. (2001) and Shin *et al*. (2014). See Verheyen (2013), Pal and Mitra (2016), and Jalal and Gopinathan (2022).

[11] "All Manufacturing" does not indicate the total of the three machinery industries (General Machinery, Electric Machinery, and Transport Equipment) but denotes the total of all manufacturing sectors/industries.

price index in a broader category called "Final Demand-Intermediate Demand price indexes (FD-ID index)." Using the information on growth rates of relevant price categories calculated from the FD-ID index, we extended the domestic input price index up to December 2022.

The NEER data is collected from the BIS website. As explained earlier, we use a reciprocal of the BIS-NEER so that an increase (decrease) in the yen's NEER that we use in this study can be defined as depreciation (appreciation) of the yen.

The World Industrial Production Index (World IPI) is constructed by taking a weighted average of the IPI series for 20 major trading partner countries for Japan. IPI series are obtained from the CEIC Database. The 20 partner countries are selected based on the criteria that the destination country's share equals one percent or larger of Japan's total exports. Seasonality is adjusted using the Census X12 method.

The export price index (yen basis), domestic input price index, NEER of the yen, and World IPI are index numbers standardized to 100 as of 2005. All series are converted to natural logarithms. We checked the time-series properties of the variables using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit-root tests. Although not reported in this paper, almost all variables are non-stationary in levels and stationary in first differences.[12]

3.2 Expected Exchange Rates

The BOJ publishes data on expected exchange rates of the yen vis-à-vis the USD obtained from a large-scale firm-level survey, the TANKAN survey, conducted four times a year (in March, June, September, and December). The BOJ sends a questionnaire to thousands of Japanese firms about the expected exchange rates of the yen vis-à-vis the USD that sample firms use for their export planning and business forecasts in each half of the fiscal year.[13]

Table 1 illustrates the structure of the data on expected exchange rates.[14] For example, the survey in March 2022 obtains information on the firm's forecast of the

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[12] One or two series are found to be stationary in levels. Still, this result slightly changes depending on whether the constant is included only or both constant and trend in the unit-root test specification. The results of unit-root tests are available upon request.

[13] In the December 2022 survey, for instance, questionnaires were sent to 9,235 firms (3,793 for manufacturing and 5,442 for non-manufacturing firms), and the response rate was 99.4%. See the BOJ website (https://www.boj.or.jp/statistics/tk/gaiyo/2021/index.htm).

[14] The following discussion is built upon the pioneering work of Nguyen and Sato (2019), who introduced a novel method for constructing the monthly series of expected exchange rates based on the BOJ TANKAN data. This method forms the basis of our current analysis.

exchange rate for the first half of the fiscal year 2022 (April–September 2022).[15] The predictions obtained in the March 2022 survey are updated in the June 2022 survey. Let us assume that the sample firms' answers are most reliable for the first three post-survey months, which enables us to construct the quarterly series of expected exchange rates: the March 2022 survey provides the data on (reliable) expected exchange rates for the first quarter (April–June 2022), the June 2022 survey for the second quarter (July–September 2022), the September 2022 survey for the third quarter (October–December 2022), and the December 2022 survey for the fourth quarter (January–March 2023).

[Insert Table 1 around here]

We finally convert the quarterly expected exchange rates to the monthly series by assuming that the firm's prediction will not be updated for the first three post-survey months, i.e., the "constant interpolation" approach. Since industry-breakdown data on expected exchange rates are available from the Bank of Japan TANKAN, we constructed the monthly series of the expected exchange rates for (i) All Manufacturing, (ii) General Machinery, (iii) Electric Machinery, and (iv) Transport Equipment. The expected exchange rates are standardized to 100 as of 2015.

4. Empirical Results

4.1 Benchmark Results

We present the estimated results of Equation (13) based on the MT-NARDL-PE model.[16] In this sub-section, we show the results for the benchmark case (40/20/40), where multiple-threshold values are chosen by 40% and 60% quantiles of the yen's NEER series.[17] We reorder the monthly NEER series in descending order; as shown in Figure 2, the upper 40% are considered as the weak yen period (W or +), the lower 40% are considered as the strong yen period (S or −), and the middle 20% are considered as the neutral period (N or ±).[18] Using prediction errors between the actual (realized) nominal

[15] Japanese fiscal year starts in April and ends in March.

[16] We rely on AIC to choose the lag order of each variable in Equation (13).

[17] Specifically, (40/20/40) means that we choose the two threshold values so that the upper 40%, middle 20%, and lower 40% can be categorized, respectively, into the "weak yen," "neutral," and "strong yen" periods in level.

[18] Again, as explained in Section 3, we use a reciprocal of the BIS-NEER so that an increase (decrease)

exchange rate of the yen vis-à-vis the USD (i.e., JPY/USD) and the survey-based expected exchange rate, we further distinguish between unexpected yen depreciation in the weak yen period (WD or $++$) and unexpected yen appreciation in the weak yen period (WA or $+-$). Similarly, we distinguish between unexpected yen depreciation in the strong yen period (SD or $-+$) and unexpected yen appreciation in the strong yen period (SA or $--$).

4.1.1 Bounds Tests for Cointegration

Table 2 presents the results of the bounds F-test for four industries. To estimate the MT-NARDL-PE model, we first included a trend term in a cointegrating space to allow for possible misspecification or omitted variables in a long-run equation. Including a trend term is necessary for the electric machinery industry, where electric components, including semiconductors, tend to show a strong downward price trend. We estimated the long-run equilibrium relationship and found that the trend term is statistically significant for the Electric Machinery and Transport Equipment. As it is not statistically significant, we do not include the trend term for All Manufacturing and General Machinery.

Conducting the bounds F-test, we have found a cointegrating relationship at least at the 10% significance level for three machinery industries: General Machinery, Electric Machinery, and Transport Equipment. A cointegrating relationship is not found for All Manufacturing, likely because All Manufacturing includes other industries such as Textiles, Chemical Products, and Metal Products in addition to the three machinery industries.

We additionally conducted the bounds t-test for cointegration and found a cointegrating relationship only for the Transport Equipment. This suggests that we have somewhat weak evidence for cointegration in the General Machinery and Electric Machinery. As shown in Table 5 below, however, the estimated error-correction term in an error-correction model is negative and strongly significant for the three machinery industries, the t-statistic for which is around -5.0 or over. This may be supporting evidence for cointegration in the three machinery industries.

[Insert Table 2 around here]

After finding cointegrating relationships for three machinery industries, we estimate long-run equilibrium relationships to examine possible asymmetric ERPT

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in the yen's NEER that we use in this study can be defined as depreciation (appreciation) of the yen.

between strong and weak yen periods and between unexpected yen appreciation and depreciation phases.

4.1.2 Asymmetry in Long-Run Coefficients

Table 3 presents the estimated results of long-run equilibrium relationships based on Equation (13).[19] Our primary interest is in the estimated coefficient of NEER, which measures the degree of ERPT or PTM. Specifically, when exporters conduct PTM behavior, the estimated coefficient of NEER becomes significantly positive and closer to one. In contrast, when exporters raise the degree of ERPT, the estimated coefficient of NEER is not statistically significant and is closer to zero.

[Insert Table 3 around here]

First, in exports of All Manufacturing, the long-run NEER coefficients are asymmetric between weak and strong yen periods: the long-run NEER coefficient is significantly positive only in the strong yen period (Table 3). Although there is an apparent asymmetry, a cointegrating relationship was not found for All Manufacturing in Table 2.

Second, in exports of General Machinery, we observe a clear pattern of asymmetric ERPT (Table 3). In the weak yen period, the long-run NEER coefficient is significantly positive (0.395) for the unexpected yen depreciation phase (NEER_WD). In contrast, it is not statistically significant for the unexpected yen appreciation phase (NEER_WA). In the strong yen period, the long-run NEER coefficient is significantly positive for both unexpected yen depreciation and appreciation phases. However, the magnitude of the estimated coefficients is larger in the unexpected depreciation phase (0.614) than in the unexpected appreciation phase (0.413), which suggests a higher degree of PTM in the unexpected depreciation phase.

Third, in the Electric Machinery exports, the long-run NEER coefficient is significantly positive only during the unexpected yen depreciation phase of the strong yen period (NEER_SD). In contrast, the estimated NEER coefficient is significantly negative during the neutral period. This is a surprising result because Japanese electric machinery exports tend to be invoiced in USD (Ito *et al*., 2018), which implies strong PTM behavior and, hence, significantly positive NEER coefficients in Table 3. The long-run input price

[19] We also report the estimated results of the long-run equilibrium relationship and conditional error-correction model for all manufacturing industries, although the cointegrating relationship was not found in Table 2.

coefficient (1.289) is significantly positive and larger than unity. This means that the export price of the Electric Machinery industry tends to overreact to input price changes. A trend term is also significantly negative, which captures a continuous price decline in electric components, including semiconductors and information and communication technology (ICT) products.

Fourth, the results for Transport Equipment exports differ markedly from those for General Machinery and Electric Machinery exports. The long-run NEER coefficients are significantly positive in Transport Equipment exports for both weak and strong yen periods, irrespective of whether it is unexpected depreciation or appreciation. This result suggests a strong tendency for transport equipment exporters to conduct PTM behavior.

4.1.3 Wald Test Results for Long-Run Estimation

To test for the long-run coefficient symmetry in Equation (13), we conduct the Wald test, where the null hypothesis is that long-run coefficients are symmetric (identical) between the two phases. Specifically, we test for the four different pairs: We first test for symmetry between unexpected depreciation and appreciation in (a) the weak yen levels (WD-WA in Table 4 or (iv) and (iii) in Figure 2) and in (b) the strong yen levels (SD-SA in Table 4 or (ii) and (i) in Figure 2). We next test for symmetry between the weak and strong yen levels, focusing on either (c) unexpected depreciation phases (WD-SD in Table 4 or (iv) and (ii) in Figure 2) or (d) unexpected appreciation phases (WA-SA in Table 4 or (iii) and (i) in Figure 2).

[Insert Table 4 around here]

Table 4 presents the results of the Wald test for coefficient symmetry. Let us first look at the results of the symmetry test between unexpected depreciation and appreciation in Table 4 (1). During the weak yen levels, asymmetric ERPT/PTM is not found for all industries (1a in Table 4). However, during the strong yen levels, the null hypothesis of coefficient symmetry is rejected at least at the 5% level for the three machinery industries (1b in Table 4). As shown in Table 3, the magnitude of estimated coefficients is larger in the unexpected depreciation phase than in the unexpected appreciation phase. Thus, during the strong yen levels, the degree of PTM (ERPT) is higher (lower) in the unexpected depreciation phase for the three machinery industries.

Next, look at the results of the symmetry test between the weak and strong yen levels. The null hypothesis of the coefficient symmetry cannot be rejected except for the two cases: Electric Machinery exports focusing on unexpected yen depreciation (2a in

Table 4) and Transport Equipment exports focusing on unexpected yen appreciation (2b in Table 4).

First, in the Electric Machinery exports, the estimated NEER coefficient is positive (1.445) and statistically significant at the 1% level only during the unexpected depreciation phase in the strong yen levels, whereas the estimated coefficient is unusually higher than unity (Table 3). Second, in the Transport Equipment exports, the degree of estimated NEER coefficients in the unexpected yen appreciation is smaller during the strong yen levels (0.50) than the weak yen levels (1.02). This suggests that the Transport Equipment exporters choose complete PTM during the weak yen levels, while the degree of PTM declines to 50% during the strong yen levels (Table 3).

Thus, the asymmetric ERPT or PTM is generally observed during the strong yen levels for exports of the three machinery industries. The strong tendency for PTM is typically observed in Transport Equipment exports, while it is rarely observed during the weak yen levels in other industries' exports. For further investigation, we make additional empirical analysis in Section 4.2 using the disaggregated export price data.

4.1.4 Asymmetry in Short-Run Coefficients

Table 5 presents the estimated results of ECM for All Manufacturing and the three machinery industries. The estimated results of the contemporaneous short-run NEER coefficients are positive and statistically significant, and the magnitude of the estimated NEER coefficients looks quite similar across the four exchange rate phases in each industry. All error-correction terms (ECTs) are negative and strongly significant.

We then test symmetry in estimated short-run contemporaneous NEER coefficients between unexpected yen depreciation and appreciation phases. The results are presented in Table 6, indicating that we cannot reject the null for the coefficient equality except that the Electric Machinery exports are considered in the unexpected yen appreciation during the strong yen levels. This suggests symmetry in the Japanese exporters' short-run ERPT or PTM across yen depreciation and appreciation periods. Gopinath *et al*. (2010) show that the short-run pricing behavior, either ERPT or PTM, tends to be governed by the choice of invoice currency. Thus, we may conclude that exporters are unlikely to change the invoice currency choice even when the exchange rate fluctuates largely. This finding is reconsidered in Section 4.2.

[Insert Tables 5 and 6 around here]

4.2 Additional Analysis

4.2.1 Different Values of Multiple-Thresholds: Robustness Check

So far, we have assumed specific values for two thresholds with three periods (weak yen/neutral/strong yen), i.e., "Benchmark Case (40/20/40)," which is chosen arbitrarily. For the robustness check, we try other threshold values, not only from (1/3, 1/3, 1/3) to (45/10/45) but also (50/50).

The bounds test results with different threshold values are presented in Appendix Table A2, which shows that we can find a cointegrating relationship in most cases for three machinery industries within a range from (1/3, 1/3, 1/3) to (43/14/43). Table A3 presents the results of long-run coefficients obtained from the estimation of the MT-NARDL-PE model. Our benchmark result is quite robust, ranging from (35, 30, 35) to (42/16/42). Moreover, as shown in Table A4, the benchmark results of the test for long-run symmetry is robust within a range from (35/30/35) to (41/18/41). Table A5 shows that we cannot reject the null hypothesis for short-run symmetry in All Manufacturing, General Machinery, and Transport Equipment, whereas the null of symmetry is often rejected in Electric Machinery between unexpected yen depreciation and appreciation during the strong yen levels.

Thus, the MT-NARDL-PE model works well, and our benchmark findings are quite robust, ranging from (35/30/35) to (41/18/41). This implies that the neutral period should not be too small (less than 18%) or too large (more than 30%).

4.2.2 Sectoral Analysis

We have so far investigated the asymmetric ERPT/PTM behavior using industry-level data. This sub-section examines the exporters' pricing behavior using disaggregated sectoral data. We chose eight sectors listed in Appendix Table A1: (i) General Purpose Machinery, (ii) Production Machinery, (iii) Business Oriented Machinery, (iv) Electronic Components and Devices, (v) Electrical Machinery and Equipment, (vi) Information and Communications Equipment, (vii) Passenger Motor Cars, and (viii) Engines and Parts.

We first performed the bounds tests for cointegration and the results are presented in Table 7. By conducting the bounds F-test, seven out of eight sectors are found to have long-run cointegrating relationships between variables. We also performed the bounds t-test and found that the null hypothesis can be rejected for three out of eight cases: Electrical Machinery and Equipment, Passenger Motor Cars, and Engines and Parts. In Electronic Components and Devices, the null of no cointegration cannot be rejected, but the estimated statistic (-4.51) is very close to the critical value (-4.53) at the 10% level. Thus, the cointegration test results have improved using the disaggregated sectoral data.

Table 8 presents the estimated results of the long-run equilibrium relationship for each of the eight sectors. The results are almost consistent with the results in Table 3.

First, as for the three sectors in the General Machinery industry, the estimated NEERs are quite similar to those of General Machinery in Table 4. Although the estimated coefficient of NEER_SD is far larger than unity in Business Oriented Machinery, the null of no cointegration is not rejected for this sector (Table 7).

Second, we observe somewhat unusual results for the three sectors in the Electric Machinery industry (Table 8). As for Electrical Machinery and Equipment, the estimated results are very similar to those of the three General Machinery sectors. In contrast, the estimated coefficients of NEER_WA and NEER_N are negative and statistically significant for Electronic Components and Devices, which may be due to the strong downward trend of electronic component prices. Even though including a trend term in the long-run equilibrium relationship, we obtain such an unusual minus sign for estimated NEER coefficients. In Information and Communications Equipment, the estimated NEER coefficients are unusually large. The above observation indicates possible misspecification of our NARDL model for the two Electric Machinery sectors: (iv) Electronic Components and Devices and (vi) Information and Communications Equipment.

Third, and more intriguingly, in the Transport Equipment industry, the estimated NEER coefficients differ markedly between Passenger Motor Cars and Engines and Parts. In Passenger Motor Car’s exports, the estimated NEER coefficients are all positive and statistically significant, which suggests a strong PTM tendency. The magnitude of the NEER coefficients is also similar, except for the NEER_WA coefficient, which is supported by the Wald test (Table 9).

In contrast, in Engines and Parts exports, only the NEER_SD coefficient is positive and statistically significant, and the other NEER coefficients are not statistically significant. This indicates that the degree of ERPT is large in Engines and Parts exports, and only during the unexpected depreciation phase in the strong yen levels did Japanese exporters raise the PTM level in their exports. As shown by Ito *et al*. (2018), about half of exports in Engines and Parts are invoiced in yen, which differs markedly from Passenger Motor Cars exports typically invoiced in USD and importers’ currency. The results of ERPT symmetry are presented in Table 9, which supports the above observation.

Table 10 presents the estimated results of the error-correction model.[20] Our primary interest is in the sign and magnitude of the short-run NEER coefficients, which look very similar between unexpected depreciation and appreciation in both weak and

[20] To save space, we only present the contemporaneous log-differenced NEERs' estimated results.

strong yen levels. The Wald test for the short-run NEER coefficients in Table 11 supports this observation. Since the short-run NEER coefficients reflect the invoice currency choice, we may say that Japanese exporters' invoice currency choice was unlikely to be changed between unexpected depreciation and appreciation phases in both weak yen and strong yen levels.

[Insert Tables 7, 8, 9, 10, and 11 around here]

4.2.3 Time-Varying Invoice Currency Choice

ERPT or PTM is mainly governed by the invoice currency choice, at least in the short-run, but is affected by exporters' pricing behavior in the medium- and long-run. We have found that the degree of ERPT or PTM often differs between unexpected yen depreciation and appreciation during strong yen levels. The estimated results of first-differenced NEERs in the error-correction model suggest the invariant choice of invoice currency.

In this sub-section, we directly estimate time-varying coefficients of the invoice currency choice in Japanese exports of the eight sectors to confirm the above findings. We rely on the estimation method developed by Ito *et al.* (2016; 2018) and set up the following state-space model:

$$\Delta \ln(P^x_{yen} / P^x_c)_t = \beta_t \cdot \Delta \ln E_{yen/\$,t} + \gamma_t \cdot \Delta \ln E_{yen/eur,t} + \varepsilon_t \quad (14)$$

$$\beta_t = \beta_{t-1} + v_t \quad (15)$$

$$\gamma_t = \gamma_{t-1} + \mu_t \quad (16)$$

where P^x_{yen} and P^x_c denote the *yen*-based and *contract currency*-based export prices, respectively. The Bank of Japan publishes the two types of export price indices by industry/sector. $E_{yen/\$}$ and $E_{yen/eur}$ denote the nominal exchange rate of the yen vis-à-vis the USD and euro, respectively. ε, v, and μ denote the Gaussian disturbances with zero mean. We use the Kalman filter technique to estimate time-varying coefficients, β and γ, which represent the time-varying USD invoiced share and the time-varying euro invoiced share, respectively. The time-varying yen invoiced share, α, can be obtained by $\alpha = 1 - \beta - \gamma$.[21]

[21] For further details of the estimation of time-varying invoice currency share, see Appendix A1.

Figure 3 presents the time-varying estimates of the yen, USD, and euro invoiced shares from January 2000 to December 2022. Let us first look at time-varying estimates for the three sectors of the General Machinery. In General Purpose Machinery (Figure 3(i)), the yen share declined from around 70% to about 50% in 2015–16. This large change in the invoice currency choice is captured by the result of the Wald test for the short-run symmetry between weak and strong yen levels, focusing on unexpected depreciation (Table 11). In Production Machinery exports, the yen-invoiced share is very high, around 70% or higher, after 2010, and has not changed largely over the sample period (Figure 3(ii)). In Business Oriented Machinery exports, the yen-invoiced share declined after 2021 (Figure 3(iii)), but we did not find a cointegrating relationship in this sector (Table 7).

[Insert Figure 3 around here]

Second, turning to the three Electric Machinery sectors, the USD-invoiced share is higher than the yen-invoiced share in Electronic Components and Devices (Figure 3(iv)) and Information and Communications Equipment (Figure 3(vi)), where the invoice currency share shows gradual changes.[22] The yen-invoiced share is slightly higher than the USD-invoiced share in Electrical Machinery and Equipment (Figure 3(v)). The relatively stable share of invoice currency is consistent with the test results for the short-run symmetry in Table 11.

Third, in Passenger Motor Cars, the USD share is far higher than the yen share (Figure 3(vii)). In contrast, the yen share is higher than the USD share from 2010 in Engines and Parts (Figure 3(viii)).

In summary, the time-varying estimates of invoice currency share support the short-run symmetry in ERPT/PTM. There is little evidence that Japanese exporters changed their invoice currency choice except for General Purpose Machinery exports. We may safely say that Japanese exporters changed their pricing behavior, not the invoice currency choice, between unexpected appreciation and depreciation in strong yen levels.

[22] In Electronic Components and Devices (Figure 3(iv)), the time-varying estimates of invoice currency share are presented from January 2011, because the estimated results are extremely unstable from 2000 to 2010.

This is the case for different pricing behavior in the unexpected depreciation between strong and weak yen levels. Japanese machinery exporters strategically switch or adjust their pricing behavior between unexpected yen appreciation and depreciation without changing the invoice currency choice.

5. Concluding Remarks

We have empirically investigated how the degree of ERPT or PTM changed in response to unexpected yen depreciation and appreciation. We employed the NARDL model with multiple thresholds and expected exchange rates to rigorously distinguish between unexpected yen appreciation and depreciation phases.

We have found that whereas PTM behavior becomes evident during the strong yen period, there is a marked difference in the degree of ERPT or PTM between unexpected yen depreciation and appreciation. Japanese exporters strategically shift their pricing behavior, alternating between ERPT and PTM strategies in response to unexpected yen appreciation and depreciation. The above findings obtained from the benchmark model are supported by different values of multiple thresholds with a range of (weak yen/neutral/strong yen) periods from (35/30/35) to (41/18/41). By estimating the time-varying parameter model of the invoice currency share, we found that exporters' strategical shift of their pricing behavior between ERPT and PTM was not affected by the change in the invoice currency choice. Our empirical findings would have significant implications for Japanese export firms in devising effective pricing strategies amid unanticipated and considerable yen appreciation and depreciation.

In this study, we have not empirically explored what causes Japanese exporters' different pricing behaviors between unexpected yen appreciation and depreciation phases. Future research will require more rigorous investigation.

Appendix: Estimation Method of the Invoice Currency Share[23]

The Bank of Japan (BOJ) publishes two types of price indices for Japanese exports and imports: (1) a *yen*-based export/import price index and (2) a *contract-currency*-based export/import price index. The BOJ collects information on export prices based on contract (invoice) currency from sample firms and then calculates the yen-based export price by using the yen's bilateral nominal exchange rate (monthly average) vis-à-vis each contract currency.

For a clear exposition, let us assume that Japanese exporters use only three currencies: yen, US dollars (USD), and euros (EUR), in their exports and also that the BOJ constructs the yen-invoiced export price (P_{yen}), USD invoiced export price ($P_{\$}$) and EUR-invoiced export price (P_{eur}).[24] Then, we can define the yen-based export price index (P_{yen}^{x}) as follows:

$$P_{yen}^{x} = (P_{yen})^{\alpha}(P_{\$} \cdot E_{yen/\$})^{\beta}(P_{eur} \cdot E_{yen/eur})^{\gamma} \qquad \text{(A1)}$$

where α, β, and γ represent the share of yen invoicing, USD invoicing and EUR invoicing exports, respectively, and $\alpha + \beta + \gamma = 1$. $E_{yen/\$}$ and $E_{yen/eur}$ denote the yen's bilateral nominal exchange rate vis-à-vis the USD and EUR, respectively. The export price based on contract currencies (P_{c}^{x}) can be defined as $P_{c}^{x} = (P_{yen})^{\alpha}(P_{\$})^{\beta}(P_{eur})^{\gamma}$. Thus, the yen-based export price index (P_{yen}^{x}) can be reformulated into:

$$\begin{aligned} P_{yen}^{x} &= (P_{yen})^{\alpha}(P_{\$})^{\beta}(P_{eur})^{\gamma}(E_{yen/\$})^{\beta}(E_{yen/eur})^{\gamma} \\ &= P_{c}^{x}(E_{yen/\$})^{\beta}(E_{yen/eur})^{\gamma} \end{aligned} \qquad \text{(A2)}$$

By dividing both sides of Equation (A2) by P_{c}^{x} and taking the natural logarithm, we obtain:

$$\ln(P_{yen}^{x} / P_{c}^{x}) = \beta \ln E_{yen/\$} + \gamma \ln E_{yen/eur} \qquad \text{(A3)}$$

By definition, the share of USD invoicing (β) and EUR invoicing (γ) can be estimated by Equation (A3). The share of yen invoicing can be obtained by subtracting the shares

[23] The following exposition is based on Ito *et al*. (2016; 2018).

[24] This is not an extreme assumption. In the second half of 2015, these three currencies account for 96.3 percent of invoice currencies of Japanese total exports (see Ito *et al*. (2018), Table 2.2).

of both USD and EUR-invoicing from unity: $\alpha = 1 - \beta - \gamma$. To ensure the stationarity of variables, we use the first-difference model for OLS estimation:

$$\Delta \ln(P^x_{yen} / P^x_c)_t = \beta \cdot \Delta \ln E_{yen/\$,t} + \gamma \cdot \Delta \ln E_{yen/eur,t} + \varepsilon_t \qquad \text{(A4)}$$

where Δ is the first-difference operator, and ε is an independently and normally distributed error term with zero mean and a constant variance.

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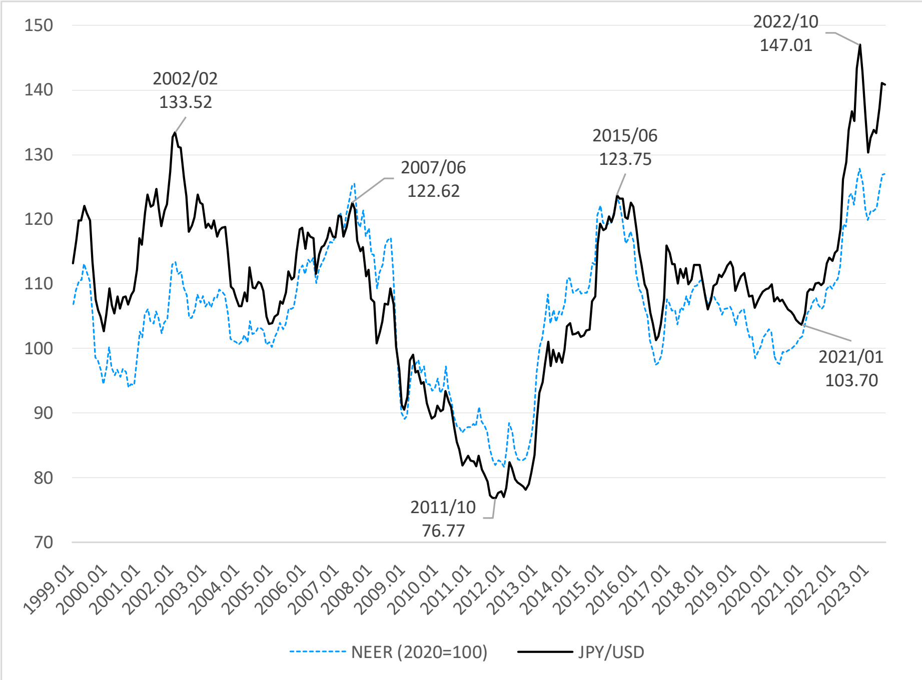
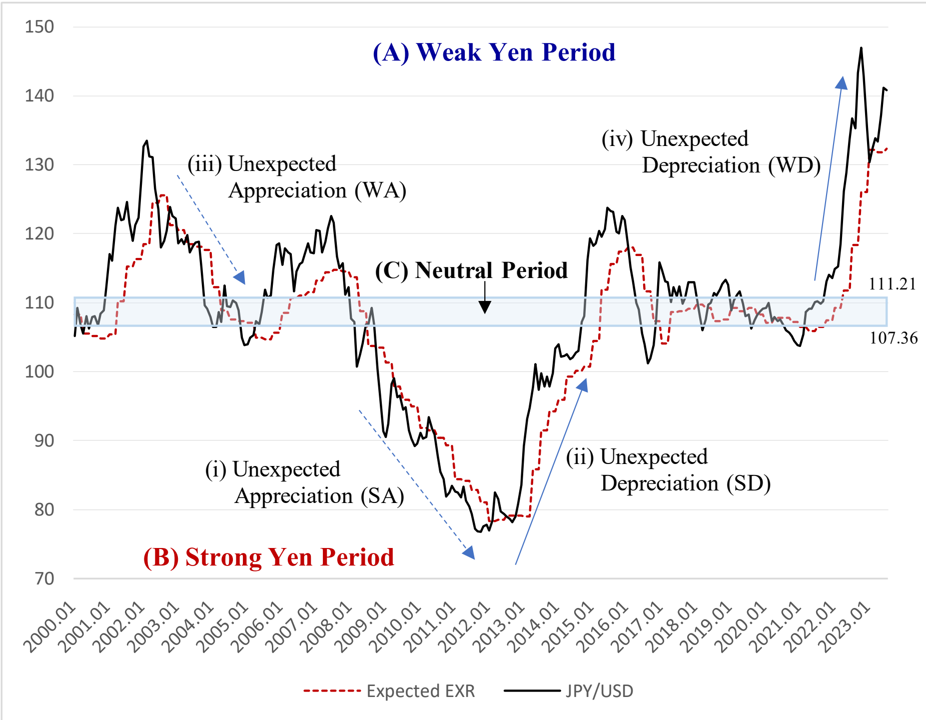
Figure 1. Bilateral Nominal Exchange Rate of the Yen vis-à-vis the US Dollar and BIS Nominal Effective Exchange Rate (2020=100): January 1999–July 2023



Note: The definition of the BIS Nominal Effective Exchange Rate (NEER) of the yen is changed as follows: An increase (decrease) in NEER means yen depreciation (appreciation), the base year of which is 2020. "JPY/USD" denotes the bilateral nominal exchange rate of the yen vis-à-vis the US dollar.

Source: Bank for International Settlements (BIS) website; IMF, International Financial Statistics, online.

Figure 2. Bilateral Nominal Exchange Rate of the Yen vis-à-vis the US Dollar: Actual and Predicted Exchange Rates (January 2000–July 2023)

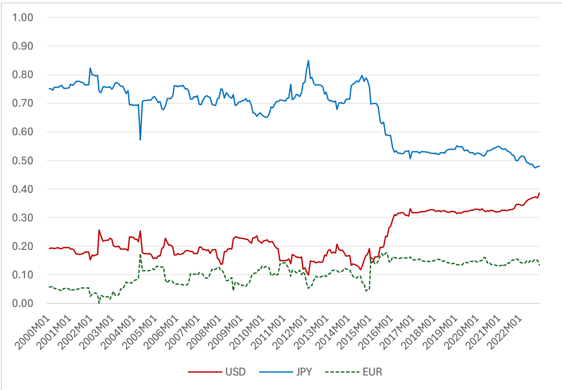


Note: "JPY/USD" denotes the bilateral nominal exchange rate of the yen vis-à-vis the US dollar. "Expected EXR" denotes the survey data on the expected bilateral nominal exchange rate of the yen vis-à-vis the US dollar provided by the Bank of Japan (BOJ). We use the expected exchange rate by all Japanese manufacturing firms. BOJ publishes the quarterly series of the expected exchange rate. By using the conversion method from quarterly series to monthly series developed by Nguyen and Sato (2019), we also converted the quarterly expected exchange rate series to the monthly series. Rectangular area shaded by light blue shows the middle 20% ranging from 107.36 to 111.21 obtained by the multiple-threshold method that decomposes the whole sample period into three periods: the yen appreciation (lower 40%), neutral (middle 20%), and depreciation (upper 40%) periods.

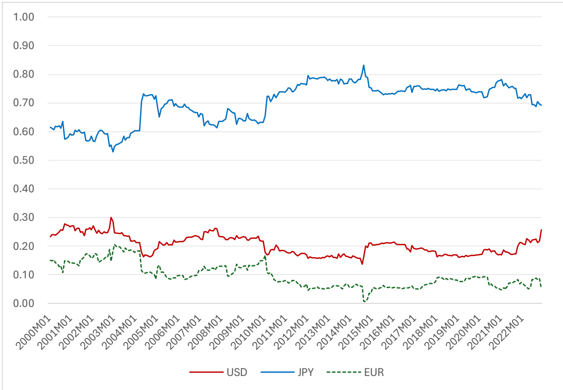
Source: IMF, International Financial Statistics, online; Bank of Japan, TANKAN.

Figure 3. Time-Varying Invoice Currency Share: Exports of Eight Sectors

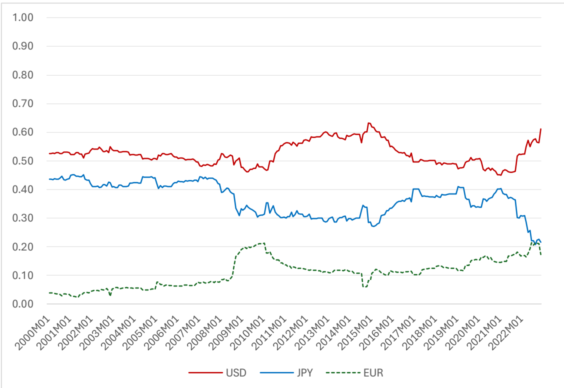
(i) General purpose machinery



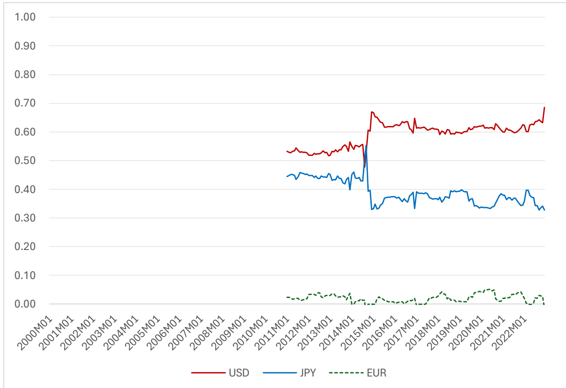
(ii) Production machinery



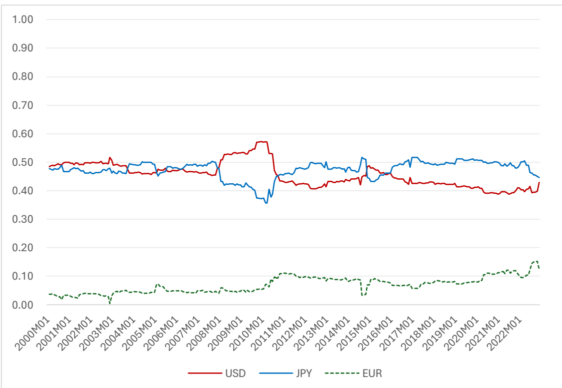
(iii) Business oriented machinery



(iv) Electronic components and devices



(v) Electrical machinery and equipment



(vi) Information and communications equipment

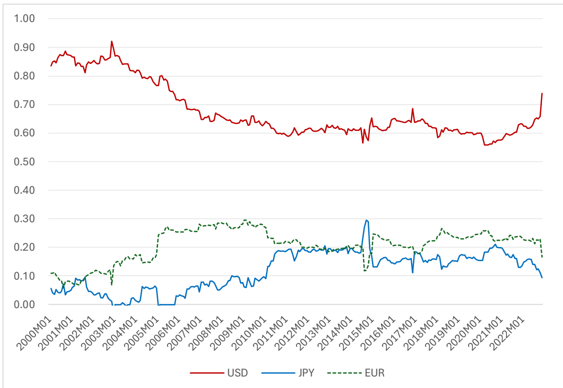
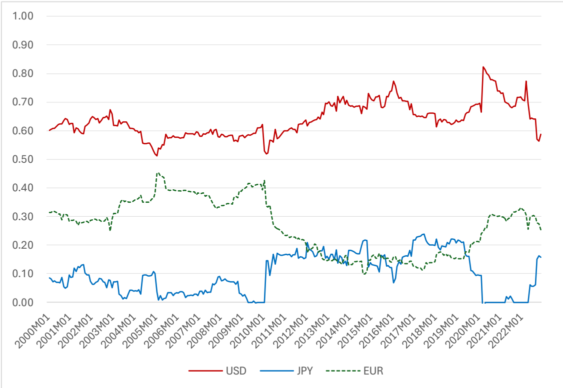
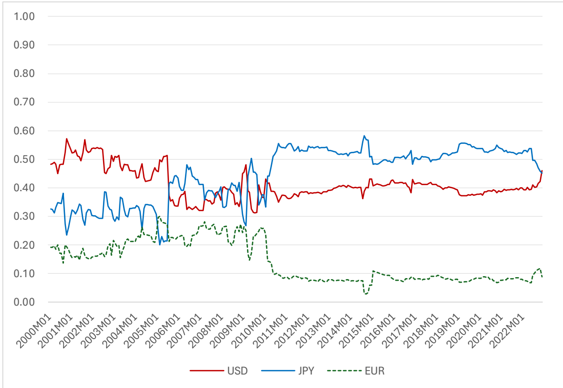


Figure 3 (cont.) Time-Varying Invoice Currency Share: Exports of Eight Sectors

(vii) Passenger motor cars



(viii) Engines and parts for passenger motor car



Note: Time-varying estimates of invoice currency share (US dollar, yen, and euro) in Japanese exports for the period from January 2000 to December 2022 are presented. All time-varying estimates of the US dollar (USD) invoiced share are statistically significant in terms of the two standard error confidence bands. Time-varying estimates of the euro invoiced share are not necessarily statistically significant, but even insignificant estimates are plotted in the above figures. The time-varying estimates of the yen invoiced share are computed by subtracting the sum of USD and euro invoiced estimates from unity, with an assumption that only three currencies, the USD, euro, and yen, are used in Japanese exports.

Source: Authors' estimation.

Table 1. Illustration of the Bank of Japan expected exchange rates for the 2022 fiscal year

Survey conducted in :	2022										2023		
	3	4	5	6	7	8	9	10	11	12	1	2	3
March 2022	·	E_3S_4	E_3S_5	E_3S_6	E_3S_7	E_3S_8	E_3S_9	·	·	·	·	·	·
June 2022		·	·	·	E_6S_7	E_6S_8	E_6S_9	·	·	·	·	·	·
September 2022							·	E_9S_{10}	E_9S_{11}	E_9S_{12}	E_9S_1	E_9S_2	E_9S_3
December 2022										·	$E_{12}S_1$	$E_{12}S_2$	$E_{12}S_3$

Note: The Bank of Japan TANKAN survey is conducted four times a year: in March, June, September, and December. For illustrative purposes, we show the four-time survey in 2022 (far left column), and the red circles represent the time of the surveys. In March and September surveys, sample firms answer the questions about their expected exchange rate for the coming two quarters (six months). For instance, $E_3S_4 = E_3S_5 = E_3S_6 = \cdots = E_3S_9$ in the March 2022 survey, where E and S denote the expectation operator and the bilateral nominal exchange rate of the yen vis-à-vis the USD, respectively. The expected exchange rate is updated in June and December surveys. The June 2022 survey, for instance, presents the *revised* expected exchange rate for the coming one-quarter (three months) ($E_6S_7 = E_6S_8 = E_6S_9$). Assuming that the expected exchange rate is reliable only for the first three post-survey months, we can construct the quarterly series of expected exchange rates: i.e., $E_3S_4 = E_3S_5 = E_3S_6$ for the first quarter of the fiscal year 2022, $E_6S_7 = E_6S_8 = E_6S_9$ for the second quarter of the fiscal year 2022, and $E_9S_{10} = E_9S_{11} = E_9S_{12}$ for the third quarter of the fiscal year 2022, and so forth. Next, we construct the monthly series of expected exchange rates by making "constant" interpolation.

Table 2. Results of Bounds Test for Cointegration: Benchmark Case (40/20/40)

Benchmark (40%)	Bounds F-test	Bounds t-test
All Industries	2.244	-2.146
General Machinery	4.178**	-3.542
Electric Machinery	3.302*	-3.101
Transport Equipment	4.734***	-5.113**

Note: The results of the bounds F-test and t-test for cointegration in Equation (13) are reported. Triple (***), double (**), and single (*) asterisks denote 1%, 5%, and 10% significance, respectively.

Source: Authors' estimation.

Table 3. Result of Long-Run Cointegrating Coefficients: Benchmark Case (40/20/40)

Benchmark (40%)	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.428	0.010	0.015	0.509**	0.558**	0.056	-0.102	
	(0.284)	(0.910)	(0.344)	(0.239)	(0.220)	(0.293)	(0.291)	
General Machinery	0.395***	0.031	0.153	0.614***	0.413***	0.638***	-0.266***	
	(0.106)	(0.259)	(0.102)	(0.074)	(0.064)	(0.174)	(0.084)	
Electric Machinery	0.421	-0.362	-0.877**	1.445***	0.363	1.289***	-0.032	-0.004**
	(0.425)	(0.672)	(0.409)	(0.252)	(0.315)	(0.329)	(0.400)	(0.002)
Transport Equipment	0.613***	1.021***	0.531***	0.767***	0.500***	0.426***	-0.491***	0.001***
	(0.119)	(0.224)	(0.095)	(0.066)	(0.070)	(0.126)	(0.098)	(0.000)

Note: Triple (***), double (**), and single (*) asterisk(s) denote 1%, 5%, and 10% significance, respectively. Standard errors are in parentheses. "NEER_WD" denotes the unexpected yen Depreciation in the Weak yen period (upper 40%). "NEER_WA" denotes the unexpected yen Appreciation in the Weak yen period (upper 40%). "NEER_N" denotes the Neutral period (middle 20%). "NEER_SD" denotes the unexpected yen Depreciation in the Strong yen period (lower 40%). "NEER_SA" denotes the unexpected yen Appreciation in the Strong yen period (lower 40%).

Source: Authors' estimation.

Table 4. Wald Test for Symmetry in Long-Run Coefficients: Benchmark Case (40/20/40)

Benchmark (40%)	All	General M.	Electric M.	Transport Eq.
(1) H0: Long-run symmetry between unexpected yen depreciation and appreciation				
(1a) WD-WA	0.202	1.807	1.201	2.475
$H_0: -(\rho_2/\rho_1) = -(\rho_3/\rho_1)$	(0.6532)	(0.1801)	(0.2741)	(0.1169)
(1b) SD-SA	0.029	5.690**	7.736***	9.672***
$H_0: -(\rho_5/\rho_1) = -(\rho_6/\rho_1)$	(0.8660)	(0.0178)	(0.0058)	(0.0021)
(2) H0: Long-run symmetry between weak and strong yen levels				
(2a) WD-SD	0.038	2.077	3.693*	1.071
$H_0: -(\rho_2/\rho_1) = -(\rho_5/\rho_1)$	(0.8454)	(0.1508)	(0.0558)	(0.3018)
(2b) WA-SA	0.312	1.766	0.865	4.434**
$H_0: -(\rho_3/\rho_1) = -(\rho_6/\rho_1)$	(0.5772)	(0.1851)	(0.3534)	(0.0362)

Note: Triple (***), double (**), and single (*) asterisk(s) denote 1%, 5%, and 10% significance, respectively. Probabilities are in parentheses. The null hypothesis is based on Equation (13). "(1a) WD-WA" denotes the test for symmetry in long-run coefficients between unexpected yen depreciation and appreciation in the weak yen period. "(1b) SD-SA" denotes the test for symmetry in long-run coefficients between unexpected yen depreciation and appreciation in the strong yen period. "(2a) WD-SD" denotes the test for symmetry in long-run coefficients of unexpected depreciation between the weak yen and strong yen periods. "(2b) WA-SA" denotes the test for symmetry in long-run coefficients of unexpected appreciation between the weak yen and strong yen periods.

Source: Authors' estimation.

Table 5. Result of Error-Correction Model: Benchmark Case (40/20/40)

Benchmark	All Manufacturing	General Machinery	Electric Machinery	Transport Equipment
Constant	0.138***	0.269***	-0.039***	0.677***
	(0.032)	(0.046)	(0.007)	(0.102)
d(NEER_WD)	0.618***	0.450***	0.589***	0.730***
	(0.025)	(0.024)	(0.035)	(0.032)
d(NEER_WD(-1))		0.134***		
		(0.036)		
d(NEER_WA)	0.640***	0.499***	0.562***	0.827***
	(0.053)	(0.058)	(0.066)	(0.077)
d(NEER_WA(-1))		0.213***		
		(0.064)		
d(NEER_N)	0.596***	0.456***	0.613***	0.618***
	(0.037)	(0.039)	(0.051)	(0.053)
d(NEER_N(-1))		0.148***		-0.029
		(0.047)		(0.053)
d(NEER_N(-2))				-0.066
				(0.053)
d(NEER_N(-3))				-0.122**
				(0.053)
d(NEER_SD)	0.606***	0.409***	0.532***	0.743***
	(0.029)	(0.032)	(0.043)	(0.045)
d(NEER_SD(-1))		0.056	-0.108**	
		(0.038)	(0.045)	
d(NEER_SA)	0.568***	0.430***	0.428***	0.709***
	(0.027)	(0.027)	(0.039)	(0.034)
d(NEER_SA(-1))	-0.030	0.098***	-0.090**	
	(0.027)	(0.036)	(0.039)	
d(NEER_SA(-2))	-0.072***		-0.078**	
	(0.026)		(0.038)	
d(Input Price)	0.332***		0.456***	
	(0.037)		(0.088)	
d(Input Price(-1))	0.120***			
	(0.032)			
d(World IPI)	-0.026		-0.048**	
	(0.019)		(0.023)	
d(World IPI(-1))	-0.031			
	(0.021)			
d(World IPI(-2))	-0.072***			
	(0.021)			
d(World IPI(-3))	-0.041**			
	(0.019)			
ECT	-0.029***	-0.094***	-0.036***	-0.143***
	(0.007)	(0.016)	(0.007)	(0.022)
Adj-R^2	0.927	0.803	0.839	0.849
D.W.	1.929	1.967	1.973	2.013

Note: The dependent variable is the first difference in the export price index for each industry. Triple (***), double (**), and single (*) asterisk(s) denote 1%, 5%, and 10% significance, respectively. Standard errors are in parentheses. See the note in Table 3 for the variable definition. $d(\cdot)$ denotes the first difference operator. "ECT" denotes an error-correction term.

Source: Authors' estimation.

Table 6. Wald Test for Symmetry in Short-Run Coefficients: Benchmark Case (40/20/40)

Benchmark (40%)	All	General M.	Electric M.	Transport Eq.
(1) H0: Short-run symmetry between unexpected yen depreciation and appreciation				
(1a) WD-WA	0.136	0.550	0.123	1.208
$H_0 : \gamma_{20} = \gamma_{30}$	(0.7131)	(0.4589)	(0.7260)	(0.2728)
(1b) SD-SA	0.884	0.223	3.347*	0.333
$H_0 : \gamma_{50} = \gamma_{60}$	(0.3480)	(0.6369)	(0.0685)	(0.5642)
(2) H0: Short-run symmetry between weak and strong yen levels				
(2a) WD-SD	0.120	1.011	1.110	0.054
$H_0 : \gamma_{20} = \gamma_{50}$	(0.7294)	(0.3155)	(0.2931)	(0.8167)
(2b) WA-SA	1.438	1.083	2.980*	1.786
$H_0 : \gamma_{30} = \gamma_{60}$	(0.2315)	(0.2989)	(0.0855)	(0.1826)

Note: A single asterisk (*) denotes 10% significance. Probabilities are in parentheses. The null hypothesis is based on Equation (13). "(1a) WD-WA" denotes the test for symmetry in short-run coefficients between unexpected yen depreciation and appreciation in the weak yen period. "(1b) SD-SA" denotes the test for symmetry in short-run coefficients between unexpected yen depreciation and appreciation in the strong yen period. "(2a) WD-SD" denotes the test for symmetry in short-run coefficients of unexpected yen depreciation between the weak yen and strong yen periods. "(2b) WA-SA" denotes the test for symmetry in short-run coefficients of unexpected appreciation between the weak yen and strong yen periods.

Source: Authors' estimation.

Table 7. Results of Bounds Test for Cointegration: Eight Sectors

Benchmark (40%)	Bounds F-test	Bounds t-test
General Purpose Machinery	4.162**	-4.121
Production Machinery	3.795**	-4.046
Business Oriented Machinery	2.705	-2.969
Electronic Components and Devices	3.816**	-4.510
Electrical Machinery and Equipment	6.318***	-6.020***
Information and Communications Equipment	5.705***	-1.390
Passenger Motor Cars	3.605*	-4.831*
Engines and Parts	6.496***	-5.855***

Note: The results of the bounds F-test and t-test for cointegration in Equation (13) are reported. Triple (***), double (**), and single (*) asterisk(s) denote 1%, 5%, and 10% significance, respectively.

Source: Authors' estimation.

Table 8. Result of Long-Run Cointegrating Coefficients: Eight Sectors

Benchmark Case (40/20/40)

Benchmark (40%)	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
General Purpose Machinery	0.358***	0.097	0.100	0.597***	0.442***	0.743***	-0.237***	
	(0.105)	(0.260)	(0.103)	(0.069)	(0.063)	(0.150)	(0.080)	
Production Machinery	0.372***	0.100	0.154	0.408***	0.373***	0.361**	-0.122	
	(0.101)	(0.228)	(0.095)	(0.069)	(0.065)	(0.158)	(0.078)	
Business Oriented Machinery	0.467*	0.696	0.393	1.667***	0.468**	1.163***	-0.756***	
	(0.279)	(0.651)	(0.290)	(0.202)	(0.198)	(0.381)	(0.247)	
Electronic Components	0.436	-1.223**	-0.643**	1.079***	0.571***	1.240***	-0.177	-0.005***
and Devices	(0.305)	(0.487)	(0.275)	(0.150)	(0.205)	(0.210)	(0.238)	(0.001)
Electrical Machinery and	0.262***	0.015	0.625***	0.708***	0.332***	1.027***	-0.079	
Equipment	(0.070)	(0.173)	(0.103)	(0.054)	(0.062)	(0.072)	(0.076)	
Information and	-1.389	3.768	-4.405	2.906**	-1.248	6.042**	-0.715	
Communications Equipment	(1.579)	(4.447)	(2.859)	(1.292)	(2.286)	(3.038)	(1.486)	
Passenger Motor Cars	0.852***	1.387***	0.872***	0.848***	0.793***	0.072	-0.764***	0.002***
	(0.166)	(0.328)	(0.132)	(0.096)	(0.105)	(0.193)	(0.145)	(0.001)
Engines and Parts	0.178	-0.411	0.133	0.791***	0.024	0.594***	-0.330***	
	(0.126)	(0.332)	(0.125)	(0.099)	(0.083)	(0.166)	(0.110)	

Note: Triple (***), double (**), and single (*) asterisk(s) denote 1%, 5%, and 10% significance, respectively. Standard errors are in parentheses. See note in Table 3.

Source: Authors' estimation.

Table 9. Wald Test for Symmetry in Long-Run Coefficients: Eight Sectors

Benchmark (40%)	General Purpose Machinery	Production Machinery	Business Oriented Machinery	Electronic Components and Devices	Electrical Machinery and Equipment	Information and Communi-cations Equipment	Passenger Motor Cars	Engines and Parts
(1) H0: Long-run symmetry between unexpected yen depreciation and appreciation								
(1a) WD-WA	0.919	1.251	0.106	10.743***	2.321	1.116	2.029	2.979*
$H_0: -(\rho_2/\rho_1) = -(\rho_3/\rho_1)$	(0.3386)	(0.2644)	(0.7448)	(0.0012)	(0.1289)	(0.2918)	(0.1556)	(0.0856)
(1b) SD-SA	3.780*	0.209	17.659***	5.139**	22.651***	1.831	0.193	47.323***
$H_0: -(\rho_5/\rho_1) = -(\rho_6/\rho_1)$	(0.0530)	(0.6481)	(0.0000)	(0.0243)	(0.0000)	(0.1773)	(0.6609)	(0.0000)
(2) H0: Long-run symmetry between weak and strong yen levels								
(2a) WD-SD	2.697	0.060	9.017***	3.048*	22.384***	3.281*	0.000	11.324***
$H_0: -(\rho_2/\rho_1) = -(\rho_5/\rho_1)$	(0.1017)	(0.8065)	(0.0029)	(0.0821)	(0.0000)	(0.0713)	(0.9874)	(0.0009)
(2b) WA-SA	1.428	1.136	0.096	9.833***	2.597	0.660	2.843*	1.441
$H_0: -(\rho_3/\rho_1) = -(\rho_6/\rho_1)$	(0.2331)	(0.2875)	(0.7566)	(0.0019)	(0.1083)	(0.4173)	(0.0931)	(0.2312)

Note: Triple (***), double (**), and single (*) asterisk(s) denote 1%, 5%, and 10% significance, respectively. Probabilities are in parentheses. The null hypothesis is based on Equation (13). See note in Table 4.

Source: Authors' estimation.

Table 10. Result of Error-Correction Model: Eight Sectors

Benchmark (40%)	General Purpose Machinery	Production Machinery	Business Oriented Machinery	Electronic Components and Devices	Electrical Machinery and Equipment	Information and Communi-cations Equipment	Passenger Motor Cars	Engines and Parts
Constant	0.204***	0.579***	0.126***	-0.005***	0.033***	-0.330***	1.077***	0.433***
	(0.035)	(0.104)	(0.027)	(0.001)	(0.005)	(0.047)	(0.186)	(0.059)
d(NEER_WD)	0.528***	0.360***	0.625***	0.588***	0.504***	0.950***	0.883***	0.530***
	(0.023)	(0.041)	(0.034)	(0.049)	(0.040)	(0.069)	(0.046)	(0.042)
d(NEER_WA)	0.550***	0.440***	0.602***	0.426***	0.610***	0.821***	1.019***	0.538***
	(0.056)	(0.094)	(0.078)	(0.096)	(0.080)	(0.142)	(0.107)	(0.101)
d(NEER_N)	0.518***	0.325***	0.735***	0.624***	0.608***	0.905***	0.782***	0.469***
	(0.038)	(0.063)	(0.053)	(0.071)	(0.059)	(0.109)	(0.074)	(0.069)
d(NEER_SD)	0.459***	0.364***	0.592***	0.496***	0.515***	0.802***	0.940***	0.524***
	(0.031)	(0.050)	(0.044)	(0.059)	(0.048)	(0.085)	(0.063)	(0.063)
d(NEER_SA)	0.486***	0.361***	0.549***	0.402***	0.453***	0.797***	0.920***	0.501***
	(0.025)	(0.046)	(0.037)	(0.055)	(0.043)	(0.076)	(0.047)	(0.046)
d(Input Price)		-0.220	0.336***	0.618***	-0.118		0.188	
		(0.138)	(0.109)	(0.137)	(0.117)		(0.146)	
d(World IPI)			-0.109***			-0.146***	-0.037	
			(0.024)			(0.049)	(0.034)	
ECT	-0.091***	-0.167***	-0.049***	-0.077***	-0.170***	-0.016***	-0.142***	-0.130***
	(0.016)	(0.030)	(0.010)	(0.013)	(0.024)	(0.002)	(0.025)	(0.018)
Adj-R^2	0.845	0.518	0.830	0.747	0.750	0.687	0.823	0.655
D.W.	2.135	2.008	2.039	1.979	2.038	2.042	2.008	2.193

Note: The dependent variable is the first difference in the export price index for each industry. Triple (***), double (**), and single (*) asterisk(s) denote 1%, 5%, and 10% significance, respectively. Standard errors are in parentheses. See the note in Table 5.

Source: Authors' estimation.

Table 11. Wald Test for Symmetry in Short-Run Coefficients: Eight Sectors

Benchmark (40%)	General Purpose Machinery	Production Machinery	Business Oriented Machinery	Electronic Components and Devices	Electrical Machinery and Equipment	Information and Communi-cations Equipment	Passenger Motor Cars	Engines and Parts
(1) H0: Short-run symmetry between unexpected yen depreciation and appreciation								
(1a) WD-WA	0.126	0.581	0.072	2.239	1.381	0.601	1.193	0.005
$H_0 : \gamma_{20} = \gamma_{30}$	(0.7232)	(0.4467)	(0.7888)	(0.1359)	(0.2411)	(0.4390)	(0.2757)	(0.9440)
(1b) SD-SA	0.396	0.001	0.518	1.424	0.942	0.002	0.057	0.081
$H_0 : \gamma_{50} = \gamma_{60}$	(0.5299)	(0.9720)	(0.4722)	(0.2339)	(0.3327)	(0.9657)	(0.8112)	(0.7761)
(2) H0: Short-run symmetry between weak and strong yen levels								
(2a) WD-SD	2.997*	0.004	0.337	1.541	0.032	1.778	0.521	0.007
$H_0 : \gamma_{20} = \gamma_{50}$	(0.0846)	(0.9518)	(0.5621)	(0.2157)	(0.8591)	(0.1835)	(0.4710)	(0.9324)
(2b) WA-SA	1.026	0.550	0.345	0.045	2.917*	0.020	0.621	0.106
$H_0 : \gamma_{30} = \gamma_{60}$	(0.3121)	(0.4589)	(0.5574)	(0.8330)	(0.0889)	(0.8863)	(0.4315)	(0.7448)

Note: A single asterisk (*) denotes 10% significance. Probabilities are in parentheses. The null hypothesis is based on Equation (13). See note in Table 6.

Source: Authors' estimation.

Appendix Tables

Table A1: Industry Classification of the Bank of Japan Export Price Index

All Manufacturing (100.0)			
	Textiles (0.9)		
	Chemicals and related products (11.8)		
	Metals and related products (10.4)		
	General purpose, production and business oriented machinery (19.7)		
		(i) General purpose machinery (5.2)	
			Steam and gas turbines; Engines; Pumps and compressors; Refrigerators and air conditioning apparatus; Bearings; Miscellaneous general-purpose machinery
		(ii) Production machinery (11.8)	
			Agricultural machinery; Machinery and equipment for construction and mining; Textile machinery; Daily lives industry machinery; Casting equipment and plastic processing machinery; Metal cutting machine tools; Metal processing machinery; Machinists' precision tools; Semiconductor making equipment; Robots
		(iii) Business oriented machinery (2.6)	
			Measuring instruments; Medical instruments; Optical instruments and lenses
	Electric and electronic products (21.0)		
		(iv) Electronic components and devices (12.8)	
			Semiconductor devices; Integrated circuits; Liquid crystal panel; Electric circuit; Miscellaneous electronic components
		(v) Electrical machinery and equipment (6.7)	
			Rotating electrical equipment; Wiring devices; Electrical equipment for internal combustion engines; Miscellaneous industrial electric equipment; Household electric equipment; Applied electronic equipment; Electric measuring instruments; Electric bulbs; Electric luminaries; Batteries
		(vi) Information and communications equipment (1.5)	
			Radio communication equipment; Video equipment and digital camera; Personal computers and electronic computing equipment (accessory equipment)
	Transportation equipment (27.0)		
		(vii) Passenger motor cars (14.5)	
		(viii) Engines and parts for passenger motor cars (6.6)	
			Internal combustion engines for motor vehicles; Motor vehicle parts
		Others (5.9)	
	Other primary products and manufactured goods (9.3)		

Note: Figures in parenthesis indicate the share of each industry's (or sector's) exports in the total manufacturing exports (i.e., All Manufacturing). General Machinery denotes "General purpose, production and business oriented machinery." Electric Machinery denotes "Electric and electronic products." Transport Equipment denotes "Transportation equipment."

Source: Bank of Japan.

Table A2. Results of Bounds Test for Cointegration: Robustness Check

One-third	Bounds *F*-test	Bounds *t*-test	Benchmark (40%)	Bounds *F*-test	Bounds *t*-test
All Industries	2.459	-1.882	All Industries	2.244	-2.146
General Machinery	3.901**	-3.168	General Machinery	4.178**	-3.542
Electric Machinery	5.923***	-2.989	Electric Machinery	3.302*	-3.101
Transport Equipment	4.189**	-4.917**	Transport Equipment	4.734***	-5.113**
34%	Bounds *F*-test	Bounds *t*-test	41%	Bounds *F*-test	Bounds *t*-test
All Industries	2.878	-2.678	All Industries	2.257	-2.169
General Machinery	4.637***	-3.807	General Machinery	4.140**	-3.556
Electric Machinery	4.339**	-3.157	Electric Machinery	3.284*	-3.090
Transport Equipment	5.084***	-5.170**	Transport Equipment	4.635***	-5.042**
35%	Bounds *F*-test	Bounds *t*-test	42%	Bounds *F*-test	Bounds *t*-test
All Industries	2.671	-2.410	All Industries	2.412	-2.574
General Machinery	3.724**	-3.261	General Machinery	4.520***	-3.769
Electric Machinery	3.883**	-2.965	Electric Machinery	4.004**	-3.024
Transport Equipment	5.034***	-5.154**	Transport Equipment	5.813***	5.971***
36%	Bounds *F*-test	Bounds *t*-test	43%	Bounds *F*-test	Bounds *t*-test
All Industries	2.698	-2.680	All Industries	2.621	-2.717
General Machinery	4.159**	-3.541	General Machinery	4.462***	-3.269
Electric Machinery	3.625**	-3.012	Electric Machinery	3.705**	-2.864
Transport Equipment	4.850***	-5.030**	Transport Equipment	6.027***	-6.151***
37%	Bounds *F*-test	Bounds *t*-test	44%	Bounds *F*-test	Bounds *t*-test
All Industries	2.658	-2.537	All Industries	2.176	-2.148
General Machinery	3.536**	-3.258	General Machinery	3.021	-2.436
Electric Machinery	3.632**	-2.966	Electric Machinery	2.887	-1.826
Transport Equipment	4.821***	-5.003**	Transport Equipment	4.650***	-4.897**
38%	Bounds *F*-test	Bounds *t*-test	45%	Bounds *F*-test	Bounds *t*-test
All Industries	2.385	-2.383	All Industries	2.231	-2.228
General Machinery	4.262***	-3.522	General Machinery	2.700	-2.033
Electric Machinery	4.286**	-3.577	Electric Machinery	2.127	-1.359
Transport Equipment	4.507***	-4.905**	Transport Equipment	4.342**	-4.461*
39%	Bounds *F*-test	Bounds *t*-test	50%	Bounds *F*-test	Bounds *t*-test
All Industries	2.143	-1.869	All Industries	2.546	-2.324
General Machinery	4.027**	-3.564	General Machinery	2.924	-2.007
Electric Machinery	3.850**	-3.157	Electric Machinery	2.193	-1.054
Transport Equipment	4.775***	-5.096**	Transport Equipment	4.555**	-4.468*

Note: Triple (***), double (**), and single (*) asterisk(s) denote 1%, 5%, and 10% significance, respectively.

Source: Authors' estimation.

Table A3. Results of Long-Run Cointegrating Coefficients: Robustness Check

One-third	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.666	-0.796	-0.433	0.662	0.649**	-0.216	0.061	
	(0.544)	(1.366)	(0.884)	(0.406)	(0.289)	(0.421)	(0.347)	
General Machinery	0.268	-0.156	0.012	0.888***	0.426***	1.002***	-0.357***	
	(0.166)	(0.395)	(0.259)	(0.137)	(0.093)	(0.266)	(0.130)	
Electric Machinery	0.160	-2.031**	-2.007*	2.416***	0.369	1.930***	-0.321	-0.003*
	(0.590)	(0.842)	(1.037)	(0.524)	(0.362)	(0.414)	(0.494)	(0.002)
Transport Equipment	0.668***	0.798***	0.448***	0.855***	0.476***	0.302**	-0.577***	0.001***
	(0.099)	(0.249)	(0.161)	(0.088)	(0.064)	(0.143)	(0.107)	(0.000)

34%	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.545*	-0.155	-0.399	0.483**	0.609***	0.066	0.009	
	(0.327)	(0.683)	(0.530)	(0.227)	(0.190)	(0.233)	(0.255)	
General Machinery	0.414***	-0.032	-0.075	0.685***	0.408***	0.772***	-0.282***	
	(0.140)	(0.264)	(0.223)	(0.084)	(0.071)	(0.193)	(0.103)	
Electric Machinery	0.308	-1.330*	-1.729**	1.463***	0.615*	1.251***	-0.051	-0.003*
	(0.520)	(0.693)	(0.825)	(0.289)	(0.324)	(0.416)	(0.480)	(0.002)
Transport Equipment	0.679***	1.000***	0.325**	0.761***	0.535***	0.388***	-0.501***	0.001***
	(0.107)	(0.231)	(0.146)	(0.067)	(0.050)	(0.114)	(0.097)	(0.000)

35%	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.594*	-0.093	-0.538	0.506*	0.595***	0.051	0.011	
	(0.356)	(0.808)	(0.620)	(0.261)	(0.218)	(0.266)	(0.295)	
General Machinery	0.379**	-0.048	-0.028	0.681***	0.424***	0.808***	-0.259**	
	(0.154)	(0.315)	(0.254)	(0.095)	(0.083)	(0.231)	(0.121)	
Electric Machinery	0.257	-0.991	-1.830**	1.532***	0.593	1.334***	-0.093	-0.003
	(0.535)	(0.752)	(0.903)	(0.311)	(0.369)	(0.412)	(0.503)	(0.002)
Transport Equipment	0.689***	0.985***	0.327**	0.758***	0.532***	0.370***	-0.500***	0.001***
	(0.105)	(0.233)	(0.147)	(0.067)	(0.052)	(0.111)	(0.098)	(0.000)

36%	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.448	0.005	-0.396	0.549**	0.601***	0.083	-0.025	
	(0.307)	(0.757)	(0.511)	(0.234)	(0.200)	(0.234)	(0.272)	
General Machinery	0.389***	-0.036	0.031	0.697***	0.411***	0.766***	-0.311***	
	(0.142)	(0.295)	(0.208)	(0.090)	(0.077)	(0.212)	(0.108)	
Electric Machinery	0.255	-0.870	-1.749**	1.644***	0.516	1.315***	-0.165	-0.003
	(0.561)	(0.758)	(0.845)	(0.315)	(0.377)	(0.418)	(0.490)	(0.002)
Transport Equipment	0.684***	0.969***	0.411***	0.771***	0.515***	0.373***	-0.519***	0.001***
	(0.118)	(0.242)	(0.147)	(0.068)	(0.059)	(0.117)	(0.101)	(0.000)

37%	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.407	-0.107	-0.331	0.592**	0.583***	0.065	-0.084	
	(0.310)	(0.874)	(0.458)	(0.248)	(0.213)	(0.248)	(0.283)	
General Machinery	0.334**	-0.071	0.053	0.707***	0.423***	0.776***	-0.295**	
	(0.152)	(0.342)	(0.190)	(0.096)	(0.084)	(0.232)	(0.115)	
Electric Machinery	0.413	-1.084	-1.775**	1.781***	0.340	1.281***	-0.104	-0.005*
	(0.601)	(0.789)	(0.819)	(0.335)	(0.406)	(0.434)	(0.520)	(0.002)
Transport Equipment	0.727***	0.901***	0.459***	0.781***	0.488***	0.350***	-0.529***	0.001***
	(0.124)	(0.249)	(0.142)	(0.070)	(0.064)	(0.120)	(0.105)	(0.000)

38%	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.369	0.140	0.001	0.618***	0.588***	0.145	-0.107	
	(0.239)	(0.824)	(0.264)	(0.201)	(0.190)	(0.225)	(0.261)	
General Machinery	0.402***	0.069	0.194*	0.652***	0.405***	0.665***	-0.286***	
	(0.110)	(0.291)	(0.100)	(0.077)	(0.070)	(0.187)	(0.093)	
Electric Machinery	0.058	-0.500	-0.597*	1.567***	0.550*	1.369***	-0.409	-0.002
	(0.433)	(0.695)	(0.358)	(0.230)	(0.296)	(0.305)	(0.346)	(0.002)
Transport Equipment	0.576***	0.964***	0.582***	0.785***	0.527***	0.442***	-0.530***	0.001***
	(0.127)	(0.247)	(0.091)	(0.069)	(0.072)	(0.133)	(0.105)	(0.000)

39%	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.419	-0.323	0.182	0.480	0.583**	-0.088	-0.017	
	(0.363)	(1.196)	(0.481)	(0.314)	(0.268)	(0.396)	(0.369)	
General Machinery	0.342***	-0.004	0.153	0.668***	0.425***	0.696***	-0.272***	
	(0.118)	(0.276)	(0.115)	(0.078)	(0.068)	(0.186)	(0.088)	
Electric Machinery	-0.021	-0.745	-0.881*	1.577***	0.458	1.645***	-0.162	-0.003*
	(0.480)	(0.746)	(0.465)	(0.256)	(0.321)	(0.333)	(0.399)	(0.002)
Transport Equipment	0.614***	0.959***	0.549***	0.783***	0.513***	0.409***	-0.517***	0.001***
	(0.120)	(0.234)	(0.104)	(0.069)	(0.069)	(0.122)	(0.103)	(0.000)

Benchmark (40%)	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.428	0.010	0.015	0.509**	0.558**	0.056	-0.102	
	(0.284)	(0.910)	(0.344)	(0.239)	(0.220)	(0.293)	(0.291)	
General Machinery	0.395***	0.031	0.153	0.614***	0.413***	0.638***	-0.266***	
	(0.106)	(0.259)	(0.102)	(0.074)	(0.064)	(0.174)	(0.084)	
Electric Machinery	0.421	-0.362	-0.877**	1.445***	0.363	1.289***	-0.032	-0.004**
	(0.425)	(0.672)	(0.409)	(0.252)	(0.315)	(0.329)	(0.400)	(0.002)
Transport Equipment	0.613***	1.021***	0.531***	0.767***	0.500***	0.426***	-0.491***	0.001***
	(0.119)	(0.224)	(0.095)	(0.066)	(0.070)	(0.126)	(0.098)	(0.000)

Table A3 (cont.) Results of Long-Run Cointegrating Coefficients: Robustness Check

41%	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.433	-0.018	-0.021	0.520**	0.553**	0.060	-0.118	
	(0.295)	(0.923)	(0.370)	(0.251)	(0.226)	(0.298)	(0.300)	
General Machinery	0.394***	0.011	0.142	0.622***	0.414***	0.646***	-0.276***	
	(0.107)	(0.263)	(0.109)	(0.075)	(0.065)	(0.170)	(0.086)	
Electric Machinery	0.466	-0.412	-0.948**	1.480***	0.320	1.324***	-0.048	-0.005***
	(0.419)	(0.669)	(0.435)	(0.256)	(0.316)	(0.319)	(0.400)	(0.002)
Transport Equipment	0.614***	1.005***	0.529***	0.772***	0.501***	0.434***	-0.489***	0.001***
	(0.118)	(0.229)	(0.106)	(0.068)	(0.070)	(0.125)	(0.100)	(0.000)

42%	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.436	-0.077	-0.381	0.447*	0.588***	0.073	-0.036	
	(0.282)	(0.736)	(0.575)	(0.233)	(0.214)	(0.256)	(0.288)	
General Machinery	0.392***	-0.045	-0.079	0.629***	0.414***	0.765***	-0.277***	
	(0.116)	(0.243)	(0.200)	(0.081)	(0.069)	(0.201)	(0.092)	
Electric Machinery	-0.119	-0.846	-1.523*	1.369***	0.435	1.933***	-0.216	-0.002
	(0.545)	(0.786)	(0.870)	(0.298)	(0.384)	(0.392)	(0.462)	(0.002)
Transport Equipment	0.608***	1.109***	0.222*	0.747***	0.529***	0.426***	-0.445***	0.001***
	(0.084)	(0.164)	(0.113)	(0.051)	(0.046)	(0.089)	(0.073)	(0.000)

43%	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.553*	0.052	-1.099	0.364	0.589***	0.037	0.068	
	(0.298)	(0.669)	(0.829)	(0.247)	(0.217)	(0.237)	(0.305)	
General Machinery	0.425***	-0.150	-0.394	0.647***	0.413***	0.894***	-0.297**	
	(0.144)	(0.250)	(0.383)	(0.103)	(0.083)	(0.270)	(0.114)	
Electric Machinery	-0.363	-1.174	-2.530*	1.464***	0.700	1.989***	-0.262	-0.001
	(0.647)	(0.738)	(1.454)	(0.356)	(0.447)	(0.443)	(0.523)	(0.002)
Transport Equipment	0.595***	1.008***	-0.058	0.719***	0.596***	0.382***	-0.474***	0.002***
	(0.085)	(0.156)	(0.164)	(0.054)	(0.046)	(0.088)	(0.072)	(0.000)

44%	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.520	-0.074	0.478	0.269	0.524*	-0.233	0.016	
	(0.369)	(0.956)	(1.001)	(0.401)	(0.296)	(0.328)	(0.395)	
General Machinery	0.440**	-0.313	0.050	0.807***	0.432***	0.931**	-0.398**	
	(0.187)	(0.389)	(0.464)	(0.196)	(0.114)	(0.387)	(0.164)	
Electric Machinery	-0.471	-1.046	-3.724	3.161**	0.443	2.517***	-0.350	-0.001
	(1.188)	(1.370)	(3.058)	(1.245)	(0.795)	(0.902)	(0.892)	(0.005)
Transport Equipment	0.586***	0.899***	0.192	0.878***	0.606***	0.415***	-0.545***	0.002***
	(0.116)	(0.226)	(0.248)	(0.095)	(0.070)	(0.123)	(0.099)	(0.000)

45%	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.386	-0.171	1.066	0.086	0.517*	-0.227	0.043	
	(0.386)	(0.965)	(0.906)	(0.446)	(0.301)	(0.308)	(0.395)	
General Machinery	0.279	-0.623	0.875	0.724**	0.453***	1.114**	-0.423*	
	(0.254)	(0.527)	(0.589)	(0.279)	(0.147)	(0.542)	(0.218)	
Electric Machinery	-1.058	-2.966	0.046	3.433	0.463	2.587**	0.331	-0.004
	(1.713)	(2.065)	(3.342)	(2.241)	(1.121)	(1.257)	(1.480)	(0.006)
Transport Equipment	0.564***	0.635**	0.762**	0.789***	0.574***	0.419***	-0.570***	0.002***
	(0.135)	(0.294)	(0.314)	(0.142)	(0.092)	(0.149)	(0.123)	(0.001)

50%	NEER_WD	NEER_WA	NEER_N	NEER_SD	NEER_SA	Input Price	World IPI	Trend
All Industries	0.434	-0.092		0.290	0.611**	-0.136	0.112	
	(0.267)	(0.775)		(0.301)	(0.240)	(0.247)	(0.337)	
General Machinery	0.322	-0.603		0.754***	0.495***	0.985**	-0.354*	
	(0.206)	(0.467)		(0.225)	(0.136)	(0.500)	(0.212)	
Electric Machinery	-0.601	-4.055		3.334	-0.041	2.604	0.894	-0.008
	(1.942)	(3.198)		(2.436)	(1.755)	(1.856)	(2.329)	(0.010)
Transport Equipment	0.629***	0.628**		0.772***	0.556***	0.396**	-0.587***	0.002***
	(0.135)	(0.271)		(0.110)	(0.089)	(0.153)	(0.132)	(0.001)

Note: Triple asterisks (***), double asterisks (**), and a single asterisk (*) denote 1%, 5%, and 10% significance, respectively. Standard errors are in parentheses. See note in Table 3.

Source: Authors' estimation.

Table A4. Wald Test for Symmetry in Long-Run Cointegrating Coefficients: Robustness Check

		All	General M.	Electric M.	Transport Eq.
One-third	WD-WA	0.879	0.954	3.893**	0.232
		(0.3495)	(0.3295)	(0.0496)	(0.6304)
	SD-SA	0.001	8.243***	7.438***	14.049***
		(0.9792)	(0.0044)	(0.0068)	(0.0002)
34%	WD-WA	0.871	2.150	3.178*	1.397
		(0.3515)	(0.1439)	(0.0759)	(0.2383)
	SA-SD	0.228	6.473**	3.487*	7.914***
		(0.6332)	(0.0116)	(0.0630)	(0.0053)
35%	WD-WA	0.611	1.425	1.583	1.160
		(0.4351)	(0.2337)	(0.2095)	(0.2824)
	SA-SD	0.081	4.283**	3.287*	7.255***
		(0.7756)	(0.0395)	(0.0711)	(0.0075)
36%	WD-WA	0.339	1.794	1.378	1.000
		(0.5611)	(0.1816)	(0.2416)	(0.3183)
	SA-SD	0.033	6.462**	4.826**	8.718***
		(0.8568)	(0.0116)	(0.0290)	(0.0034)
37%	WD-WA	0.333	1.216	2.197	0.357
		(0.5644)	(0.2712)	(0.1395)	(0.5509)
	SA-SD	0.001	5.725**	6.458**	10.041***
		(0.9765)	(0.0175)	(0.0117)	(0.0017)
38%	WD-WA	0.081	1.256	0.569	1.906
		(0.7766)	(0.2634)	(0.4515)	(0.1686)
	SA-SD	0.013	7.062***	7.303***	7.212***
		(0.9106)	(0.0084)	(0.0074)	(0.0077)
39%	WD-WA	0.374	1.454	0.859	1.694
		(0.5415)	(0.2291)	(0.3550)	(0.1943)
	SA-SD	0.073	7.171***	7.299***	8.435***
		(0.7872)	(0.0079)	(0.0074)	(0.0040)
40%	WD-WA	0.202	1.807	1.201	2.475
		(0.6532)	(0.1801)	(0.2741)	(0.1169)
	SD-SA	0.029	5.690**	7.736***	9.672***
		(0.8660)	(0.0178)	(0.0058)	(0.0021)
41%	WD-WA	0.229	1.954	1.523	2.242
		(0.6328)	(0.1634)	(0.2183)	(0.1355)
	SA-SD	0.011	5.905**	8.534***	9.277***
		(0.9161)	(0.0158)	(0.0038)	(0.0026)
42%	WD-WA	0.486	2.780*	0.574	6.510**
		(0.4864)	(0.0967)	(0.4495)	(0.0113)
	SA-SD	0.260	5.109**	3.618*	12.601***
		(0.6106)	(0.0246)	(0.0583)	(0.0005)
43%	WD-WA	0.657	5.409**	0.744	4.856**
		(0.4183)	(0.0208)	(0.3893)	(0.0284)
	SA-SD	0.639	4.039**	1.826	3.493*
		(0.4247)	(0.0455)	(0.1778)	(0.0628)
44%	WD-WA	0.490	4.747**	0.114	1.420
		(0.4845)	(0.0303)	(0.7358)	(0.2345)
	SA-SD	0.392	3.429*	3.775*	7.996***
		(0.5318)	(0.0652)	(0.0531)	(0.0051)
45%	WD-WA	0.436	3.998**	0.765	0.045
		(0.5095)	(0.0466)	(0.3825)	(0.8329)
	SA-SD	1.017	0.951	1.725	2.821*
		(0.3141)	(0.3305)	(0.1902)	(0.0943)
50%	WD-WA	0.537	4.904**	1.314	0.000
		(0.4642)	(0.0277)	(0.2527)	(0.9989)
	SA-SD	1.060	1.271	0.983	2.806*
		(0.3042)	(0.2606)	(0.3223)	(0.0951)

Note: Triple asterisks (***), double asterisks (**), and a single asterisk (*) denote 1%, 5%, and 10% significance, respectively. Probabilities are in parentheses. See note in Table 4.

Source: Authors' estimation.

Table A5. Wald Test for Symmetry in Short-Run Coefficients in Conditional Error-Correction Model: Robustness Check

		All	General M.	Electric M.	Transport Eq.
One-third	WD-WA	0.228	0.706	0.711	1.050
		(0.6333)	(0.4017)	(0.4000)	(0.3066)
	SD-SA	1.204	0.242	3.907**	0.427
		(0.2735)	(0.6232)	(0.0492)	(0.5141)
34%	WD-WA	0.220	0.641	0.974	1.883
		(0.6391)	(0.4242)	(0.3248)	(0.1712)
	SA-SD	0.814	0.561	1.187	0.467
		(0.3677)	(0.4545)	(0.2769)	(0.4948)
35%	WD-WA	0.319	0.806	0.071	1.758
		(0.5728)	(0.3702)	(0.7905)	(0.1860)
	SA-SD	0.355	0.921	1.967	0.322
		(0.5519)	(0.3382)	(0.1621)	(0.5707)
36%	WD-WA	0.393	0.693	0.070	1.814
		(0.5311)	(0.4059)	(0.7915)	(0.1792)
	SA-SD	0.370	0.911	2.186	0.425
		(0.5436)	(0.3408)	(0.1406)	(0.5150)
37%	WD-WA	0.125	0.699	0.236	1.267
		(0.7238)	(0.4038)	(0.6275)	(0.2613)
	SA-SD	0.374	0.888	2.626	0.504
		(0.5413)	(0.3469)	(0.1064)	(0.4782)
38%	WD-WA	0.138	0.676	0.885	1.321
		(0.7110)	(0.4117)	(0.3477)	(0.2516)
	SA-SD	0.513	0.633	4.291**	0.207
		(0.4746)	(0.4268)	(0.0393)	(0.6494)
39%	WD-WA	0.156	0.556	0.909	1.238
		(0.6928)	(0.4564)	(0.3413)	(0.2669)
	SA-SD	0.737	0.014	3.514*	0.757
		(0.3914)	(0.9053)	(0.0620)	(0.3851)

		All	General M.	Electric M.	Transport Eq.
40%	WD-WA	0.136	0.550	0.123	1.208
		(0.7131)	(0.4589)	(0.7260)	(0.2728)
	SD-SA	0.884	0.223	3.347*	0.333
		(0.3480)	(0.6369)	(0.0685)	(0.5642)
41%	WD-WA	0.151	0.592	0.122	1.220
		(0.6979)	(0.4424)	(0.7270)	(0.2704)
	SA-SD	0.931	0.192	3.497*	0.298
		(0.3355)	(0.6613)	(0.0626)	(0.5856)
42%	WD-WA	0.069	0.431	0.730	2.002
		(0.7932)	(0.5122)	(0.3938)	(0.1583)
	SA-SD	0.470	0.420	2.581	0.455
		(0.4935)	(0.5175)	(0.1094)	(0.5008)
43%	WD-WA	0.032	0.168	0.200	1.804
		(0.8589)	(0.6823)	(0.6554)	(0.1804)
	SA-SD	0.602	0.408	2.800*	0.139
		(0.4386)	(0.5235)	(0.0955)	(0.7091)
44%	WD-WA	0.131	0.211	0.058	1.460
		(0.7181)	(0.6461)	(0.8105)	(0.2280)
	SA-SD	0.730	0.109	3.740*	0.057
		(0.3936)	(0.7416)	(0.0543)	(0.8108)
45%	WD-WA	0.151	0.271	0.005	1.210
		(0.6980)	(0.6028)	(0.9443)	(0.2723)
	SA-SD	0.762	0.168	2.390	0.084
		(0.3834)	(0.6822)	(0.1234)	(0.7723)
50%	WD-WA	0.096	0.491	0.016	1.400
		(0.7571)	(0.4839)	(0.8988)	(0.2378)
	SA-SD	0.778	0.008	6.844***	0.103
		(0.3785)	(0.9286)	(0.0094)	(0.7488)

Note: Triple asterisks (***), double asterisks (**), and a single asterisk (*) denote 1%, 5%, and 10% significance, respectively. Probabilities are in parentheses. See note in Table 6.

Source: Authors' estimation.