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INVOICING CURRENCY AND EXCHANGE RATE PASS-THROUGH IN JAPANESE IMPORTS: A PANEL VAR ANALYSIS

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ABSTRACT

This study utilizes the granular Japanese customs data from 2014 to 2020 to examine the exchange rate pass-through (ERPT) to Japanese import prices. It mainly focuses on the impact of the invoicing currency choice on ERPT. The ERPT elasticity in products invoiced in the exporter's currency is greater than those invoiced in yen. In the full sample analysis, the ERPT elasticity was 0.75 for products invoiced in the exporter's currency, compared to about 0.19 for yen-invoiced products. We find the same tendency for imports from two Asian powerhouses: China and Thailand. There is no significant difference in the ERPT elasticity between products invoiced in the exporter's currency and those invoiced in a third currency (i.e., a currency other than yen or the exporter's currency). In addition, an asymmetric pass-through is found, namely the ERPT during the appreciation phase of the yen is higher than during the depreciation phase. This finding is interpreted that foreign exporters strengthen their pricing-to-market behavior during the yen depreciation phase to maintain their market share.

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1. Introduction

This study investigates exchange rate pass-through (ERPT) in import prices using newly available Japanese customs data.[1] Questions regarding ERPT are relevant in the open macro literature. For example, how corporate profits respond to the exchange rate changes would be important in evaluating the stock price reaction to the exchange rate changes. How the inflation rate responds to the exchange rate changes is an important factor in deciding monetary policy.

Researchers have tried to understand what determines ERPT.[2] Among various potential determinants, we focus on invoicing currency. Gopinath et al. (2010), one of the earliest studies in this literature, explored the relationship between invoicing currency and ERPT using unpublished micro data on import prices of the United States (U.S.) collected by the Bureau of Labor Statistics (BLS) for the period 1994-2005. They showed a significant difference in ERPT in prices of goods invoiced in the U.S. dollar (USD, 25 percent) versus non-USD (95 percent). Choudhri and Hakura (2015) examined ERPT in import and export prices for advanced and emerging market economies. They found that the share of the exporter's currency and the USD in imports positively affected ERPT in import prices. Fabling and Sanderson (2015) examined the impact of invoicing currency on ERPT on export prices using comprehensive shipment-level data from New Zealand. They revealed that export prices denominated in the New Zealand dollar (NZD) respond more to exchange rate changes when those transactions are invoiced in foreign currencies than in the NZD. They also found that the impact of firm-level characteristics on ERPT disappeared once invoicing currency was considered in the analysis, implying the significant importance of invoicing currency as a determinant of ERPT. Corsetti et al. (2022) focused on the large and persistent sterling depreciation after the Brexit referendum and showed that ERPT was complete for transactions invoiced in producer currency and low for sales invoiced in foreign currencies based on the transaction-level trade data of the United Kingdom (U.K.).

This paper can be differentiated from these existing papers in the following three aspects. First, this research is the first to analyze ERPT using granular Japanese customs data extending from 2014 to 2020. The original transaction-level data enables us to identify the invoicing currency used in each transaction, and it covers the universe of Japanese trade during the sample period. We aggregate this transaction-level data by nine-digit Harmonized System (HS) codes for each importing partner economy, identifying each product's predominant invoicing currency. Some existing research used microdata from the U.S. and some euro area economies, but this paper is the first to examine the Japanese case. The Japanese yen (JPY) is the third most traded currency in foreign exchange markets, following the USD and the euro. Thus, this study would contribute to deepening the insight into ERPT by providing a case study of an economy with the third most-traded currency that has yet to be

[1] We investigated the choice of invoicing currency based on the same data in Yoshimi et al. (2024) and Yoshida et al. (2024).

[2] Among other determinants, Campa and Goldberg (2005) revealed that exchange rate volatility had an impact on ERPT, but macroeconomic variables played a minor role in the evolution of ERPT over time using the data from 23 OECD economies. Li et al. (2015) investigated the impact of exporters' productivity on ERPT based on a Chinese firm-level dataset.

examined. As a byproduct, our analysis provides additional insights on the use of two important currencies in Asia: China's Renminbi (RMB) and Thailand's Baht (THB). Notably, the usage of the RMB has historically been limited in trade invoicing due to China's capital controls. Indeed, Gopinath et al. (2010) excluded China from their analysis sample. However, our data shows that the usage of the RMB is sufficiently prevalent, allowing us to include samples of the RMB invoicing in Japan's imports from China. Similarly, we extract samples for invoicing in the THB, enabling the analysis of goods invoiced in the THB in Japan's imports from Thailand. Therefore, our study provides novel evidence on the extent of ERPT when Asian local currency invoicing is made.

Second, we investigate the case of vehicle currency pricing (VCP) in which invoicing is conducted in a currency other than the exporter's or importer's national currency. One of our aims in analyzing VCP is to deliver evidence on ERPT in the world of the "dominant currency paradigm." Gopinath et al. (2020) labeled the phenomenon that only a limited number of international currencies (typically the USD and the euro) are used in a major part of international trade as the dominant currency paradigm. Despite ranking third in trading volume, the JPY is not widely used beyond transactions involving Japan. This characteristic of the Japanese yen results in a significant share of three invoicing currencies – the JPY (local currency), the exporter's currency (producer's currency), and the USD (dominant currency) – being maintained in many imports from economies outside the U.S. Data from economies like the U.S. and the eurozone, where the trading shares of the USD or the euro dominate, make it difficult to compare the differences in ERPT due to variations in the type of invoicing currency, such as the dominant currency, the producer's currency, and the local currency. Put differently, the dominant currency cannot be distinguishable from the local currency in case imports to the U.S. or euro-zone economies are analyzed. Therefore, besides being the first ERPT study using Japanese customs data, this study possesses the advantage of comparing ERPT among VCP (or USD-invoicing in imports from outside the U.S.), producer's currency pricing (PCP), and local currency pricing (LCP) with a large sample size due to its reliance on Japanese data.

Third, we investigate how ERPT could differ in the appreciation and depreciation phases since our data include both the yen's depreciation and appreciation phases.[3] The depreciation phase is defined as the period from October 2014, when the second round of quantitative and qualitative easing policies was implemented, to July 2015, when a slowdown in China's economy became evident. the JPY depreciated by 14.1% against the USD over this period, averaging a 1.4% monthly depreciation. The appreciation phase is considered from August 2015, following the devaluation of the RMB, to November 2016, when Donald Trump won the presidential election. The JPY appreciated 12.1% against the USD over this period, averaging a 0.8% monthly appreciation. The ERPT was approximately 0.60 in the depreciation phase and about 0.78 in the appreciation phase. As our data set includes these two contrasting phases, we can examine the asymmetric effects of ERPT between these two phases.

We adopt a Panel Vector Autoregressive (PVAR) model developed by Holtz-Eakin et al. (1988). We incorporate fixed effects for each importing partner economy and a nine-digit HS code.[4]

[3] Asymmetry and nonlinearity of ERPT are well documented by Bussiere (2013).

[4] For the use of VAR models in the study of ERPT, see Ito and Sato (2008), Shioji (2012), Choudhri and Hakura

This approach allows us to adjust for import price changes that may arise due to differences in partner economies or products.

The major findings of our analysis are summarized as follows. First, the ERPT is approximately 0.60 when not accounting for the invoicing currency. We use the nominal exchange rate between the exporter's currency. However, for products predominantly invoiced in the producer currency (PCP products, hereafter) and products predominantly invoiced in the Japanese yen (LCP products, hereafter), the ERPTs are 0.75 and 0.19, respectively. These findings are consistent with previous studies indicating that ERPT is higher for PCP goods than LCP goods in import prices. This conclusion remains consistent across most economies, including China and Thailand, and product category analyses.

Second, the ERPT elasticity is 0.79 and 0.75 for VCP and PCP products, respectively. The elasticity is slightly higher for VCP products, but the difference is not large. We also examine ERPT in imports from non-USD areas to consider the dominant currency paradigm. USD invoiced products have slightly higher ERPT elasticity (0.79) than PCP products (0.76). However, again, the difference is not large. The ERPT elasticity for products invoiced in USD is somewhat higher when the nominal exchange rate between USD and JPY is utilized (0.82) than when the nominal exchange rate between the exporter's currency and JPY is used (0.79). Overall, the ERPT elasticity is higher for products invoiced in foreign currencies, including the exporter's and third vehicle currencies, than those invoiced in the home currency.

Third, concerning asymmetry, the ERPT during the depreciation phase of the yen was observed to be lower than that in the appreciation phase. We can interpret these results from the perspective of foreign firms seeking to secure market share in the Japanese market as follows. Consider foreign firms exporting to Japan, facing a depreciation of their home currency against the JPY (an appreciation phase for the yen). Even without changing the prices set in the exporting economy's currency, these firms would see an improvement in the competitiveness of yen-denominated prices in the Japanese market, leading to increased export volumes and expanded market share. Consequently, during the yen's appreciation phase, the incentive for these firms to alter prices set in the exporting economy's currency is minimal, and a substantial portion of the yen's appreciation is likely to pass through to yen-denominated import prices. Conversely, in the event of an appreciation of the exporting economy's currency against the yen (a depreciation phase for the yen), price competitiveness in the Japanese market decreases without maintaining prices in the exporting economy's currency, leading to reduced export volumes and a shrinking market share. On this occasion, exporting firms will likely intensify their pricing-to-market (PTM) behavior to prevent an excessive rise in yen-denominated prices. This reasoning rationalizes our analysis that ERPT is higher in the yen's appreciation phase than in the depreciation phase. The tendency for ERPT to be higher in the appreciation phase than in the depreciation phase remains unchanged even when analyzing PCP goods and LCP goods separately.

The remainder of this paper is organized as follows: Sections 2 and 3 provide an overview of

(2015), and Sasaki et al. (2022).

the data and methodology, respectively. Section 4 presents our key findings. Section 5 conducts additional analysis, and Section 6 concludes the paper.

2. Data

This section provides a summary and overview of Japanese customs data used in this research. We also briefly discuss the yen's exchange rate evolution in the sample period.

2.1. Product-level aggregation of Japanese customs data

We use Japanese customs data that contain the following information for each import transaction: trade value (in yen),[5] corresponding quantity (numbers and/or weight such as tons or kilograms), invoicing currency, Harmonized System (HS) nine-digit classification, identification information for Japanese importers (ID number, name, address, and telephone number), exporting economy, trade partners' information (name and address), and declaration date, time, and other relevant details. The sample period is from the first day of 2014 to the last day of 2020.

In the analysis, the original data provided at the transaction level is aggregated at the HS nine-digit product level for each month while distinguishing based on the exporting economy and invoicing currency. While this aggregation results in the loss of detailed transaction-level information, it offers the following advantages. First, there may be transactions involving different items in the transaction-level original data, even within the same HS nine-digit level. Consequently, it becomes challenging to discern whether changes in unit price are due to variations in specific products or are the result of the type of unit price revisions we hypothesize. Aggregation serves to smooth out such noise inherent in transaction-level data. Second, the unit price at the transaction level varies depending on the trading partner (exporter). Japanese importers submit exporters' names to the customs. Unfortunately, this information is not recorded consistently, and typographical errors are observed. As a result, it is often difficult to determine if different transactions involve the same exporter. This study aims to examine the ERPT to Japan's import prices thoroughly. Therefore, aggregating at the product level is advantageous in mitigating the problem caused by these differences among exporters and securing a more significant number of products.

In distinguishing between LCP, PCP, and VCP products, we refer to the ratio of invoicing currency based on the import value for each product at the HS nine-digit level by the exporting economy throughout the sample period. We define products for which the import value of yen-invoiced transactions exceeds 95% as LCP products and those for which the import value of transactions invoiced in the exporting economy's legal currency exceeds 95% as PCP products. VCP products are defined as products for which the import value invoiced in currencies other than the yen and the exporting economy's legal currency exceeds 95%. Hence, even within the same HS nine-digit

[5] In cases where the invoicing currency for import declarations is a foreign currency, it is converted into Japanese yen based on the foreign exchange rate applicable on the day on which import declaration of the goods concerned is made. The applicable rates are based on average of the market rates for the week of two weeks before the day of import declaration, which are published by the Director-Generals of regional customs on a weekly basis.

product, whether it is classified as an LCP, PCP, or VCP product can differ depending on the exporting economy. The categorization by major invoicing currencies is determined based on their shares throughout the sample period, ensuring that the classification of each product-economy observation remains unchanged. The reason for using 95% as the threshold, rather than 100%, is that setting the threshold at 100% would lead to the exclusion of any product from the category if it undergoes even a single transaction in a different currency, resulting in a significant reduction in the sample size.[6]

2.2. Data overview

In the analysis of this study, we narrow down the exporting economies through a two-step process. Firstly, to incorporate economies with significant macroeconomic impact, all economies within the top ten of Japan's import partners based on import value in the latest sample year (i.e., 2020) are included in the analysis. Secondly, for economies ranked 11th to 30th, we include economies where PCP comprises more than 5% and those exporting more than ten product categories at the HS9 digit level following the approach outlined by Gopinath et al. (2010). As a result, the full sample includes 16 economies: Australia, Belgium, China, France, Germany, Italy, South Korea, Saudi Arabia, Spain, Switzerland, Taiwan, Thailand, United Arab Emirates, the U.K., the U.S., and Viet Nam. The share of imports from these economies in Japanese total imports in the sample period is 70.7%.

Table 1 presents the average share of each type of invoicing currency calculated at the product-economy level in the full sample and sub-samples. Those shares are calculated based on import value. The number of observations is also reported. In the full sample, the shares of LCP, PCP, and VCP are roughly evenly distributed. Reflecting the high utilization of the USD in non-USD areas, VCP holds the highest share (37.3%). However, LCP and PCP also command significant shares, at 28.0% and 34.7%, respectively. The table also shows the shares by sub-sample. For instance, out of the 16 economies in the full sample, we restricted the sample to economies with a PCP share exceeding 5% and more than ten imported products (i.e., we restricted exporting economies based on the selection method of Gopinath et al., 2010). This sub-sample is labeled as "Selected economies" in the table and includes nine economies: Belgium, France, Germany, Italy, Spain, Switzerland, Thailand, the U.K., and the U.S. In this sub-sample, the share of PCP products significantly increases (59.2%) compared to the full sample because exporting economies are restricted to relatively large economies, and the currencies of those economies are used more in transactions than small economies' currencies. The share of each type of product does not significantly differ across depreciation and appreciation phases.

=== Table 1 ===

The table also presents the shares for each selected economy. The PCP share is highest in imports from the U.S., reflecting that the producer's currency of the U.S. is the USD. The euro-area

[6] All analyses in the paper use the 95% threshold. We changed the threshold to 90% in the baseline analysis with the full sample shown in Panel (a) of Figure 2, but the analytical result does not change qualitatively.

economies also have a relatively high PCP share. We should note that the USD and euro are dominant currencies in global trade, so a high share of PCP for these economies is unsurprising. In the case of Thailand, the VCP share is the highest among the three types of invoicing currency. This observation is in line with the view of the dominant currency paradigm. In the table, VCP includes all other currencies than the JPY and the exporter's currency: the USD is included in the case of Thailand. The Thai case significantly reflects the high share of the USD in imports from Thailand. The same tendency is observed for Switzerland and the U.K., although the PCP share (invoicing in the Swiss franc and British pound, respectively) is much higher than that of the Thai case.

Considering China's importance in Japan's imports,[7] the table also shows information on imports from China. The observation count is the largest among all economies, standing at 309,024. The type of invoicing currency with the highest share is VCP at 74.6%. This finding reflects the predominant use of the USD, a third-country currency, in imports from China. The share of PCP is low at 5.1%. This low utilization of the RMB is likely due to China's capital controls. The LCP share, the Japanese yen, is 20.2%.

The table also shows the results by product category. We define each product category following Gopinath et al. (2010).[8] Sample economies are the same as the full sample. We rely on those product categories in our by-product analyses, as we do not obtain the convergence of PVAR estimations in some HS two-digit products due to a lack of observations. The distribution of shares varies across product categories. The highest share of LCP is observed in Category 14, "Precious or semiprecious stones (HS71)" (36.6%). In Category 15, "Base metals and articles of base metals (HS72-HS83)" (34.2%), and Category 6, "Products of chemical and allied industries (HS28-HS38)" (34.0%), LCP shares are also notable. Additionally, LCP shares exceed 30% in several other product categories. Conversely, Category 19, "Arms and ammunition (HS93)," stands out with a notably low LCP share (5.1%), where PCP holds the majority share at 72.4%. We observe the highest VCP share in Category 5, "Mineral products (HS25-HS27)" (52.7%), while a substantial share of 52.2% is observed in Category 9, "Wood and articles of wood (HS44-HS46)".

Table 2 shows the number and share of product-economy pairs according to the predominant invoicing currency (i.e., LCP, PCP, and VCP).[9] Those numbers are generally smaller than the number

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[7] China's share of Japan's imports in 2020 (23.4%) is the largest among all economies. The U.S. has the second largest share (10.7%), but there is a significant gap with China.

[8] Product categories are defined as follows. Category 1: Live animals; animal products (HS01-HS05), Category 2: Vegetable products (HS06-HS14), Category 3: Animal/vegetable fats, oils (HS15), Category 4: Prepared foodstuffs (HS16-HS24), Category 5: Mineral products (HS25-HS27), Category 6: Products of chemical and allied industries (HS28-HS38), Category 7: Plastics/rubber articles (HS39-HS40), Category 8: Rawhides/leather articles, furs (HS41-HS43), Category 9: Wood and articles of wood (HS44-HS46), Category 10: Pulp of wood/other fibrous cellulosic material (HS47-HS49); Category 11: Textile and textile articles (HS50-HS63); Category 12: Footwear, headgear, etc. (HS64-HS67), Category 13: Misc. manufactured articles (HS68-HS70), Category 14: Precious or semiprec. stones (HS71), Category 15: Base metals and articles of base metals (HS72-HS83), Category 16: Machinery and mechanical appliances, etc. (HS84-HS85), Category 17: Vehicles, aircraft, etc. (HS86-HS89), Category 18: Optical, photographic, etc. (HS90-HS92), Category 19: Arms and ammunition (HS93), Category 20: Articles of stone, plaster, etc. (HS94-HS96). Figure A1 in the Appendix presents results pertaining to the same product category within the same economy. Insufficient sample sizes prevented convergence in many economy-product category samples, so we could not report these cases in the figure.

[9] Our dataset constitutes an unbalanced panel. For example, as indicated in Table 2, the number of panels in the "All" category of the full sample is 42,852. If this were a balanced panel, it would result in 3,599,568 observations,

of observations shown in Table 1, as each product-economy pair appears in multiple years. The sum of LCP, PCP, and VCP shares is below one in all cases, as we only count product-economy observations with the share of imports with each type of invoicing currency exceeding the 95% threshold. Within the full sample, there are 42,852 product-economy pairs. Of these, 2,468 observations have more than 95% of the import value invoiced in the JPY (i.e., LCP products). The number of PCP and VCP products is 8,743 and 6,101, respectively. Accordingly, the share of PCP products is 20.4%, the highest among the three classifications. The distribution tendency in sub-samples is similar between Tables 1 and 2, although some notable differences exist, especially in product categories. For instance, PCP product share (20.2%) is highest among three types of products in Category 12, "Footwear, headgear, etc. (HS64-HS67)", as shown in Table 2, while the VCP share (42.4%) is highest among three types of invoicing currency as shown in Table 1.

=== Table 2 ===

Figure 1 presents the yen's exchange rate evolution over the sample period. Specifically, it plots the monthly narrow nominal effective exchange rate index (NEER), obtained from the Bank of International Settlements' website, and the nominal exchange rate of yen vis-à-vis the USD (USD/JPY), obtained from the Bank of Japan's website.[10] The left and right vertical axes represent NEER and USD/JPY, respectively. The right vertical axis is inverted in the figure, with smaller values represented higher up. A rise in NEER indicates an appreciation of the yen against the currencies of its trading partners, whereas a rise in USD/JPY in the figure reflects the yen's appreciation against the dollar. Throughout most of the sample period, NEER and USD/JPY move in the same direction. While there is no clear trend in the exchange rate movement over the entire sample period, a transition from a weakening yen trend to a strengthening yen trend is observed around July 2015. The first half of the weakening yen trend followed the implementation of the second round of quantitative and qualitative easing policies in October 2014, while the latter half of the strengthening yen trend lasted until November 2016, when Donald Trump won the presidential election. In this paper, we also conduct additional analysis focusing on these contrasting periods to examine asymmetric ERPT.

=== Figure 1 ===

3. Methodology

As shown in Table 2, our dataset comprises 42,852 panels defined at the product-economy level for the full sample. Therefore, it is anticipated that product-economy-specific variations may

calculated as 42,852 panels multiplied by 84 months. However, Table 1 shows that the actual number of observations is 1,683,411, representing 46.8% of the number expected in a balanced panel scenario. A similar situation exists for each subsample. This paper aggregates data at the product-economy-month level, but it is noted that the ratio generally decreases when the analysis is conducted at a more disaggregated level.

[10] The general observation is unchanged if we use the broad index of NEER instead of the narrow index, as narrow and broad indexes generally move in tandem.

influence import prices. For instance, if a technological innovation occurs in the production of a specific product in a particular exporting economy, the price of that product exported from that economy may fluctuate relative to the price of the same product exported to Japan from other economies. To account for such effects, we adopt a PVAR model in this study. Goodhart and Hoffmann (2008) noted that the "*advantage of using a panel-modeling framework is that it substantially increases the efficiency and the power of the analysis*" (p.188). The large sample size enhances the efficiency of the estimators, which is a major advantage of using panel data. Additionally, this paper employs HS nine-digit products for analysis, which, when conducting VAR analysis for each product and exporting economy, yields over 40,000 estimation results, as shown in Table 2, obscuring the overall picture. Analyzing panel data is beneficial for grasping the overall relationship between invoicing currency and ERPT in Japan's imports and examining differences across subsamples. Other models, such as the Global VAR (GVAR) model used by Dees et al. (2007), also exist for modeling VAR with panel data. However, in estimating GVAR, it is necessary to identify interdependencies among panels from the data before proceeding with the analysis. While this task is feasible when the cross-sections of the panel represent economies, it becomes challenging in our analysis, which includes all products at the HS nine-digit level in the panel, not just economies. Therefore, we opt for the PVAR model in this study.

We formalize the PVAR model as follows:

$$Y_{i,p,t} = A_{i,p} + A(L)Y_{i,p,t} + \varepsilon_{i,p,t} \qquad i = 1, \cdots, N \qquad p = 1, \cdots, M. \tag{1}$$

In this equation, i represents exporting economies, p represents products classified at the HS nine-digit level, and t represents periods (months). N and M are the number of exporting economies and products, respectively. $Y_{i,p,t}$ is a $(NM \times 1)$ vector of endogenous variables, $A_{i,p}$ is a $(NM \times 1)$ vector of product-economy specific fixed effects, and $\varepsilon_{i,p,t}$ is a $(NM \times 1)$ vector of disturbance terms. $A(L)$ is a matrix of lag operator, and the lag length is set to three periods for all estimations.[11] The vector of endogenous variables comprises four variables: the log difference of CPI of the exporting economy ($\Delta CPI_{i,t}$), the log difference of Nikkei 225 index ($\Delta Nikkei225_t$), the log difference of the nominal bilateral exchange rate of the exporters currency against the yen ($\Delta ER_{i,t}$), and the log difference of the unit price ($\Delta P_{i,p,t}$). We introduce CPI to consider the price level of exporting economies. This variable may also reflect the production cost of exporting products. Nikkei 225 index is included to consider Japan's macroeconomic condition. A positive $\Delta ER_{i,t}$ indicates the yen's depreciation. Among these variables, only $\Delta P_{i,p,t}$ is obtained from Japanese customs data. Other variables are obtained from Bloomberg. As a result, $Y_{i,p,t}$ is given by

[11] Based on statistical measures such as Akaike's Information Criterion and Bayesian Information Criterion, there was a tendency to support long lag lengths, such as 24 months. However, adopting such long lags led to insufficient sample sizes for many economies and product categories, preventing us from obtaining reliable estimation results. Further, different lag lengths depending on the economy or product category created disparities in the convergence speeds of impulse responses, making the comparison of cross-sectional analysis results challenging. Consequently, this study adopted the three-period (three-month) lag across all analyses. Sasaki et al. (2022) also used a three-period lag as a suboptimal choice in analyzing ERPT into Japanese import prices when convergence was not reached in their VAR analysis with a 6-month baseline lag. Notably, adopting long lags, such as a 24-month lag, kept the primary analytical findings of the baseline estimation with the full sample the same.

$$Y_{i,p,t} = [\Delta CPI_{i,t} \quad \Delta Nikkei225_t \quad \Delta ER_{i,t} \quad \Delta P_{i,p,t}]' \tag{2}$$

where $\Delta CPI_{i,t}$, $\Delta Nikkei225_t$, $\Delta ER_{i,t}$, and $\Delta P_{i,p,t}$ are $(1 \times NM)$ vectors of those endogenous variables.[12] Regarding the identification of shocks, we employ the Cholesky decomposition. Variables are ordered as follows in terms of exogeneity of their shocks: $\Delta CPI_{i,t}$, $\Delta Nikkei225_t$, $\Delta ER_{i,t}$, and $\Delta P_{i,p,t}$.[13]

It has been noted that OLS estimators in the PVAR model exhibit a bias. For example, Nickell (1981) pointed out that OLS estimates would be biased by lagged dependent variables on the right-hand side of the system of equations even with a large number of panels. In response, methods such as the Instrumental Variable approach (Anderson and Hsiao, 1981) and the Generalized Method of Moments (Arellano and Bond, 1991) have been employed. However, Goodhart and Hofmann (2008) have pointed out that OLS estimation can be more effective than the Instrumental Variable method, and have adopted fixed-effect OLS estimation. Following Goodhart and Hofmann (2008), this paper also employs this method. In all analyses, observations in the sample where the value of $\Delta P_{i,p,t}$ falls within the top and bottom three percentiles are excluded to address outliers. Table 3 shows the descriptive statistics of our empirical variables after excluding those outliers. Table 4 shows the result of the Fisher-type unit-root test with three-month lags for empirical variables based on the Phillips-Perron tests. The null hypothesis is that all panels contain unit roots, while the alternative hypothesis is that at least one panel is stationary. The null hypothesis is rejected in all cases.

=== Tables 3 and 4 ===

4. Major empirical results

This section presents the results of our baseline analysis. After showing the results of Granger causality tests, we discuss ERPT.

4.1. Granger causality tests

Table 5 presents the chi-squared statistics for the PVAR-Granger causality Wald test. Consistent with the PVAR model, we use three-month lags in all cases. The null hypothesis is that there is no causal effect. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels,

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[12] $\Delta CPI_{i,t}$ and $\Delta ER_{i,t}$ are defined for each exporting economy and have no product dimension variations. Therefore, for these variables, the same values appear in observations for different products for the same economies. Similarly, $\Delta Nikkei225_t$ has no variations in economy and product dimensions, so the same values appear for all observations in a month. To confirm robustness, we conducted analyses with the full sample using several alternative variables. For instance, we conducted analyses using Japan's industrial production instead of the Nikkei 225 index. Also, while we used the period average for the exchange rate as the baseline, we conducted a robustness check using the end-period value. Furthermore, while we employed a weighted average of import prices using import values as weights as the baseline, we analyzed with a simple average. All these investigations yielded consistent results with the baseline estimation result with the full sample. The analysis incorporating crude oil prices is presented in Section 4.

[13] Altering the ordering of variables did not lead to any changes in the baseline estimation result.

respectively. Panel (a) shows the analysis results using the full sample. In this panel, significant causal effects are observed in all pairs except for "from ΔP to $\Delta Nikkei225$."[14] This outcome suggests the efficacy of employing a PVAR model for the analysis. Panel (b) focuses on LCP products. In contrast to Panel (a), the significance of the causal effects of other variables on ΔP decreases. For example, the significance of the causal effect from ΔER to ΔP is weaker than in the case of the full sample. This result suggests that exchange rate fluctuations are less likely to be reflected in Japan's import prices for LCP products due to a stronger tendency towards PTM. Similarly, the significance of the impact of ΔCPI on ΔP also decreases. This result implies that the influence of price increases in the exporting economy on the import prices of LCP products is weak. The impact of $\Delta Nikkei225$ on ΔP becomes non-significant, indicating that the import prices of LCP products do not respond flexibly to changes in Japan's domestic economic conditions. Panel (c) details the results for PCP products. As with Panel (a), strong significance is observed in the causal effects of ΔER and ΔCPI on ΔP. These findings indicate that for PCP products, fluctuations in exchange rates and price changes in the exporting economy are more likely to be reflected in the yen-denominated import prices in Japan.

=== Table 5 ===

4.2. Baseline results

Following Shioji (2012) and Sasaki et al. (2022), we define the ERPT elasticity on unit prices as the estimated cumulative impulse response of those prices to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. Figure 2 presents the results of the baseline analysis. Panel (a) shows the results using all samples. Similar to many previous studies, a higher ERPT elasticity is observed for PCP goods compared to LCP (i.e., yen-invoicing) goods. Specifically, the ERPT elasticity for PCP goods reaches about 0.75 in the medium to long term (e.g., after 15 months), while for LCP goods, it remains around 0.19. Therefore, it is evident that even after a certain period, the ERPT remains limited in LCP goods. In Panel (b), we restricted our analysis to the subsample of economies where the local currency share in Japanese total imports from the economy exceeds 5%, and there are more than ten imported products at the HS-9 level, following Gopinath et al. (2010). Estimation in Panel (b) contains Belgium, France, Germany, Italy, Spain, Switzerland, Thailand, the U.K., and the U.S. The result does not differ from our baseline result in Panel (a), although the ERPT elasticity is slightly lower than in the full sample case, regardless of invoicing currency.

=== Figure 2 ===

Panel (c) examines ERPT for VCP products. The analysis is based on the full sample, and for

[14] In subsequent sections, we omit subscript notations of empirical variables.

comparative purposes, the results for "All," "LCP," and "PCP" are reported. "All," "LCP," and "PCP" results are the same as those presented in Panel (a). The ERPT elasticity for VCP products is slightly higher than that for PCP products, but the difference is not as pronounced as between LCP and PCP products. Furthermore, Panel (d) excludes the U.S., the only dollar zone among the 16 sample countries, to analyze ERPT under the dominant currency paradigm. This panel additionally reports results for USD-invoiced products, where over 95% of the import value is invoiced in USD. As in the previous sections, "USD (PC/JPY)" uses the nominal exchange rate between the exporting country's currency. The same exchange rate is used for "All," "LCP," and "PCP." Consistent with Panel (c), a comparison between "PCP" and "USD (PC/JPY)" shows slightly higher ERPT for USD-invoiced products (0.79) compared to PCP products (0.76). However, again, the difference is not substantial. "USD (USD/JPY)" uses the nominal exchange rate between USD and JPY. The ERPT elasticity is 0.82, somewhat higher than the "USD (PC/JPY)" case. These results collectively indicate that even for products invoiced in a third-country currency, the ERPT elasticity is higher than that of LCP products, similar to that of PCP products. This trend remains consistent even for USD-invoiced imports from non-dollar areas, aligning with the dominant currency paradigm.

Panels (e) and (f) present results from analyses focused on the periods of yen depreciation and appreciation, respectively. We conduct the analysis for each of these periods. Comparing the results for all products labeled "All" in those panels, we find that ERPT elasticity is higher during the appreciation phase (0.78) than the depreciation phase (0.60). This result can be interpreted as follows. Foreign firms exporting to Japan, facing their currency's depreciation against the yen, improve yen-denominated price competitiveness by not changing home currency prices, thus, increasing exports and market share. These firms rarely adjust home currency prices during yen appreciation, leading to significant yen appreciation pass-through. However, if their currency appreciates against the yen, maintaining home currency prices would reduce competitiveness and exports. To counteract this, firms may adopt more aggressive PTM strategies to avoid steep yen price increases, by squeezing the profit margin. This supports our finding that ERPT elasticity is higher during yen appreciation than depreciation. Considering invoicing currency, the ERPT elasticity during the depreciation phase is 0.13 for yen-invoiced products and 0.61 for products invoiced in the exporting economy's currency. Furthermore, as shown in Panel (f), the ERPT elasticity during the appreciation phase is 0.43 for yen-invoiced products and about 1.00 for products invoiced in the exporting economy's currency. Therefore, the tendency that ERPT is higher in the appreciation phase than in the depreciation phase does not depend on the invoicing currency.

During the depreciation phase, alongside the depreciation of the yen, there was also a significant drop in the price of crude oil. Consequently, the fall in crude oil prices might have contributed to a decrease in Japan's import prices, potentially resulting in a lower observed ERPT during the depreciation phase. To adjust for this influence, Panels (g) and (h) estimate a five-variable panel VAR model that includes the log difference of crude oil price for depreciation and appreciation phases, respectively. Oil price is calculated as the monthly average of West Texas Intermediate crude oil closing price in the previous day. The data was obtained from Bloomberg. The results are consistent with the baseline results.

5. Additional Analyses

5.1. Results by economy

Figure 3 presents the results by economy selected based on the method of Gopinath et al. (2010). The main consequence is unchanged for most economies; the ERPT elasticity is higher for PCP products than LCP products, while the magnitude of responses varies across economies. Many economies exhibit ERPT elasticity close to 1 for PCP products and near 0 for LCP products, observing forecasts 15 periods ahead. This pattern applies to Belgium, Italy, Switzerland, Thailand, and the U.K. In France, Germany, Spain, and the U.S., ERPT elasticity for PCP products falls below 1. Spain exhibits a relatively minor differential between ERPT elasticity for LCP and PCP products; ERPT is 0.37 and 0.58 for LCP and PCP products, respectively.

=== Figure 3 ===

One distinguishing feature of this paper is its measurement of ERPT elasticity, which is differentiated by invoicing currency for two of Asia's economic powerhouses, China and Thailand. As demonstrated in Table 1, our dataset reveals that 5.1% of China's imports, on a value basis, are invoiced in the RMB. Moreover, as Table 2 illustrates, the share of RMB-invoiced products accounts for 0.2% of imports from China. For Thailand, the share of imports invoiced in the THB and the share of THB-invoiced products stand at 17.2% and 3.0%, respectively. It is generally uncommon for Asian local currencies to be utilized in international trade invoicing. However, in our data of Japan, which has a close trade relationship with China and Thailand, we have secured a sufficient sample size for PVAR estimation. Although China's share of PCP is not large, the substantial number of import transactions allows for the estimation of the PVAR model for PCP products imported from China. The analysis for China and Thailand does not diverge significantly from the results observed for other economies, with the ERPT elasticity being lower for LCP products and higher for PCP products. Specifically, for China, the ERPT elasticity is 0.14 for LCP products and 1.09 for PCP products, whereas for Thailand, the elasticity is 0.15 for LCP products and 1.05 for PCP products. Therefore, even in the case of Asian currencies, which are relatively less utilized in international trade transactions, it is reasonable to extend a similar understanding of the relationship between ERPT and the invoicing currency, as established by prior research in the context of other nations.

5.2. Results by product category

Figure 4 presents the results by product category. All the 16 economies considered in the full sample are included in the estimation. Focusing on the results for all products labeled as "All" in each panel, we observe the highest ERPT elasticity for Category 11, "Textile and textile articles (HS50-HS63)" (0.87), and the lowest ERPT elasticity for Category 14, "Precious or semiprec. stones (HS71)"

(0.29). The ERPT elasticity is higher for PCP products than LCP products in most cases. For instance, within the sample period, Category 16, “Machinery and mechanical appliances, etc. (HS84-HS85),” which accounts for the largest import value, shows an ERPT elasticity for PCP products at 0.75, while that for LCP products is 0.12. Similar results, consistent with the baseline analysis, were observed across many other product categories.

=== Figure 4 ===

There are some exceptions. For instance, in Category 2, “Vegetable products (HS06-HS14),” the ERPT elasticity does not significantly differ between LCP products (0.88) and PCP products (0.90). Notably, despite being classified as LCP products, the 15-period forecast of ERPT is valued at 0.88, which diverges from the baseline analytical outcomes. In contrast, within Category 14, “Precious or semiprec. stones (HS71),” the ERPT elasticities are negative for both LCP products (−0.21) and PCP products (−0.27). The emergence of negative ERPT elasticities reflects the outcome where the cumulative impulse response of prices is almost zero, while the cumulative impulse response for exchange rates is positive. This result indicates that in this product category, the yen-denominated import prices barely respond to exchange rate shocks, irrespective of whether they are LCP or PCP products. The results of the LCP products are consistent with baseline findings. However, the results for PCP products deviate from the baseline, demonstrating that even PCP products exhibit significant PTM in this product category. Furthermore, in Categories 17, “Vehicles, aircraft, etc. (HS86-HS89),” and 18, “Optical, photographic, etc. (HS90-HS92),” the ERPT elasticity for LCP products exceeds that of PCP products. This finding is contrary to the results of the baseline analysis. It is challenging to interpret those findings. Meanwhile, in most cases, with results contradicting our baseline analysis, the number of panels is relatively low, as shown in Table 2. Those results could depend on limited product-economy pairs with some unique characteristics.

6. Conclusion

In this study, we analyze ERPT to import prices at the HS9-digit level using Japanese customs data from 2014 to 2020, adopting the PVAR model approach. Our focus is particularly on how ERPT varies with the invoicing currency. The findings can be summarized as follows: First, the ERPT elasticity is lower for products that are denominated in the JPY and higher for those in exporting economy’s currency. This result aligns with numerous preceding studies. There is variability in ERPT across different economies and product categories. Second, VCP products have slightly higher ERPT elasticity than PCP products, although the difference is not substantial. Thirdly, the relation between invoicing currency and ERPT in imports from China and Thailand is in line with the results for other economies. Fourth, during periods observed within our sample when the yen appreciated, the ERPT elasticity is higher compared to periods of yen depreciation. This phenomenon is interpreted as exporters avoiding a loss of market share in Japan due to price adjustments following the yen depreciation.

The findings of this study offer several implications. The result that ERPT is strongly dependent on the invoicing currency reaffirms the importance of currency choice in corporate exchange rate risk management. However, it is crucial to recognize that, depending on the economy and product category, prices set in domestic currency may still undergo adjustments in the medium to long term, even when firms opt for invoicing in their local currency. This implies that currency choice is not a complete exchange rate risk management strategy. Additionally, the results of this analysis concerning ERPT for VCP products might serve as a benchmark for exchange rate risk management in many regions where the dominant currency paradigm applies. Furthermore, the conclusion that the spread of exchange rate shocks depends significantly on the invoicing currency highlights the importance of considering the status of invoicing currencies in discussions of optimal monetary and exchange rate policies.

This paper aims to comprehensively examine the relationship between invoicing currencies and ERPT across various exporters and products concerning imports into Japan. As a future research direction, it is imperative to delve deeper into how the characteristics of exporting economies and products correlate with ERPT. Additionally, while this analysis has been conducted at the product level, leveraging the intrinsic characteristics of the original transaction data to perform more detailed analyses remains a challenge.

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Table 1. Invoice currency share

Sample		Obs	Share (%) LCP	PCP	VCP
Full sample	Figure 2 (a)	1,683,411	28.0	34.7	37.3
Selected economies	Figure 2 (b)	926,179	25.3	59.2	15.5
Depreciation phase	Figure 2 (c)	203,713	27.9	35.3	36.9
Appreciation phase	Figure 2 (d)	324,081	28.0	35.0	37.1
Results by economy					
Selected economies					
Belgium	Figure 3 (a)	35,088	23.2	60.3	16.5
France	Figure 3 (b)	103,150	31.2	57.5	11.3
Germany	Figure 3 (c)	146,459	28.2	62.2	9.6
Italy	Figure 3 (d)	118,260	25.0	67.1	7.9
Spain	Figure 3 (e)	45,861	25.5	63.3	11.3
Switzerland	Figure 3 (f)	50,661	35.0	41.3	23.7
Thailand	Figure 3 (g)	127,394	37.4	17.2	45.4
UK	Figure 3 (h)	84,727	23.4	47.4	29.2
USA	Figure 3 (i)	214,585	12.1	87.0	1.0
China	Figure 3 (j)	309,024	20.2	5.1	74.6
Results by product category					
Category 1	Figure 4 (1)	42,751	28.4	33.5	38.1
Category 2	Figure 4 (2)	48,203	14.4	41.1	44.5
Category 3	Figure 4 (3)	7,207	10.3	54.1	35.6
Category 4	Figure 4 (4)	97,570	18.0	47.2	34.8
Category 5	Figure 4 (5)	26,664	18.6	28.8	52.7
Category 6	Figure 4 (6)	217,140	34.0	28.2	37.8
Category 7	Figure 4 (7)	113,068	33.0	30.1	36.9
Category 8	Figure 4 (8)	23,809	29.7	35.9	34.3
Category 9	Figure 4 (9)	22,091	19.7	28.1	52.2
Category 10	Figure 4 (10)	37,929	33.6	38.7	27.7
Category 11	Figure 4 (11)	219,880	20.4	28.5	51.1
Category 12	Figure 4 (12)	29,023	23.7	33.9	42.4
Category 13	Figure 4 (13)	49,400	30.5	37.9	31.6
Category 14	Figure 4 (14)	23,059	36.6	31.4	32.0
Category 15	Figure 4 (15)	183,405	34.2	29.8	36.0
Category 16	Figure 4 (16)	336,734	29.2	39.7	31.1
Category 17	Figure 4 (17)	33,374	26.0	47.1	27.0
Category 18	Figure 4 (18)	105,205	33.5	36.6	29.9
Category 19	Figure 4 (19)	1,885	5.1	72.4	22.6
Category 20	Figure 4 (20)	61,774	22.8	38.1	39.1

Source: The Japanese customs data.

Notes: The table shows the results based on a dataset aggregated at the product-economy-month level, originally from transaction-level Customs data. It presents the average shares of each type of invoicing currency. The number of observations also indicates the count of observations at the product-economy-month level. Observations in the sample where the value of $\Delta P_{i,p,t}$ falls within the top and bottom three percentiles are excluded to address outliers. The table does not count missing observations at the product-economy-month level.

Table 2. Number and share of LCP, PCP, and VCP products

		Number of panels (product-country pairs)				Share (%)		
Sample		All	LCP	PCP	VCP	LCP	PCP	VCP
Full sample	Figure 2 (a)	42,852	2,468	8,743	6,101	5.8	20.4	14.2
Selected economies	Figure 2 (b)	25,658	1,307	8,431	1,331	5.1	32.9	5.2
Depreciation phase	Figure 2 (c)	30,518	1,591	5,535	3,775	5.2	18.1	12.4
Appreciation phase	Figure 2 (d)	32,567	1,697	6,071	4,138	5.2	18.6	12.7
Results by economy								
Selected economies								
Belgium	Figure 3 (a)	1,503	84	623	70	5.6	41.5	4.7
France	Figure 3 (b)	3,093	194	1,041	75	6.3	33.7	2.4
Germany	Figure 3 (c)	3,565	209	1,148	67	5.9	32.2	1.9
Italy	Figure 3 (d)	3,405	98	1,122	69	2.9	33.0	2.0
Spain	Figure 3 (e)	1,865	107	776	79	5.7	41.6	4.2
Switzerland	Figure 3 (f)	1,632	162	221	109	9.9	13.5	6.7
Thailand	Figure 3 (g)	3,126	288	93	642	9.2	3.0	20.5
UK	Figure 3 (h)	2,712	107	407	210	3.9	15.0	7.7
USA	Figure 3 (i)	4,726	54	3,009		1.1	63.7	
China	Figure 3 (j)	5,612	102	13	1,721	1.8	0.2	30.7
Results by product category								
Category 1	Figure 4 (1)	1,333	153	348	270	11.5	26.1	20.3
Category 2	Figure 4 (2)	1,410	78	470	345	5.5	33.3	24.5
Category 3	Figure 4 (3)	252	9	95	59	3.6	37.7	23.4
Category 4	Figure 4 (4)	2,697	164	1,107	517	6.1	41.0	19.2
Category 5	Figure 4 (5)	716	51	145	211	7.1	20.3	29.5
Category 6	Figure 4 (6)	5,125	592	788	956	11.6	15.4	18.7
Category 7	Figure 4 (7)	2,419	157	334	329	6.5	13.8	13.6
Category 8	Figure 4 (8)	695	30	178	117	4.3	25.6	16.8
Category 9	Figure 4 (9)	627	20	176	139	3.2	28.1	22.2
Category 10	Figure 4 (10)	991	89	196	104	9.0	19.8	10.5
Category 11	Figure 4 (11)	7,093	179	1,607	1,494	2.5	22.7	21.1
Category 12	Figure 4 (12)	742	15	150	75	2.0	20.2	10.1
Category 13	Figure 4 (13)	1,159	71	252	98	6.1	21.7	8.5
Category 14	Figure 4 (14)	590	49	75	63	8.3	12.7	10.7
Category 15	Figure 4 (15)	4,569	391	835	537	8.6	18.3	11.8
Category 16	Figure 4 (16)	7,719	240	1,262	444	3.1	16.3	5.8
Category 17	Figure 4 (17)	838	44	156	46	5.3	18.6	5.5
Category 18	Figure 4 (18)	2,292	96	228	141	4.2	9.9	6.2
Category 19	Figure 4 (19)	79		45	7		57.0	8.9
Category 20	Figure 4 (20)	1,363	38	255	134	2.8	18.7	9.8

Source: The Japanese customs data.

Notes: The table shows the number and share of each product type (LCP, PCP, and VCP) based on the number of product-economy pairs. The ”All“ category counts all product-economy-level observations. In contrast, the ”LCP,” ”PCP,” and ”VCP“ categories count the number of product-economy-level observations with the share of each type of invoicing currency exceeding the 95% threshold. Therefore, the sum of observation numbers of the ”LCP,” ”PCP,” and ”VCP“ categories is below the number of observations of the ”All“ category. The denominator of the share of the ”LCP,” ”PCP,” and ”VCP“ categories is the observation number of the ”All“ category. Thus, the sum of the shares of the ”LCP,” ”PCP,” and ”VCP“ categories is below one hundred. The share of VPC for the U.S. and that of LCP for Category 19 will remain confidential due to the potential for identifying individual exporters and importers.

Table 3. Descriptive statistics

Variable	Obs	Mean	Std. Dev	Min	Max
ΔP	1,683,411	0.0004	0.4589	-1.2686	1.2767
ΔER	1,683,411	-0.0007	0.0198	-0.0935	0.0707
ΔNikkei225	1,683,411	0.0064	0.0448	-0.2002	0.1097
ΔCPI	1,683,411	0.0010	0.0041	-0.0205	0.0570

Source: The Japanese customs data, and Bloomberg.

Notes: The table shows the descriptive statistics of our empirical variables.

Table 4. Panel unit root test

Variable	Inverse χ2 *P* Statistics	Inverse normal *Z* Statistics	Inverse logit *L** Statistics	Modified inv. χ2 *Pm* Statistics
ΔP	1,710,000 ***	-1,160 ***	-2,680 ***	4,556 ***
ΔER	786,000 ***	-703 ***	-1,220 ***	1,995 ***
ΔNikkei225	945,000 ***	-787 ***	-1,470 ***	2,436 ***
ΔCPI	1,000,000 ***	-793 ***	-1,550 ***	2,597 ***

Source: The Japanese customs data, and Bloomberg.

Notes: The table shows the result of the Fisher-type unit-root test for empirical variables based on the Phillips-Perron tests. We use three-month lags for all variables. The null hypothesis is that all panels contain unit roots, while the alternative hypothesis is that at least one panel is stationary. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

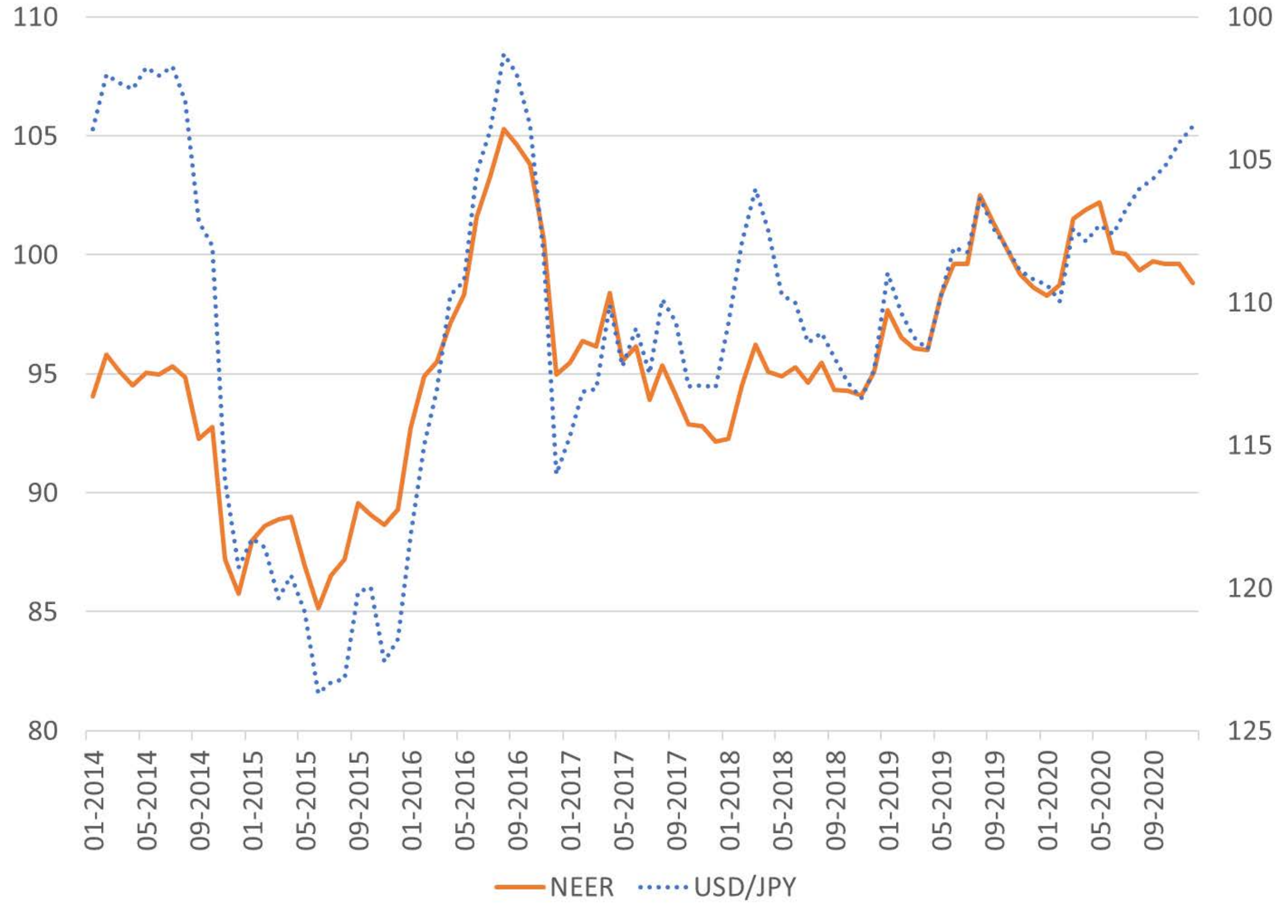
Table 5. Granger causality test

(a) All sample: Number of samples = 1,316,903		
from ΔP to ΔER	***from ΔP to ΔNikkei225***	***from ΔP to ΔCPI***
7.956**	2.126	37.183***
from ΔER to ΔP	***from ΔER to ΔNikkei225***	***from ΔER to ΔCPI***
956.830***	4696.197***	31693.119***
from ΔNikkei225 to ΔP	***from ΔNikkei225 to ΔER***	***from ΔNikkei225 to ΔCPI***
15.183***	547.580***	29989.265***
from ΔCPI to ΔP	***from ΔCPI to ΔER***	***from ΔCPI to ΔNikkei225***
15.504***	2290.695***	4167.945***
(b) LCP product: Number of samples = 69,483		
from ΔP to ΔER	***from ΔP to ΔNikkei225***	***from ΔP to ΔCPI***
8.220**	6.646*	0.541
from ΔER to ΔP	***from ΔER to ΔNikkei225***	***from ΔER to ΔCPI***
7.828*	429.166***	1250.578***
from ΔNikkei225 to ΔP	***from ΔNikkei225 to ΔER***	***from ΔNikkei225 to ΔCPI***
4.203	89.128***	1210.127***
from ΔCPI to ΔP	***from ΔCPI to ΔER***	***from ΔCPI to ΔNikkei225***
6.773*	63.547***	276.451***
(c) PCP product: Number of samples = 175,945		
from ΔP to ΔER	***from ΔP to ΔNikkei225***	***from ΔP to ΔCPI***
0.242	5.657	6.415*
from ΔER to ΔP	***from ΔER to ΔNikkei225***	***from ΔER to ΔCPI***
216.040***	1519.731***	9439.560***
from ΔNikkei225 to ΔP	***from ΔNikkei225 to ΔER***	***from ΔNikkei225 to ΔCPI***
3.061	398.119***	4339.888***
from ΔCPI to ΔP	***from ΔCPI to ΔER***	***from ΔCPI to ΔNikkei225***
36.755***	71.169***	741.374***

Source: The Japanese customs data, and Bloomberg.

Notes: The table shows the chi-squared statistics for the PVAR-Granger causality Wald test. We use three-month lags in all cases. The null hypothesis is that there is no causal effect. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

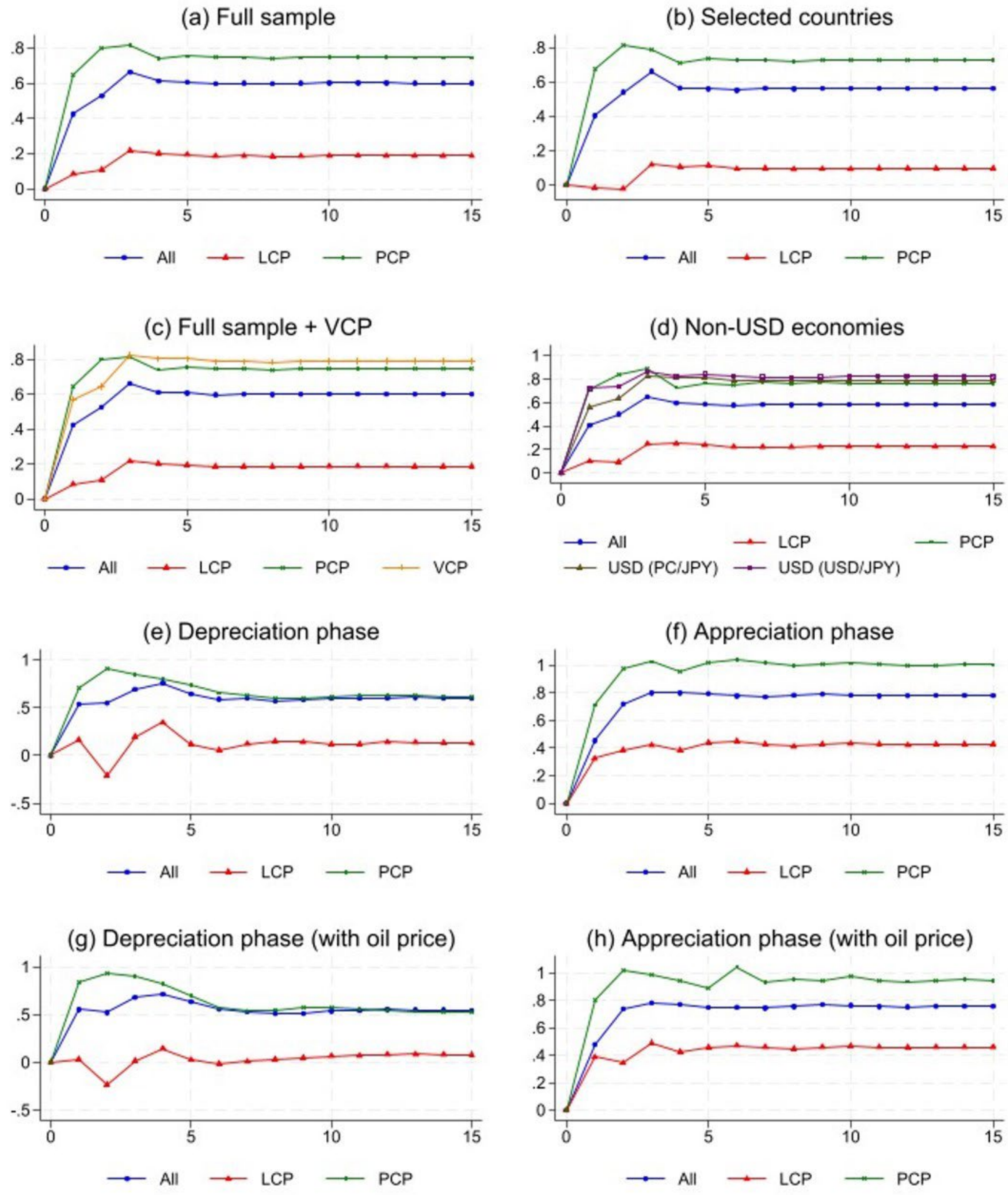
Figure 1. Evolution of the yen's exchange rate during the sample period



Source: Bank of International Settlements, and Bank of Japan.

Notes: The figure plots the narrow index of the nominal effective exchange rate of the yen (NEER) and the nominal exchange rate of the JPY vis-à-vis the USD (USD/JPY) during the sample period. The left and right vertical axes represent NEER and USD/JPY, respectively.

Figure 2. The ERPT elasticity: Baseline results

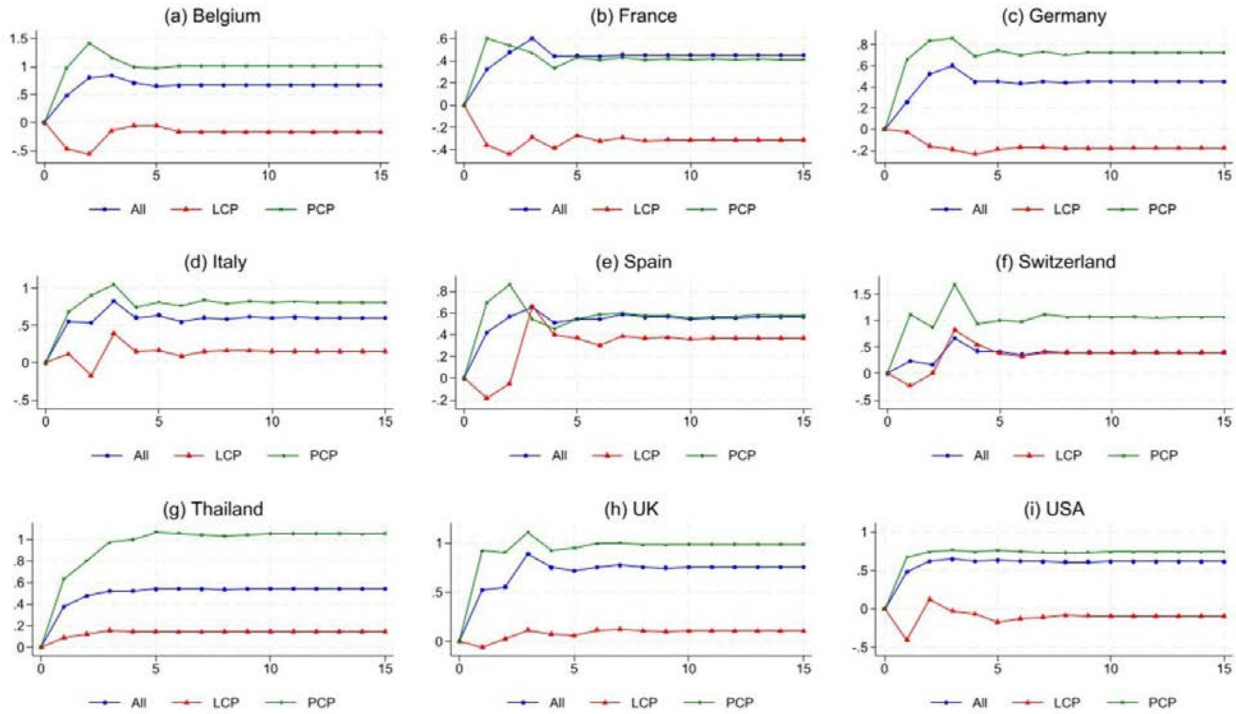


Source: The Japanese customs data

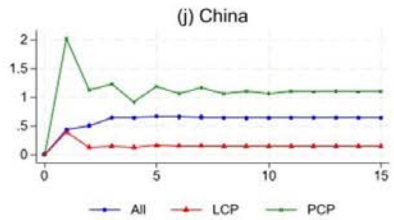
Notes: The figure shows the ERPT elasticity forecast obtained from equation (1) estimation. We estimated a four-variable PVAR model in Panels (a)-(f) and a five-variable PVAR model with three-month lags. The ERPT elasticity is defined as the estimated cumulative impulse response of the unit price to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. In Panel (b), we restricted the sample economies following the method of Gopinath et al. (2010). In Panels (c) and (d), we investigate VCP. In Panels (e) and (f), we focused on the period of the yen's rapid depreciation and appreciation, respectively. In Panels (g) and (h), we add the crude oil price to Panels (e) and (f), respectively.

Figure 3. The ERPT elasticity: Results by economy

Selected countries



China



Source: The Japanese customs data

Notes: The figure shows the ERPT elasticity obtained from equation (1) estimation for selected economies. We estimated a four-variable PVAR model with three-month lags in all estimations. The ERPT elasticity is defined as the estimated cumulative impulse response of the unit price to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. For economy selection, we follow the method of Gopinath et al. (2010).

Figure 4. The ERPT elasticity: Results by product category

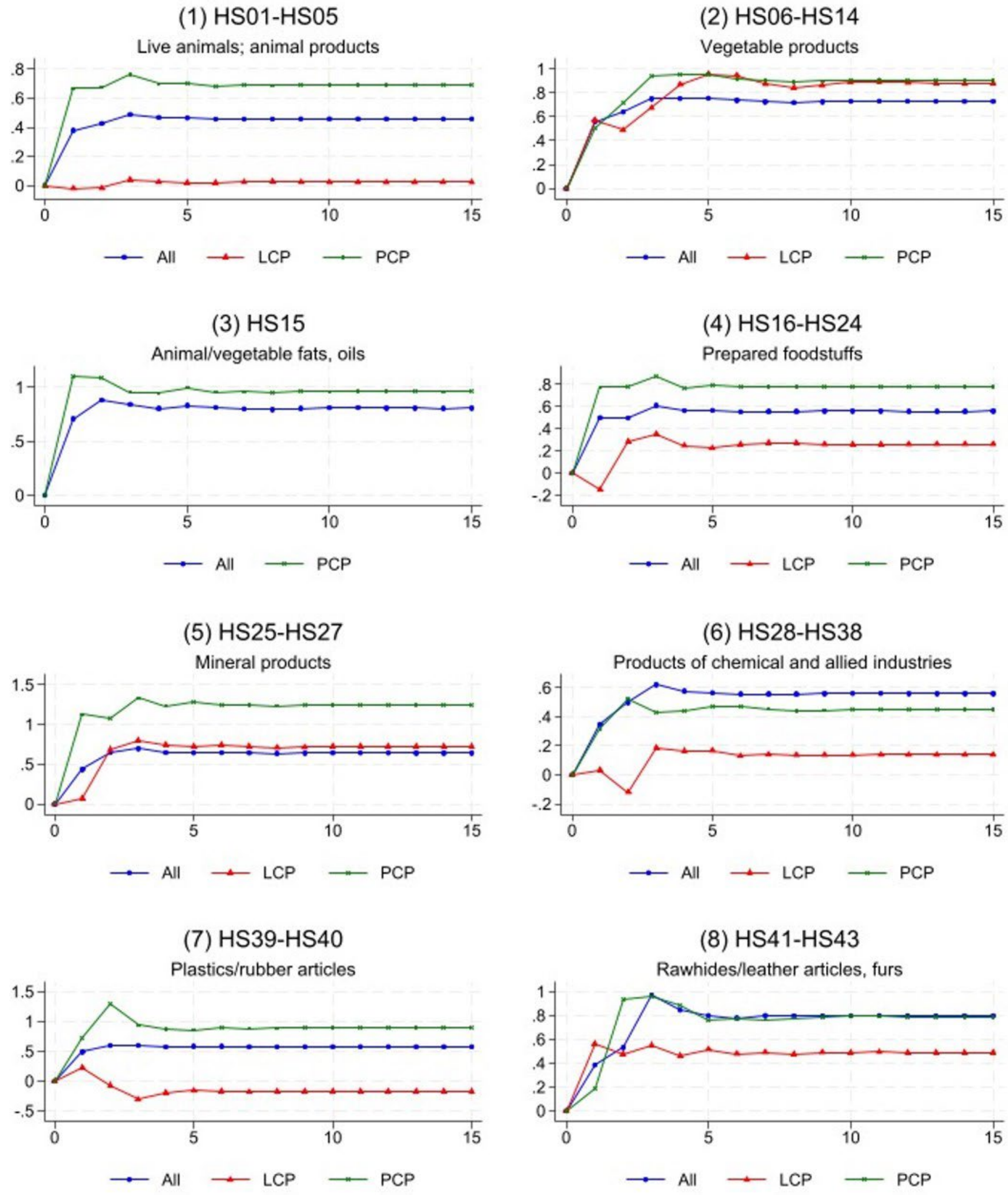


Figure 4. The ERPT elasticity: Results by product category (continued)

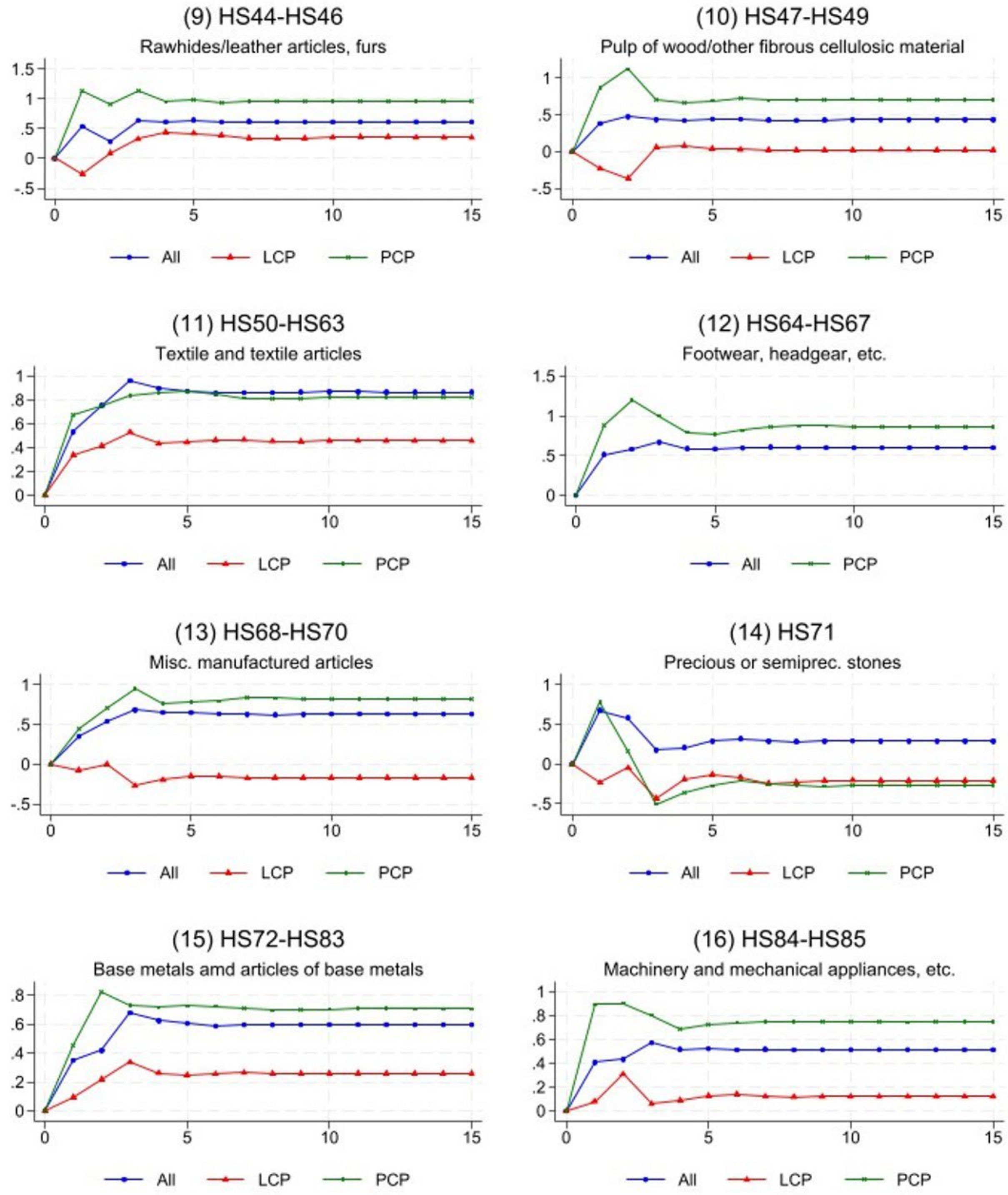
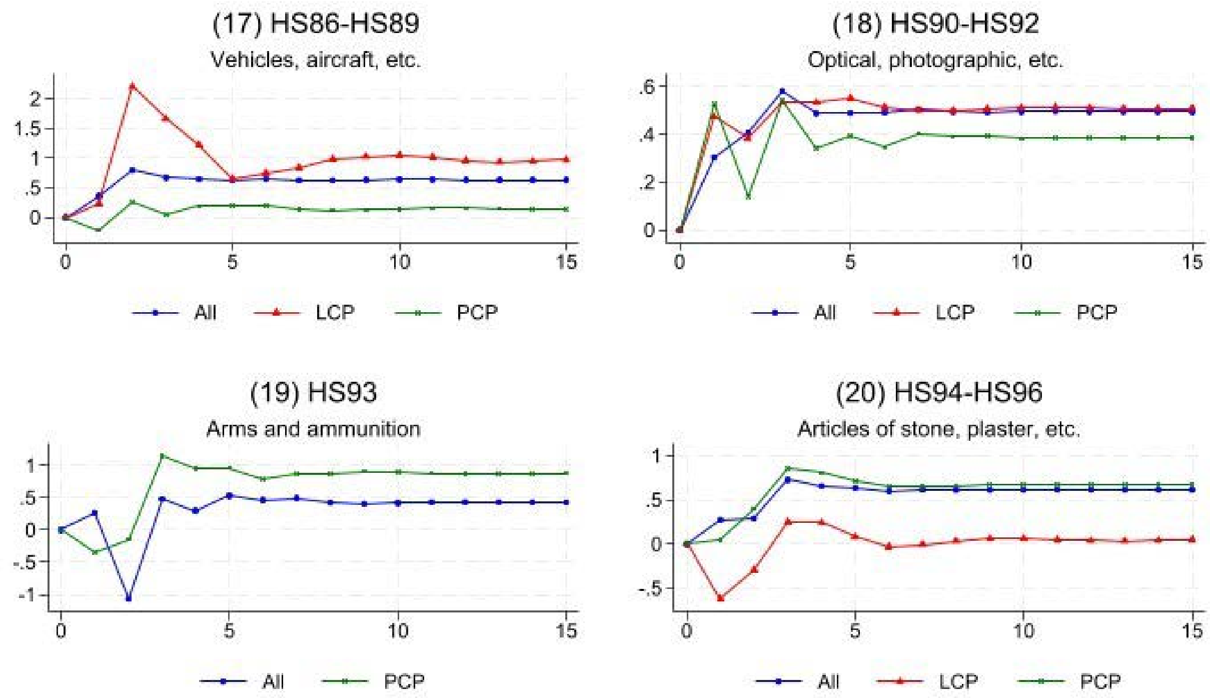


Figure 4. The ERPT elasticity: Results by product category (continued)

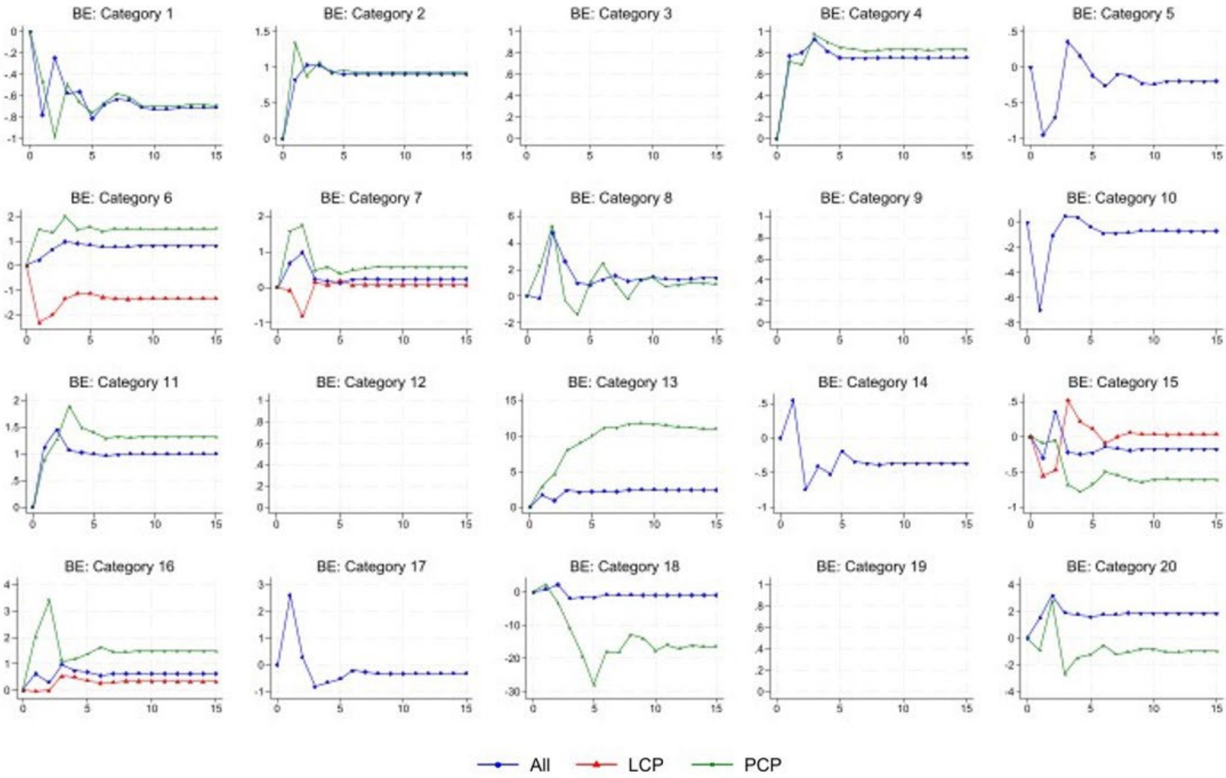


Source: The Japanese customs data

Notes: The figure shows the ERPT elasticity forecast obtained from equation (1) estimation by product category. We estimated a four-variable PVAR model with three-month lags in all estimations. The ERPT elasticity is defined as the estimated cumulative impulse response of the unit price to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. Due to a lack of sample size, the analysis results for some product categories and invoicing currencies are not shown.

Appendix

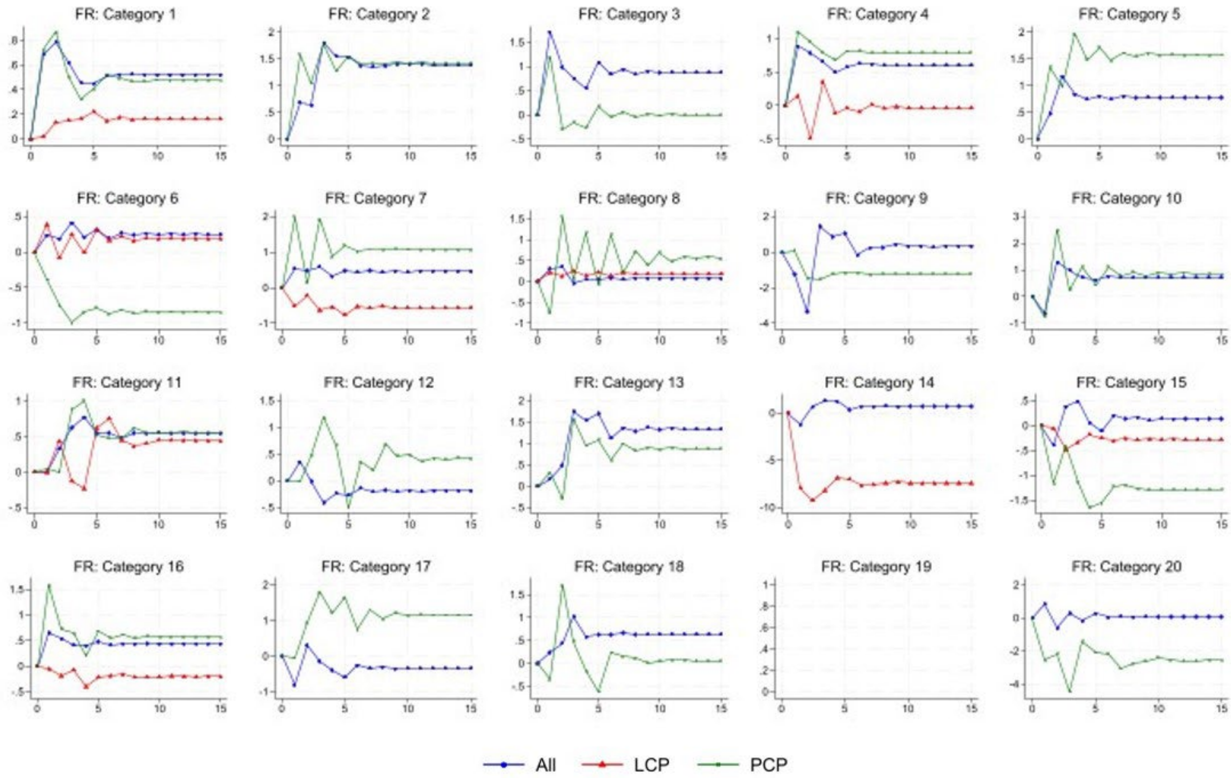
Figure A1. The ERPT elasticity: Results by product category within the same economy
A1-1. Belgium



Source: The Japanese customs data

Notes: The figure focuses on Belgium and shows the ERPT elasticity forecast obtained from equation (1) estimation for all industrial categories. We estimated a four-variable PVAR model with three-month lags in all estimations. The ERPT elasticity is defined as the estimated cumulative impulse response of the unit price to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. Due to a lack of sample size, the analysis results for some product categories and invoicing currencies are not shown.

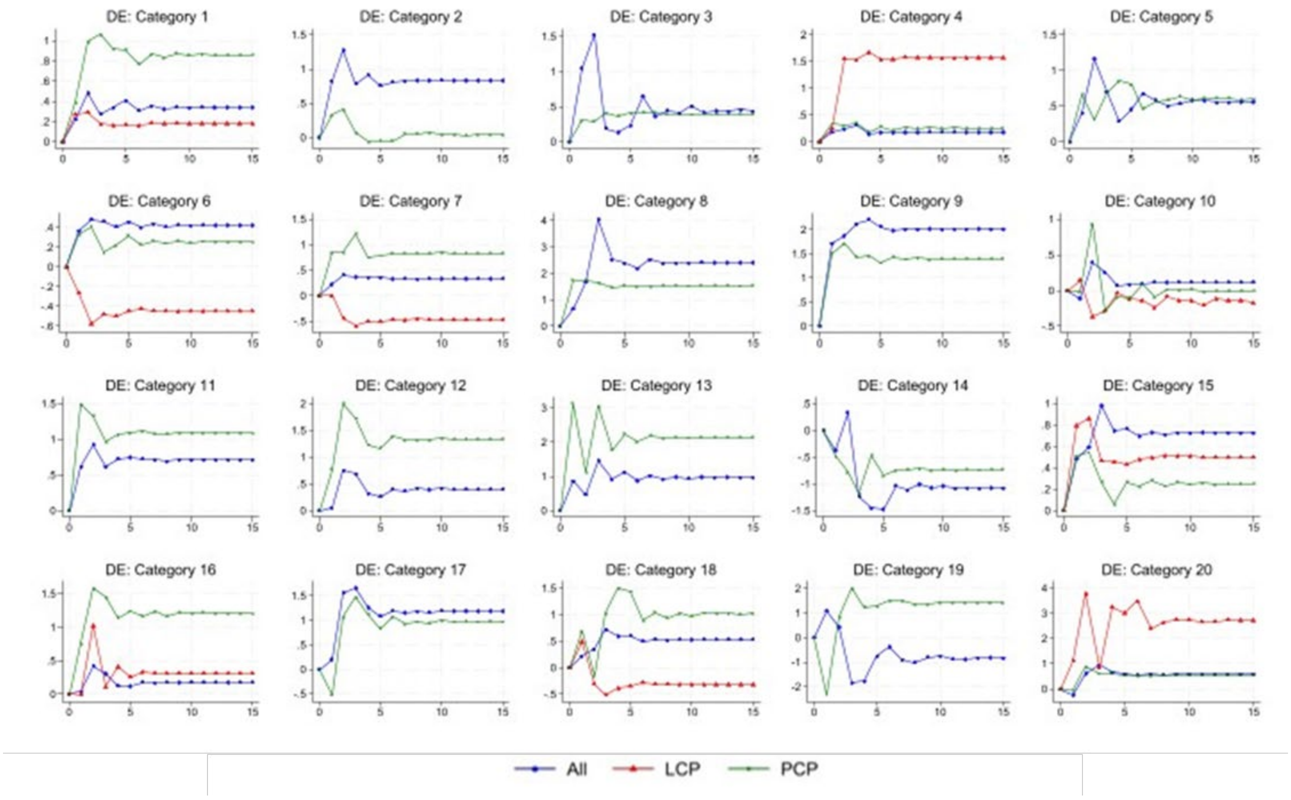
A1-2. France



Source: The Japanese customs data

Notes: The figure focuses on France and shows the ERPT elasticity forecast obtained from equation (1) estimation for all industrial categories. We estimated a four-variable PVAR model with three-month lags in all estimations. The ERPT elasticity is defined as the estimated cumulative impulse response of the unit price to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. Due to a lack of sample size, the analysis results for some product categories and invoicing currencies are not shown.

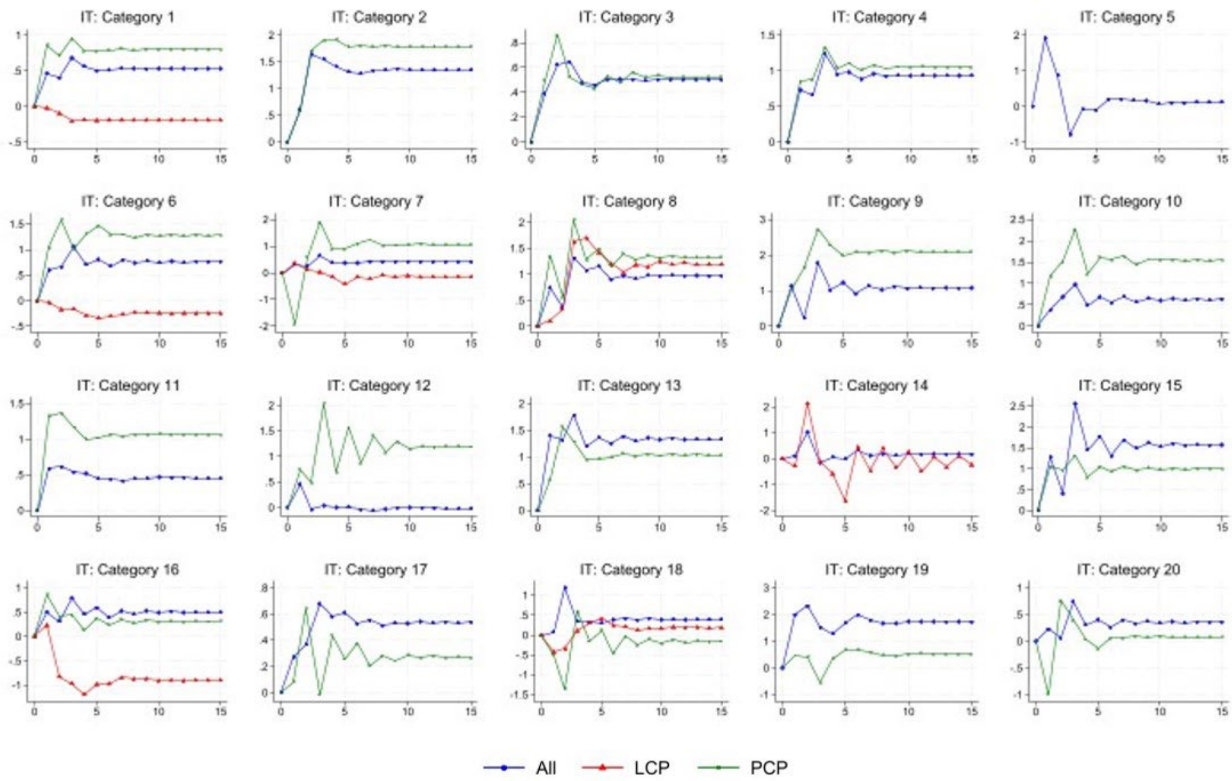
A1-3. Germany



Source: The Japanese customs data

Notes: The figure focuses on Germany and shows the ERPT elasticity forecast obtained from equation (1) estimation for all industrial categories. We estimated a four-variable PVAR model with three-month lags in all estimations. The ERPT elasticity is defined as the estimated cumulative impulse response of the unit price to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. Due to a lack of sample size, the analysis results for some product categories and invoicing currencies are not shown.

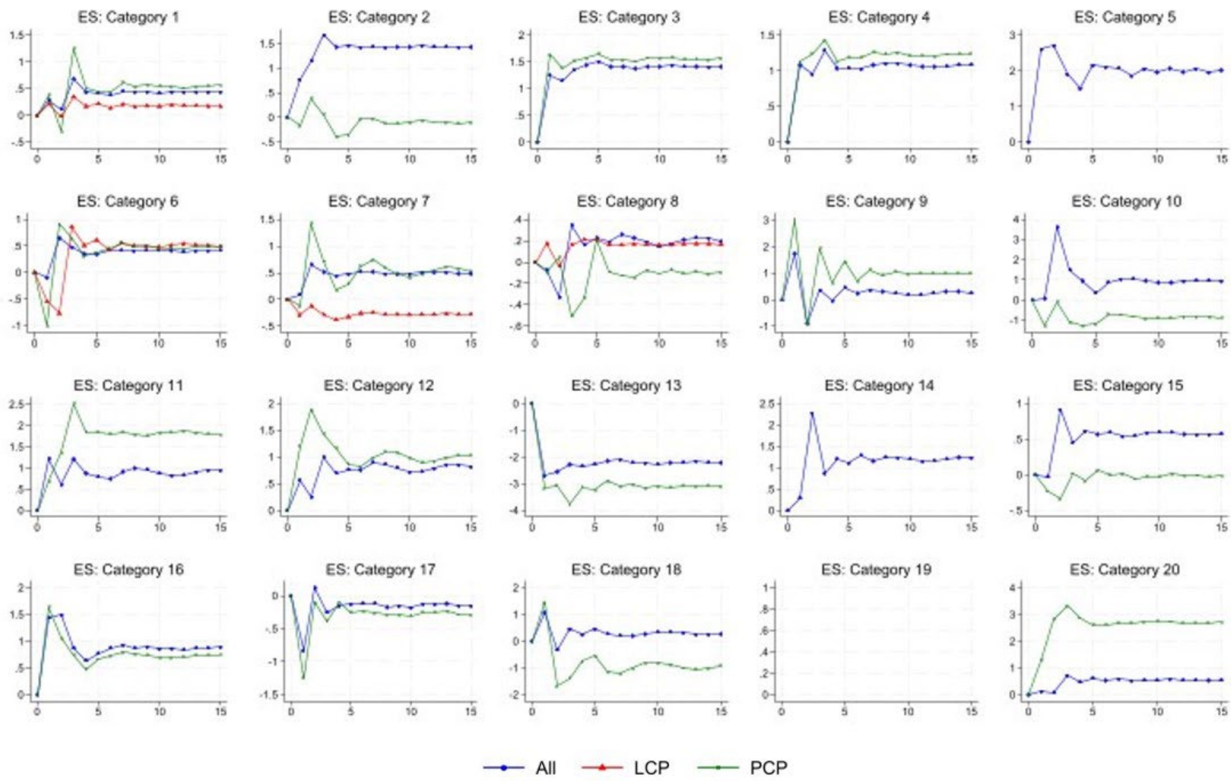
A1-4. Italy



Source: The Japanese customs data

Notes: The figure focuses on Italy and shows the ERPT elasticity forecast obtained from equation (1) estimation for all industrial categories. We estimated a four-variable PVAR model with three-month lags in all estimations. The ERPT elasticity is defined as the estimated cumulative impulse response of the unit price to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. Due to a lack of sample size, the analysis results for some product categories and invoicing currencies are not shown.

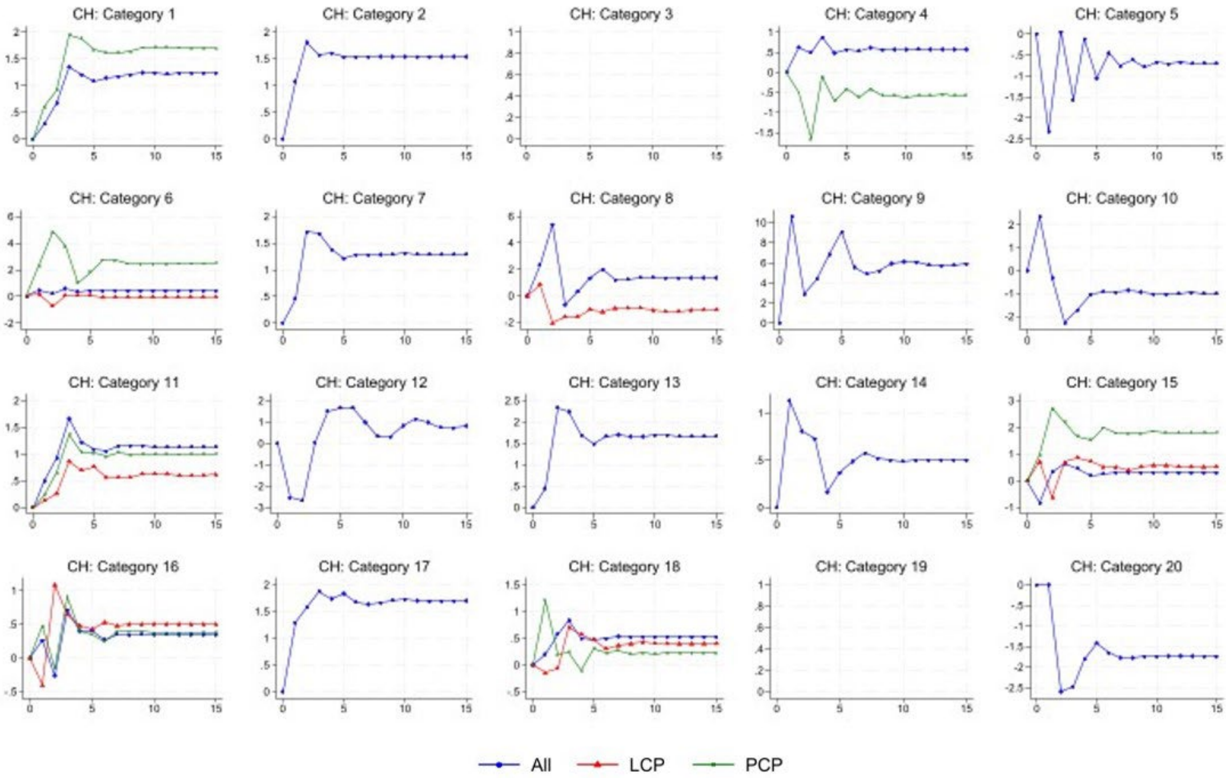
A1-5. Spain



Source: The Japanese customs data

Notes: The figure focuses on Spain and shows the ERPT elasticity forecast obtained from equation (1) estimation for all industrial categories. We estimated a four-variable PVAR model with three-month lags in all estimations. The ERPT elasticity is defined as the estimated cumulative impulse response of the unit price to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. Due to a lack of sample size, the analysis results for some product categories and invoicing currencies are not shown.

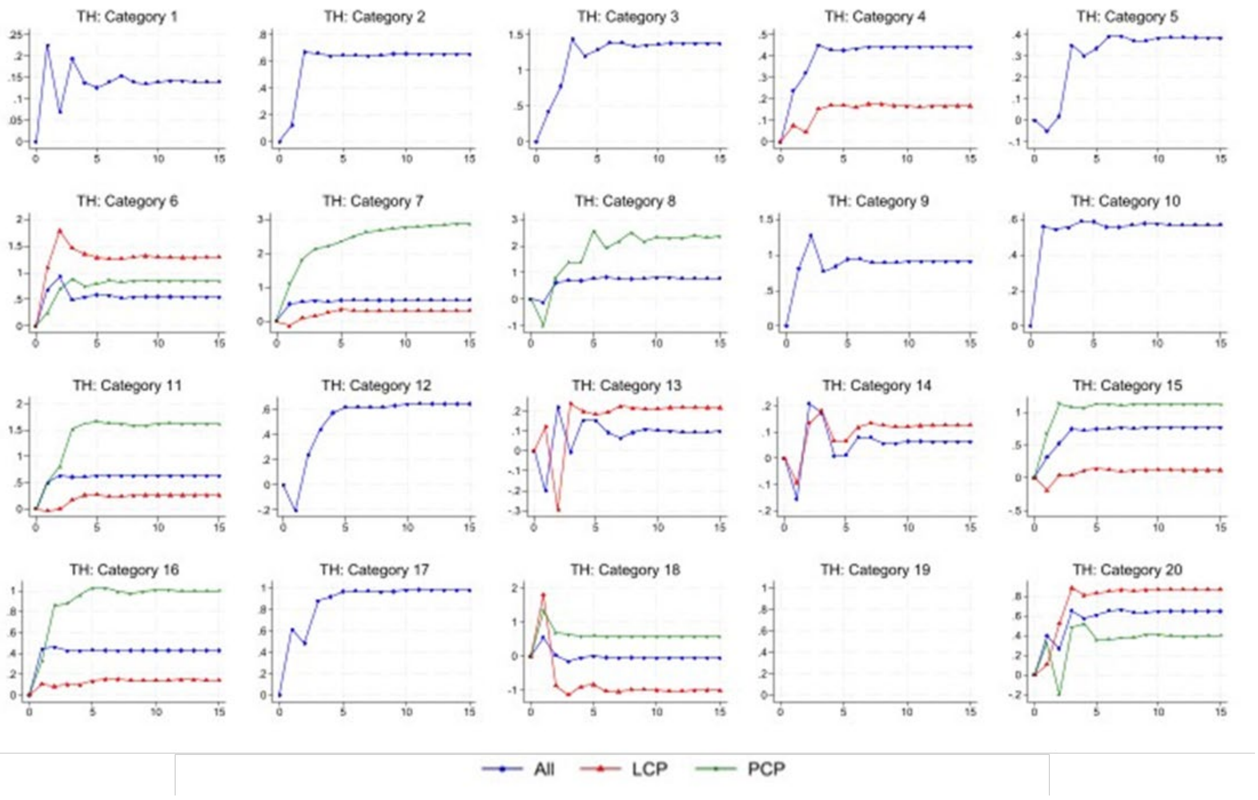
A1-6. Switzerland



Source: The Japanese customs data

Notes: The figure focuses on Switzerland and shows the ERPT elasticity forecast obtained from equation (1) estimation for all industrial categories. We estimated a four-variable PVAR model with three-month lags in all estimations. The ERPT elasticity is defined as the estimated cumulative impulse response of the unit price to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. Due to a lack of sample size, the analysis results for some product categories and invoicing currencies are not shown.

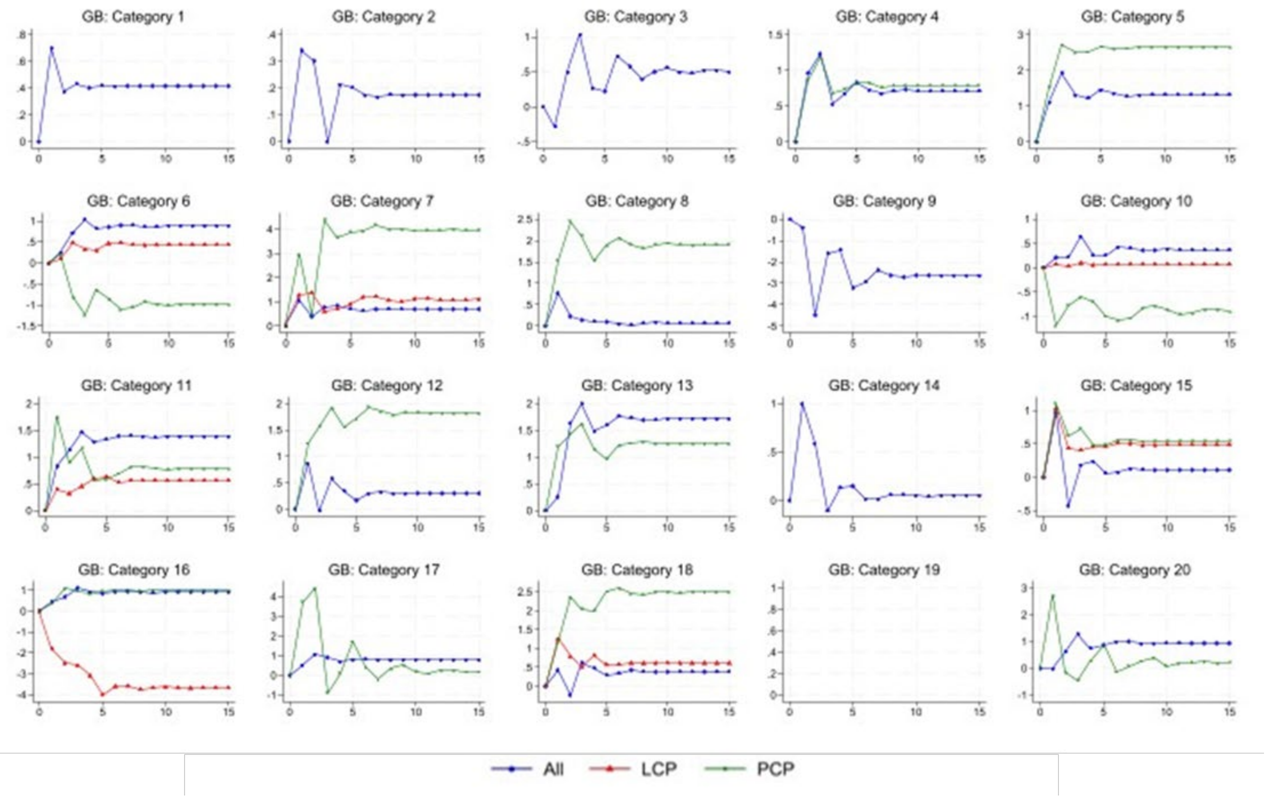
A1-7. Thailand



Source: The Japanese customs data

Notes: The figure focuses on Thailand and shows the ERPT elasticity forecast obtained from equation (1) estimation for all industrial categories. We estimated a four-variable PVAR model with three-month lags in all estimations. The ERPT elasticity is defined as the estimated cumulative impulse response of the unit price to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. Due to a lack of sample size, the analysis results for some product categories and invoicing currencies are not shown.

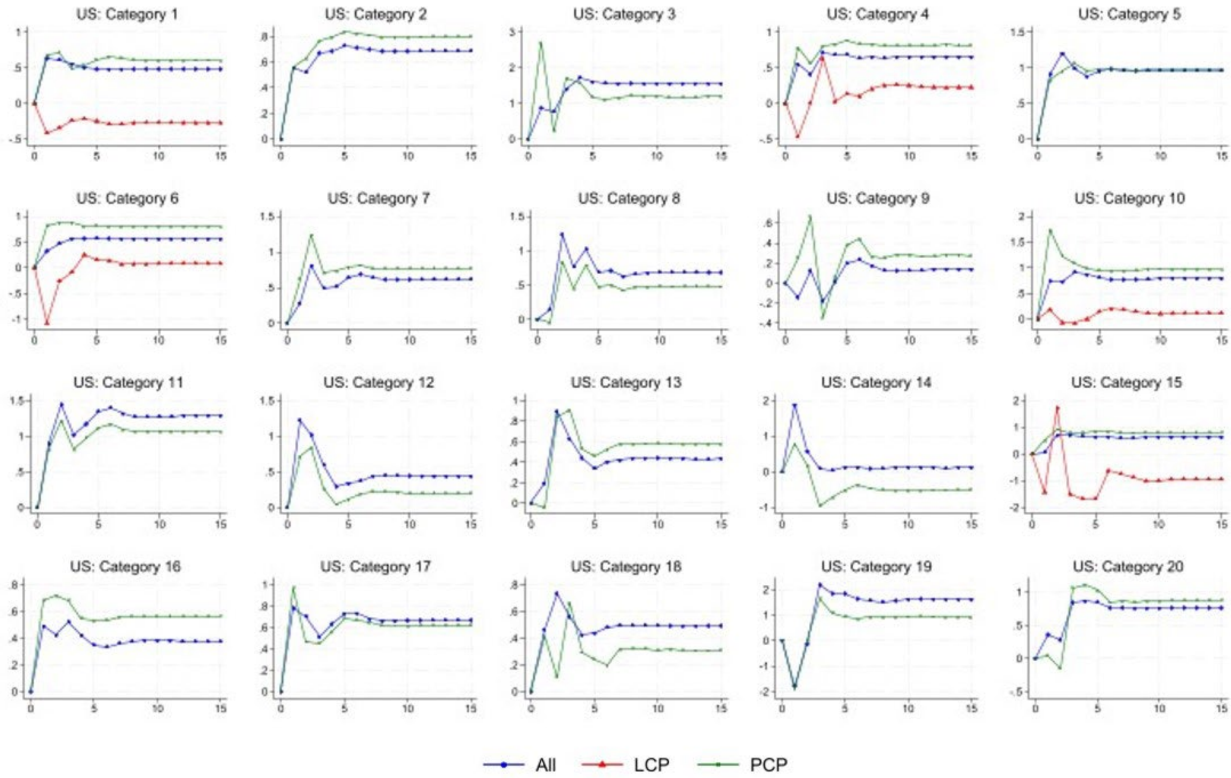
A1-8. United Kingdom



Source: The Japanese customs data

Notes: The figure focuses on the U.K. and shows the ERPT elasticity forecast obtained from equation (1) estimation for all industrial categories. We estimated a four-variable PVAR model with three-month lags in all estimations. The ERPT elasticity is defined as the estimated cumulative impulse response of the unit price to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. Due to a lack of sample size, the analysis results for some product categories and invoicing currencies are not shown.

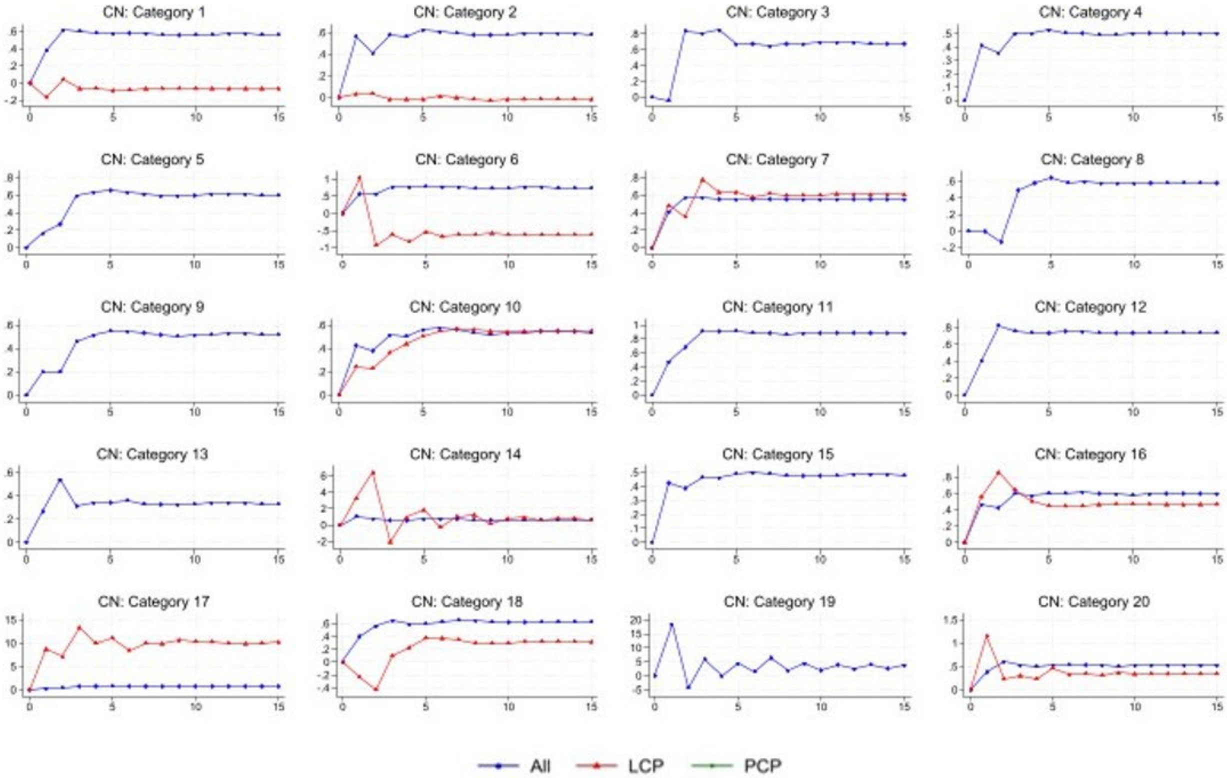
A1-9. United States



Source: The Japanese customs data

Notes: The figure focuses on the U.S. and shows the ERPT elasticity forecast obtained from equation (1) estimation for all industrial categories. We estimated a four-variable PVAR model with three-month lags in all estimations. The ERPT elasticity is defined as the estimated cumulative impulse response of the unit price to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. Due to a lack of sample size, the analysis results for some product categories and invoicing currencies are not shown.

A1-10. China



Source: The Japanese customs data

Notes: The figure focuses on China and shows the ERPT elasticity forecast obtained from equation (1) estimation for all industrial categories. We estimated a four-variable PVAR model with three-month lags in all estimations. The ERPT elasticity is defined as the estimated cumulative impulse response of the unit price to an exchange rate shock divided by the exchange rate's cumulative impulse response to the shock. Due to a lack of sample size, the analysis results for some product categories and invoicing currencies are not shown.