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【要旨】

This study examines how Japanese exporting firms adjust export prices in response to exchange rate fluctuations and how export volumes respond to these price changes, utilizing export-import declaration data collected by Japan Customs combined with firm-level information for the period from 2014 to 2020 taken from an annual survey by the Ministry of Economy, Trade, and Industry. The estimation results suggest that firms with a high import intensity tend to choose foreign currency invoicing and that the choice of foreign currency invoicing leads to incomplete exchange rate pass-through (ERPT). Moreover, not only is the ERPT small, changes in export volumes in response to price fluctuations are also quite small. Further, it takes over a year for changes in export prices to have a significant effect on export volumes. The elasticity of the volume of intermediate goods exports is particularly small.

These results suggest that involvement in global value chains, which entails actively importing intermediate goods from abroad and exporting them for further processing in foreign countries, has a significant impact on firms’ pricing strategies and the responsiveness of export quantities to exchange rate fluctuations.

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Firms in Global Value Chains and Their Responses to Exchange Rate Changes[*]

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Abstract

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Keywords: Exchange rate pass-through, export elasticity, global value chains, customs data, Japan

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1. Introduction

Expanding their exports is expected to increase firms' revenue and profits through the expansion of their market. Moreover, it is generally assumed that a depreciation of the home currency allows exporting firms to expand their exports and increase profits from exports. That is, the depreciation of the home currency allows firms to lower the prices of their products in foreign-currency terms, boosting demand and hence the quantity of exports; alternatively, they can keep foreign prices unchanged, increasing the value of exports in domestic-currency terms. In practice, however, there are cases where exports do not substantially increase in the wake of a depreciation of the domestic currency. A notable example is Japan, where firms' exports did not substantially rise during the phase of yen depreciation from 2012 to 2015 (Leigh et al., 2015).

While there is extensive prior research on the magnitude of changes in exports in response to exchange rate fluctuations, the findings indicate that the size of this response varies significantly across countries (e.g., Hooper et al., 2000; Bussiere et al., 2020) and across firms (e.g., Berman et al., 2012; Amiti et al., 2014, 2019). Although there are various factors which affect the relationship between exchange rate movements and export volumes, several recent studies suggest that participation in global value chains (GVCs) reduces the responsiveness of exports to exchange rate fluctuations (e.g., Ahmed et al., 2017; de Soyres et al., 2021; Sato and Zhang, 2019; Adler et al., 2023). These studies, relying on country-sector-level data, find that higher shares of foreign value added in exports are associated with lower exchange rate export elasticities.

Let us consider the likely reason. In the context of GVCs, a country imports intermediate goods, processes them domestically, and exports the processed intermediate goods. Furthermore, some of the intermediate goods exported by the country are re-exported further to another final destination or back to the origin country. Consequently, the impact of exchange rate fluctuations on export prices is partially offset by their effect on import prices. Additionally, the demand for intermediate goods in direct export destinations is influenced by the demand for intermediate or final goods in other countries. As a result, trade dynamics in GVCs are affected not only by exchange rate fluctuations between the home country and its direct export partners but also by exchange rates between export partners and third countries. This means that cross-border production chains potentially reduce the competitiveness gains of currency depreciation.

Empirical studies using detailed firm-level trade data suggest that increasing participation in GVCs indeed changes the relationship between trade volumes and exchange rate fluctuations. For example, Amiti et al. (2014), analyzing Belgian firm-level trade data, find that firms with a higher proportion of imported intermediate inputs tend to exhibit a low exchange rate pass-through (ERPT). Amiti et al. (2014) explain that since many exporting firms also engage in imports, and exchange rate fluctuations affect exports and imports in opposite directions, firms with a high import ratio do not lower their export prices even when the exchange rate depreciates, meaning that the ERPT is small. Although Amiti et al. (2014) do not explicitly examine the impact of GVC participation on ERPT and export elasticity, their findings imply that the expansion of GVCs weakens the relationship between exchange rate fluctuations and trade volumes, given that many firms participating in GVCs engage in both exporting and importing.[3]

On the other hand, recent empirical studies highlight that the choice of a firm's invoicing currency affects the magnitude of the ERPT and also influences export volumes due to the close relationship between a firm's pricing strategy and its invoicing currency choices. For instance, Amiti et al. (2022) show that exporting firms with high import ratios are more likely to choose foreign currency invoicing and are less likely to revise foreign-currency export prices when there are changes in the exchange rate.[4] Meanwhile, Yoshimi et al. (2023) show that in intra-firm exports of Japanese automobiles to France, the importer's currency tends to be chosen, implying that Japanese parent firms typically absorb the risk of exchange rate fluctuations and rarely adjust export prices in the importer's currency in response to exchange rate fluctuations. Further, Yoshida et al. (2024) find that two-way exporters, i.e., exporters that also import, tend to use the same invoicing currency for both exports and imports. Although these

[3] There are other studies showing that the impact of exchange rate fluctuations has become complex due to the fact that many firms engage in both exporting and importing. For example, Blaum (2024) finds that large global firms engaged in both exporting and importing increase not only their exports but also their imports after large devaluations, suggesting that it is difficult to immediately substitute imported intermediate goods with domestic ones. Alfaro et al. (2023), investigating the impact of exchange rate changes on firm-level innovation and productivity growth, suggest that the impact differs across firms and regions, depending on their trade integration into the world economy, i.e., their import intensity and/or export intensity. Alfaro et al. (2023) do not find any significant average effects of exchange rate changes for firms in industrialized countries where many firms actively both import and export, suggesting that exchange rate changes have opposite effects on exports and imports and the two effects may offset each other.

[4] In fact, the vast majority of trade is invoiced in a small number of "dominant currencies," with the US dollar playing an outsized role (Gopinath 2015; Gopinath et al. 2020), which suggests that prices tend to be sticky in the dominant currency, rather than in the destination or producer currency.

studies do not explicitly examine the relationship between GVC participation and invoicing currency choices, these results suggest that participation in GVCs is closely related to firms' pricing strategies and invoicing currency choices.

Thus, previous studies suggest that exporters tend to respond differently to exchange rate fluctuations depending on whether they are involved in GVCs. However, empirical evidence from detailed firm-level analyses remains scarce and limited to a handful of countries such as France and Belgium. This study addresses this gap using a newly available dataset that integrates export-import declaration data collected by Japan Customs with firm-level information to examine how Japanese exporting firms pass through exchange rate fluctuations to export prices and further investigate how export volumes respond to changes in export prices caused by exchange rate fluctuations.

Focusing on Japanese firms is likely to produce instructive results. Not only does Japan have a floating exchange rate, leading to significant fluctuations in exchange rates driven by the demand-supply balance in foreign exchange markets; many Japanese firms also play a crucial role in GVCs, actively engaging in exports and imports, as will be discussed in detail below. Moreover, a considerable share of Japan's exports and imports is traded in currencies other than the Japanese yen, with the US dollar serving as the most important trade invoicing currency.[5]

Against this background, we examine the determinants and size of ERPT for Japanese exporters and investigate the elasticity of export volumes in response to changes in exchange rates. Our findings can be summarized as follows. First, we find that foreign currency invoicing and no price adjustments in response to exchange rate changes leads to a smaller pass-through of exchange rate fluctuations to export prices. Moreover, firms with a high ratio of imported intermediate goods tend to choose foreign currency invoicing and are less likely to adjust their initially-set export prices in response to exchange rate changes. Second, we find that the elasticity of export volumes in response to price changes is extremely small and that it takes more than one year for export volumes to start responding to price changes. While these results are more or less consistent with Amiti et al.'s (2022) findings for Belgian exporters, we additionally find that the elasticity of export volumes is much smaller for intermediate goods than for final goods. This result suggests that involvement in GVCs, which entails actively importing intermediate goods from abroad and exporting them for further processing in foreign

[5] For more details on Japanese firms' invoice currency choices, see Shimizu et al. (2023).

countries, has a significant impact on firms' pricing strategies and the responsiveness of export quantities to exchange rate changes.

This study contributes to the literature in the following ways. First, it is one of the first empirical studies to analyze ERPT and the price elasticity of exports using detailed transaction-level trade data for Japan, one of the world's leading exporters. While much of the prior research is based on product- and destination-specific data, this study is distinct in that we estimate ERPT and price elasticities controlling not only for firm-level characteristics but also for the choice of invoice currency in each transaction. Furthermore, our study shows that, once these factors are controlled for, the price elasticity of intermediate goods exports is significantly lower than that of final goods exports. This finding highlights that participation in GVCs reduces the responsiveness of export volumes to exchange rate fluctuations.

The rest of this study is organized as follows. The next section explains the data used in this study and provides an overview of the characteristics of Japanese exports and Japanese exporting firms. Section 3 then presents our empirical framework for examining the impact of exchange rate fluctuations on export prices and reports the estimation result for ERPT. Section 4 reports the results for the elasticity of export volumes in response to exchange rate fluctuations via export price changes. Section 5 concludes.

2. Data

2.1 Japan Customs import and export declaration data

In this study, we primarily utilize export-import declaration data collected by Japan Customs spanning the period from January 1, 2014, to December 31, 2020. The data contain detailed information for each export and import transaction such as (1) the trade value (in FOB prices for exports and in CIF prices for imports in yen) and the corresponding volume (number and/or weight such as tons or kilograms), (2) the Japanese exporter's or importer's name, address, telephone number and corporate ID number, (3) the destination or source country, (4) the trade partner's name and address,

(5) the invoice currency, (6) product information (Harmonized System (HS) 9-digit classification),[6] and (7) the declaration date, time, shipping port, ship, and other details.[7]

For this study, we exclusively use data for transactions exceeding 200,000 yen in value, which fall under the "general trade" classification in Japanese trade statistics.

2.2 Firm-level characteristics

To access firm-level financial information, we leverage the firm-level data from the Basic Survey of Japanese Business Structure and Activities (BSJBSA), which are collected annually by the Ministry of Economy, Trade and Industry (METI). This survey targets firms operating in the manufacturing, mining, and other services industries, employing 50 or more workers, and having a paid-in capital of 30 million yen or more. The BSJBSA dataset includes data on sales, employment, purchase amounts, tangible fixed assets, total wage payments, and so on.

We link the firm-level panel data constructed from the BSJBSA with the Japan Customs import and export declarations data, using the 13-digit identification number for corporations (corporate number).

2.3 Overview of the Customs-BSJBSA-matched data

Table 1 summarizes the export data we use for our analysis. Ito et al. (2025) identified 65,500 exporting firms in 2017 in the original export declaration data for "general trade." In this study, we restrict our analysis to "general trade" where an exporter's corporate number and the export volume in kilograms[8] are available in order to examine the change in export unit values, i.e., the ratio of export value to export volume. We further restrict our analysis to trade by firms included in the BSJBSA. Before linking the customs data with the BSJBSA data, we identify nearly 60,000 exporting firms annually on average for the period from 2014 to 2020 in the original export declaration data that fall under the general trade classification (the first row of Table 1). The total export value by these 60,000 exporters is approximately 54 trillion yen annually on average for the 2014–2020 period. The second row of Table 1 shows that the number

[6] In Japan, a 9-digit product code is used, which combines the internationally standard 6-digit HS code with a 3-digit domestic subdivision code. While there are approximately 5,000 products at the HS 6-digit level, there are approximately 6,500 products at the HS 9-digit level for exports and 9,000 for imports.
[7] For details of the Japan Customs data, see Ito et al. (2025).
[8] In the customs data, exports measured in tons or kilograms account for slightly more than 70 percent of the total value of exports.

of exporting firms is approximately 10,000 annually for the Customs-BSJBSA-matched dataset, which is much smaller than the corresponding figure in the first row of Table 1. However, looking at the annual average total export value, the BSJBSA-matched dataset covers over 80% (=44.5 trillion yen / 54.0 trillion yen) of the total export value in the original export declarations data. According to Japan's official trade statistics, the annual export value during the period was approximately 75 trillion yen, meaning that the exports in our analysis cover approximately 60 percent of the total export value.

Table 1 also shows the annual average number of exporting firms and export value by various types of exports. First, approximately one-third of the exports in the dataset are invoiced in Japanese yen (34.2%), while more than half are invoiced in US dollar (54.4%).[9] As for exports by type of goods, approximately 70% of the exports consist of intermediate goods (71.1%).[10] Moreover, while a slightly larger share of final goods are invoiced in yen than in US dollar, in the case of intermediate goods, the large majority of exports are invoiced in US dollar. Meanwhile, nearly 80% of the exports in the dataset consist of differentiated goods (78.7%).[11]

INSERT Table 1

Next, Table 2 shows the average characteristics of firms included in the BSJBSA. The BSJBSA includes more than 28,000 firms annually on average for the period from 2014 to 2020. Out of the 28,000+ firms, nearly 10,000 firms are exporters each year. While one-third (33.6%) of the BSJBSA firms are exporters, nearly 85% (=8,172/9,658) of the exporters are also importers. Table 2 further shows that importing exporters differ substantially from non-importing exporters in terms of trade intensity and firm size. For example, the average export intensity (exports to sales ratio) is much higher for importing exporters than for non-importing exporters. The average number of export destination countries and the average number of exported products are also much larger for importing exporters than for non-importing exporters. Various indicators of firm

[9] The corresponding figures for "general trade" exports including exports by firms not included in the BSJBSA are shown in Appendix Table B1. The distribution of exports by type of invoice currency and by type of goods in Appendix Table B1 is very similar to that in Table 1. We also show the corresponding figures for intra-firm exports in Appendix Table C1.

[10] Intermediate goods are identified using the concordance table between the HS 2012 version and the Broad Economic Categories (BEC) Revision 4 provided by the United Nations Statistics Division.

[11] Differentiated goods are identified using Rauch's (1999) conservative classification.

characteristics, such as employment and output, suggest that importing exporters tend to be larger than non-importing exporters.

Table 2 further indicates that the average export-to-sales ratio for Japanese exporters is 7.8%, and a significant part of their exports are invoiced in foreign currencies. (Specifically, the average ratio of exports in Japanese yen to sales is 4.4%, while the average ratio of exports in foreign currencies to sales is 3.4%.) Interestingly, imports are more likely to be invoiced in foreign currencies than exports. (Specifically, the average share of imports in Japanese yen in total costs is 2.7%, while the average share of imports in foreign currencies in total costs is 5.6%.)

Although the BSJBSA includes firms in various services industries, most Japanese exporters fall into the manufacturing sector or wholesale and retail sector. The corresponding figures for manufacturing firms and wholesale and retail firms are shown in Appendix Table B2.

INSERT Table 2

3. Exchange Rate Pass-Through (ERPT)

3.1 Determinants of ERPT

In this section, we estimate the impact of exchange rate changes on export prices, known as the exchange rate pass-through (ERPT). When exchange rates change, exporting firms may not fully pass on the entire change to prices in foreign markets due to various reasons. Amiti et al. (2022) argue that ERPT tends to be incomplete due to two types of pricing behavior of exporting firms, and that this pricing behavior is closely related to their invoice currency choices. The first type of pricing behavior is that exporting firms, once they have set their export prices, do not adjust these prices frequently, while the second type of behavior involves the adjustment of prices in response to changes in marginal costs and/or markups.

In the case of the first pricing behavior, where exporters prefer not to change prices in destination markets (referred to as the "sticky price" case), exporters choose destination-currency invoicing. In this case, since prices in destination markets remain unchanged, exchange rate fluctuations do not get passed on to prices. That is, if exporting firms choose foreign-currency invoicing and refrain from price adjustments, the pass-through of exchange rate changes to prices is zero.

On the other hand, the second pricing behavior occurs when exporting firms adjust export prices in response to changes in marginal costs and/or markups (referred to as the "flexible price" case). For instance, firms heavily reliant on imported intermediate goods are likely to face changes in production costs when the exchange rate changes. If exporting firms adjust export prices in response to changes in marginal costs, their ERPT will be incomplete. Additionally, if there is high strategic complementarity with competitors' prices in destination markets, exporting firms adjust their prices by increasing or decreasing their markups while observing the prices of competitor firms. If exporting firms set export prices based on competitors' prices, the pass-through of exchange rate fluctuations to prices will be incomplete.

Thus, the incomplete ERPT likely can be explained by these two types of pricing behavior, i.e., firms (1) choosing foreign-currency invoicing and refraining from price adjustments (the "sticky-price" case) and (2) adjusting prices in response to changes in marginal costs and/or markups (the "flexible-price" case). We aim to estimate how these two types of pricing behavior affect the magnitude of ERPT using detailed export data at the firm level.

As Amiti et al. (2022) explain, exporters prefer destination-currency invoicing when desired prices in the destination-currency are stable, i.e., the variance of desired prices in the destination currency is smaller than that in the home currency. If exporters opt for home country-currency pricing (which we will refer to as "producer-currency pricing" below) but attempt to stabilize prices in the destination currency, they cannot pass on exchange rate changes to destination-currency prices. In this case, exporters bear the exchange rate risk, so the optimal choice when aiming to stabilize prices in the destination currency is destination-currency invoicing. These considerations mean that if the desired price in US dollars, for example, is stable, exporters would choose US dollar invoicing.

On the other hand, firms may change the destination-currency desired prices in response to changes in marginal costs and changes in markups. If an exporter uses foreign intermediate goods, the firm's marginal costs are sensitive to the exchange rate. Therefore, we use the imported intermediate goods ratio as a proxy for the firm's marginal cost sensitivity to the exchange rate. Moreover, if the firm's optimal markup is sensitive to the prices of its competitors in the destination market, i.e., if there is high strategic complementarity among competing firms, the firm is likely to adjust the destination-currency desired price in response to its competitors' prices rather than to exchange rate fluctuations.

Amiti et al. (2022) express the expected observed price change in response to changes in the exchange rate between the producer currency and destination currency and the exchange rate between the US dollar (dominant currency) and destination currency as follows:

$$\mathbb{E}dp_i^* = de_k + \delta[-\iota_i de_k + \iota_i^D de_k^D] + (1-\delta)[-(\varphi_i + \gamma_i)de_k + (\varphi_i^D + \gamma_i^D)de_k^D] \tag{1}$$

where p_i^* is the realized destination currency price for exporting firm *i* and δ denotes the probability of no price adjustment, while *(1- δ)* denotes the probability of price adjustment. e_k is the log bilateral exchange rate between destination k's currency and the exporter country's currency, and an increase in e_k corresponds to a depreciation of the destination k's currency against the producer (i.e., exporter) country currency (the Japanese yen in our case). e_k^D is the log bilateral exchange rate between destination k's currency and the US dollar, and an increase in e_k^D corresponds to a depreciation of destination k's currency against the US dollar. ι_i and ι_i^D denote the choice of invoice currency. ι_i takes zero if firm *i* chooses the producer currency, while it takes one if the firm chooses any foreign currency. ι_i^D takes one if firm *i* chooses the US dollar as the invoice currency, and zero otherwise. φ_i and φ_i^D capture the exposure of firm *i*'s marginal costs to foreign currency and US dollar fluctuations, respectively. γ_i and γ_i^D capture the exposure of firm *i*'s desired markup to foreign currencies and the US dollar.

The first term (de_k) on the right-hand side of equation (1) represents the complete pass-through of changes in the exchange rate between destination k's currency and the Japanese yen of firms pricing in yen (i.e., using producer currency pricing) and not exposed to foreign currency changes either via their marginal costs or desired markups.

The terms in the first pair of square brackets capture the direct effect of price stickiness in the destination currency or US dollar. If exporting firm *i* chooses not to adjust the price in the destination currency, destination-currency invoicing is optimal (ι_i takes one) and changes in the exchange rate between the yen and the destination currency are not passed on to destination currency prices, i.e., the pass-through is zero. Meanwhile, if firm *i* uses US dollar invoicing and does not adjust dollar prices (ι_i^D takes one), changes in the exchange rate between the US dollar and the destination currency are passed on completely. This sticky price case occurs with probability δ. The larger the degree of price stickiness δ, the greater is the impact of sticky prices on the ERPT.

The terms in the second pair of square brackets in equation (1) capture the effect of a price adjustment on the ERPT (the flexible price case). If exporting firm *i* chooses to adjust its desired price in the destination currency, the desired ERPT reflects the exposure of the firm's marginal costs and desired markup to changes in the exchange rate to the destination currency (φ_i and γ_i) and the US dollar (φ_i^D and γ_i^D).

Following Amiti et al. (2022), we estimate the following equation derived from the theoretical relationship expressed in equation (1) and examine how firm-product-destination prices respond to changes in yen-destination currency and dollar-destination currency exchange rates:

$$\Delta p_{ikt}^{*} = [\alpha + \beta\varphi_{it} + \gamma logL_{it} + \delta\iota_{ikt}]\Delta e_{kt} + [\beta^D\varphi_{it} + \gamma^D logL_{it} + \delta^D\iota_{ikt}^D]\Delta e_{kt}^D + \nu_{skt} + \epsilon_{ikt} \quad (2)$$

where dependent variable Δp_{ikt}^{*} is the log change in the price of firm-product *i* exports to destination country *k* at time *t* in destination *k*'s currency. The export price is measured as the ratio of export value to export volume, i.e., the unit value. While the export value of each of firm *i*'s products (at the HS 9-digit level) in the original customs data is recorded in Japanese yen, we convert the value into destination *k*'s currency using the monthly nominal exchange rate (period average) taken from the International Financial Statistics provided by the International Monetary Fund (IMF). Export quantities are measured in kilograms. Δe_{kt} and Δe_{kt}^D are the log change in exchange rates and measure the depreciation of destination *k*'s currency against the Japanese yen and the US dollar, respectively. The exposure of firm *i*'s marginal costs to changes in the exchange rate to the destination currency and the US dollar is proxied by the firm's import intensity, i.e., the ratio of its total value of imports to its total variable costs (φ_{it}). The exposure of firm *i*'s desired markup to changes in the exchange rate to the destination currency and the US dollar is proxied by the firm's number of employees (*logLit*), since it is well known that the elasticity of markups is proportional to firm size. The currency choice dummy

ι_{ikt} takes one if the invoicing currency for exports of firm-product *i* to destination country k at time t is not the Japanese yen, and ι_{ikt}^D is a dominant currency invoicing dummy which takes one if the invoicing currency for exports of firm-product *i* to destination country k at time t is the US dollar. ν_{skt} denotes various types of fixed effects such as industry × destination × year and industry × destination fixed effects. ϵ_{ikt} is the error term. Products are defined at the HS 9-digit level, and industries are defined at the HS 4-digit level. Because the HS 6-digit codes were revised in 2017 under the International Convention on the HS, we drop observations for the changes from 2016 to 2017 from the estimation in order to avoid any possible biases arising from the changes in the international coding system. Although we could make a concordance table between the 9-digit level product codes based on the HS 2012 and those based on the HS 2017, there are many products for which linking the old and new codes at the 9-digit level is difficult and doing so would result in a coarser classification of items. We therefore did not link the old and new codes at the 9-digit level.[12]

3.2 Estimation results of ERPT over a one-year horizon

Using the firm-product-destination-year level data for 2014–2016 and 2017–2020, we estimate equation (2) and examine the firm-level determinants of the ERPT. The coefficient of Δe_{kt}, α, is predicted to be 1, corresponding to complete ERPT, which would be observed in the case of a small firm that uses no imported inputs and prices its exports in Japanese yen. As explained above, when firm *f* opts to leave destination k prices unchanged, it is likely to choose destination-currency invoicing, and changes in the exchange rate between the yen and the destination currency are less likely to affect export prices in destination k's currency. Therefore, in the case of foreign-currency invoicing, the ERPT will be incomplete and δ is expected to be negative. In the case where an exporter chooses US dollar invoicing and does not revise dollar prices, changes in the exchange rate between the US dollar and the destination currency will be completely passed through to destination-currency prices. Therefore, δ^D is expected to be positive. The estimated coefficients δ and δ^D capture the direct effect of price stickiness on the ERPT.

[12] We also tried the same estimations using the HS 6-digit level data. At the HS 6-digit level, the HS 2012 and HS 2017 classifications are linked, allowing for the calculation of differences between product-level data from 2017 and that from 2016. Using the HS 6-digit level data from 2014 to 2020, we obtained very similar results.

For an exporter that uses imported intermediate inputs, adjusting destination k prices to reflect changes in marginal costs as a result of exchange rate changes will result in incomplete ERPT, since changes in the value of the producer country currency will affect exports and imports in opposite directions. We therefore expect that exporters with a higher share of imported intermediate inputs— i.e., greater exposure of marginal costs to exchange rate fluctuations—will exhibit a lower degree of exchange rate pass-through. Moreover, exporters that exhibit strategic complementarities in price setting in foreign markets are more likely to absorb exchange rate changes by adjusting their markups, so that the ERPT is expected to be incomplete. Therefore, β and γ are predicted to be negative.

When an exporter uses imported inputs priced in US dollars, a depreciation of destination k's currency against the US dollar results in an increase in marginal costs expressed in currency k, and vice versa. If the exporter adjusts its destination k prices in response to changes in marginal costs, it will raise prices in currency k in response to a depreciation of destination k's currency against the US dollar, and vice versa. On the other hand, firms that exhibit strategic complementarities in setting US dollar prices are more likely to absorb changes in the exchange rate between the US dollar and the destination currency by adjusting their US dollar markups and are less likely to change their dollar prices. Instead, these firms are more likely to change their prices in destination k's currency in response to dollar-destination currency exchange rate changes. Therefore, β^D and γ^D are expected to be positive. Taken together, the estimated coefficients β, γ, β^D, and γ^D capture the effect of a price adjustment on the ERPT (the flexible price case).

Table 3 shows the OLS estimation results of equation (2).[13] Column (1) of Table 3 shows the baseline result, while columns (2) and (3) show the result including only variables capturing the effect of a price adjustment (the flexible price case) and that including only variables capturing the effect of price stickiness (the sticky price case). Columns (4) to (7) present the estimation results using observations for intermediate goods only, final goods only, differentiated goods only, and homogeneous goods only, respectively. In Table 3, the variable IMP_share_{it} represents the import intensity, φ_{it}, in equation (2). We should note that the import intensity is not measured in the invoice

[13] Summary statistics for the variables used in the estimations over a one-year horizon are shown in Appendix Table B3, while the correlation matrix of the variables is presented in Appendix Table B4.

currency but using the annual value of imports in Japanese yen taken from the customs data divided by annual purchases in Japanese yen taken from the METI firm-level data (BSJBSA) for each firm. Non_JPY_{ikt} and USD_{ikt} in Table 3 represent the invoice currency dummy variables ι_{ikt} and ι_{ikt}^{D} in equation (2), respectively. The results in Table 3 show that the coefficient on Δe_{kt}, α, nearly equals 1, as expected. Additionally, the estimates of the coefficients capturing the effect of price stickiness on the ERPT, δ and δ^{D}, are strongly significant and have the expected signs. While the choice of invoice currency has a large impact on the pass-through, the coefficients capturing the effect of price adjustments (imported inputs and strategic complementarities) are not significant in many cases.

Turning to the variables capturing the flexible price case, the estimate for the coefficient measuring the extent to which imported intermediate inputs contribute to the ERPT, β, is negative, as expected. The estimated coefficient is statistically significant in many cases, although only weakly so at the 10% level in columns (1), (5), and (6). In columns (2) and (7), where observations are restricted to exports of homogeneous goods, the estimated coefficient of the strategic complementary variable (γ) has the expected sign and is statistically significant. Although β^{D}, the coefficient for the variable capturing exporters' marginal costs in terms of US dollars, was expected to be positive, we find that it is insignificant in all specifications. Overall, the exposure of exporters' marginal costs to exchange rate fluctuations (i.e., share of imported inputs) and exporters' desired markups do not strongly affect the ERPT in most cases. The results in Table 3 suggest that Japanese exporters tend to choose foreign currency invoicing without price adjustment and that this price setting behavior more strongly affects the ERPT.[14]

However, we find strongly significant coefficients for the variables capturing the flexible price case when the currency choice dummies are omitted, as shown in column (2). In fact, the share of imported inputs and firm size also affect exporters' invoice currency choice, as we discuss in Appendix A. The results in Appendix A suggest that exporters with a higher import intensity are more likely to choose foreign currency (non-yen) invoicing. In particular, firms with a higher share of imports in US dollars are more likely to invoice their exports in US dollars. We also find that larger firms as measured

[14] We also estimated various alternative specifications as robustness checks. The results, presented in Appendix B, confirm the baseline results presented here.

by employment are more likely to choose non-yen invoicing.[15] These results indicate that exporters tend to use foreign currency invoicing if their marginal costs and markups are more susceptible to exchange rate fluctuations.[16] Since these results also suggest potential endogeneity in the determinants of the ERPT, we conduct an additional estimation using proxies for the currency choice instead of using actual invoicing currency dummies. The results of this analysis, presented in Appendix Table B6, provide support for a direct causal effect of currency invoicing on the ERPT. Therefore, we use actual invoicing currency dummies in the following analysis.

Turning to the result in column (2) in Table 3, the statistically more significant and larger (in absolute value) coefficients in column (2) suggest that it is important to include the currency choice dummies in order to mitigate omitted variable bias. On the other hand, column (3) shows the result obtained when omitting the variables capturing the flexible price case. The coefficients on the currency choice dummies are slightly larger in absolute value than those in column (1), which is consistent with omitted variable bias, although the bias appears to be modest.

According to these results, while firms with a higher share of imported inputs and larger firms that likely have a larger market power in foreign markets tend to choose foreign currency invoicing, these firms tend to refrain from price adjustments in response to exchange rate fluctuations. Such foreign-currency price stickiness substantially lowers the ERPT for Japanese exports.

As shown in Table 1, the majority of Japanese exports are invoiced in foreign currencies, primarily the US dollar. According to the summary statistics for the variables we use in this study, shown in Appendix Table B3, a foreign currency is chosen as the invoicing currency in approximately 44% of the firm-product-destination-year observations used for the ERPT estimations (see the mean of Non_JPY_{ikt}). Therefore, the estimation result suggests that nearly half (44%) of Japan's export transactions exhibit very low ERPT due to price stickiness in foreign currency invoicing.

INSERT Table 3

[15] In Appendix Table A1, the estimated coefficient for the firm employment size variable (*logLit*) is positive and statistically significant.

[16] Amiti et al. (2022) explain that firms' desired pass-through and invoice currency choices are closely linked. More detailed analyses of the invoice currency choices of Japanese firms are provided by Shimizu et al. (2023), Yoshimi et al. (2023), and Yoshida et al. (2024), which use the same export-import declaration data for Japan as this paper.

3.3 Dynamics of ERPT

We also estimate the dynamics of ERPT using monthly data for the period from January 2014 to December 2020. We estimate the following equation, which is a monthly version of equation (2):

$$\Delta_h p^*_{ikt} = [\alpha_h + \beta_h \varphi_i + \gamma_h logL_{it} + \delta_h \iota_{ik}]\Delta_h e_{kt} + [\beta^D_h \varphi_i + \gamma^D_h logL_{it} + \delta^D_h \iota^D_{ik}]\Delta_h e^D_{kt} + \nu_{skt} + \epsilon_{ikt} \quad (3)$$

where Δ_h is the h-month difference, for example, $\Delta_h p^*_{ikt} \equiv p^*_{ikt} - p^*_{ik,t-h}$, while all other variables are the same as in equation (2). As in the case of the estimations for a one-year horizon, products are defined at the HS 9-digit level, and observations for this difference that span across 2016 and 2017 are not used in the estimation in order to avoid any possible biases arising from the changes in the international coding system in 2017 under the International Convention on the HS.

Table 4 shows the estimation results for equation (3), which we estimated for different time horizons ranging from 1 to 24 months. However, in Table 4, we only report the results for the 6-month, 12-month, 18-month, and 24-month differences. We find that the coefficient on the variable capturing US dollar markups, γ^D_h, tend to be statistically significant and have the expected sign. However, the coefficient on the variable capturing US dollar marginal costs tend to be negative, contrary to our expectation. For other variables capturing the flexible price case, the estimated coefficients are not statistically significant in many cases. On the other hand, the coefficients on the foreign invoicing dummies are strongly significant with the expected signs, suggesting that price stickiness has a large impact on pass-through.

As in Table 3, the results in Table 4 show that the coefficient of Δe_{kt}, α, nearly equals 1, pointing to an almost complete pass-through for small firms that use no imported inputs and price all of their exports in Japanese yen. However, for firms that use foreign currency invoicing, the ERPT is incomplete. For these firms, the sum of the estimated coefficients for Δe_{kt} and $\Delta e_{kt} \times Non\_JPY_{ikt}$ (α_h+δ_h in equation (3) above) is smaller than 1, indicating incomplete pass-through. Although one would expect the coefficients on variables capturing price stickiness, δ_h and δ^D_h in equation (3), to decline in absolute value towards zero with h and the coefficients on variables capturing the flexible price case, β_h, β_h^D, γ_h, and γ_h^D in equation (3), to increase in absolute value with h, since prices should become more flexible over longer horizons, the magnitude of the estimated coefficients appears to be quite stable over time. The pass-through for foreign currency invoicing firms is 0.238 (=1.016-0.778) after 6 months (column (1) in Table 4) and still only 0.327 (=0.973-0.646) after 24 months (column (4) in Table 4), suggesting that foreign currency invoicing strongly reduces the ERPT and that prices do not become more flexible over time.

Amiti et al. (2022) obtain similar results in the case of Belgian exports to non-euro destinations, but according to their estimates, the pass-through for non-euro invoicing firms is around 0.6 after 6 months and gradually increases over time to 0.65 after 24 months. Comparing our results in Table 4 to Amiti et al.'s (2022) estimates suggests that foreign currency invoicing with no price adjustment significantly reduces the ERPT in the case of Japanese exporters. Moreover, in the case of Japan, the effect of price adjustments on exchange rate pass-through is relatively small and lacks strong statistical significance in comparison with Belgium. While it is beyond the scope of this paper to examine in detail the reasons why Japanese exporters tend to make limited price adjustments, several closely related reasons suggest themselves. First, the exchange rate of the yen vis-à-vis other major currencies was relatively stable during the period studied in this paper. Specifically, while the yen depreciated substantially against the US dollar from the beginning of 2013 until the end of 2015 (falling by about 15%) under the economic policies introduced by Prime Minister Abe known as "Abenomics," from 2016 until 2020, the US dollar-yen exchange rate remained relatively stable, fluctuating by less than 5% annually. Thus, Japanese exporters may not have needed to adjust prices in response to currency fluctuations due to relatively stable exchange rates.

Second, previous studies have highlighted that Japanese multinational firms exhibit a high share of intra-firm trade (Ruhl 2015; Ramondo et al. 2016; Matsuura et al. 2023). Moreover, research indicates that Japanese firms tend to employ foreign currency invoicing in intra-firm trade (e.g., Yoshimi et al. 2023), suggesting that the prevalence of intra-firm trade may influence the pricing behavior and magnitude of pass-through of Japanese firms. While Lakatos and Ohnsorge (2017), using industry-destination-year level data for US exports, show that intra-firm trade is less affected by exchange rate fluctuations than arm's-length trade, further investigation and rigorous empirical analysis is needed to determine whether ERPT varies depending on the type of trade, such as intra-firm or arm's-length.

Third, as shown in Table 1, approximately 70% of Japanese exports are intermediate goods exports. The nature of transactions, the terms and conditions of transactions, and the degree of relationship specificity between trading partners differ substantially between intermediate goods trade and final goods trade, which may lead to differences in pricing strategies and ERPT. Furthermore, factors such as product quality and substitutability with other products likely also influence exporters' pricing strategies and the magnitude of ERPT.[17]

INSERT Table 4

4. Response of Export Volumes

Next, we estimate the price elasticity of export volumes, i.e., the extent to which changes in export prices due to exchange rate fluctuations lead to changes in export volumes. Following Amiti et al. (2022), our estimation consists of two stages. In the first stage, we estimate the pass-through of exchange rate changes to prices. Then, in the second stage, using the estimated changes in export prices obtained in the first stage, we estimate the relationship between changes in export values and changes in export prices.

To start with, using annual data, we estimate the following specification:

$$\Delta q_{ikt}^{*} = \theta \Delta p_{ikt}^{*} + f_i + \nu_{skt} + u_{ikt} \qquad (4)$$

where q^{*}_{ikt} denotes the volume of exports (in kilogram) in logarithm and θ is the elasticity of demand over one year. Both the first stage and second stage estimations include a full set of firm (f_i) and industry (HS 4-digit) × destination × year (ν_{skt}) fixed effects. p^{*}_{ikt} is the export unit price for firm-product i in destination currency k in year t in logarithm and is obtained by estimating equation (2) in the first stage. As these fixed effects absorb all macroeconomic variations, including exchange rate movements, the stand-alone yen-destination currency exchange rate variable (Δe_{kt}) is dropped from the first-stage estimation. Thus, the estimates of θ capture the differential change in export volumes in

[17] For example, Fontaine et al. (2023) suggest that the patterns and magnitudes of price adjustments in response to economic shocks are heterogeneous, depending on the availability of alternative suppliers and the degree of buyers' bargaining power.

response to differential changes in prices across firm-products with different characteristics.

Using the export unit prices estimated in the first stage, we estimate equation (4) in the second stage. Table 5 shows the second stage estimation results obtained using annual data. Although the sign of the elasticity is always negative, as expected (i.e., export volumes fall if prices rise), the estimated coefficients are insignificant in all the cases. Therefore, we find that, over a one-year horizon, export quantities are very inelastic. Moreover, although the magnitude of the estimated elasticities for final goods and homogeneous goods exports (columns (3) and (5) in Table 5) are larger than those for other goods, they are not statistically significant.

INSERT Table 5

Taking into account the possibility that it may take more than one year for volumes to respond to price changes, we next estimate the following specification for various horizons h using monthly data:

$$\Delta_h q_{ikt}^* = \theta_h \Delta_h p_{ikt}^* + f_i + \nu_{skt} + u_{ikt} \qquad (5)$$

where Δ_h is the h-month difference and θ_h is the elasticity of demand over horizon h. Similar to the estimation of equation (4), both the first stage and the second stage estimations include a full set of firm and industry × destination × time fixed effects.

Table 6 shows the second stage estimation results using monthly data. Although the estimated elasticity is statistically significant at the 10% level over a 12-month horizon, its absolute value is very small. For the 18-month and the 24-month horizons, the elasticity increases in absolute value and becomes statistically significant. However, even for the 24-month horizon, the elasticity is only around 0.2. This implies that even with a 10% decrease in export prices due to exchange rate changes, export volumes only increase by 2%, and vice versa. The finding that it takes over a year for changes in export prices to begin affecting export volumes aligns with the result in Amiti et al. (2022). However, while the absolute value of the elasticity for the 24-month horizon in Amiti et al. (2022) is close to 1, for Japan, we only obtain a value of around 0.2, which is extremely small.[18]

In addition, the estimated elasticities in Table 6 are much smaller than those estimated by Sasaki and Yoshida (2018) using HS 2-digit industry-destination level export data for Japan for the period from 1988 and 2014. A possible reason for the difference is that we use much more detailed annual export data at the firm, HS 9-digit product, destination level. It should also be noted that within the framework employed in this paper we cannot take extensive margin effects into account. While price changes via exchange rate changes can potentially encourage firms to export new products to new destinations or cause existing firms to stop exporting existing products to current destinations (the extensive margin), our analysis focuses only on cases where firms continue to export the same products to the same destinations (the intensive margin). In contrast, Sasaki and Yoshida (2018) estimate elasticities at the HS 2-digit industry level, which includes such extensive margin effects. This means that, by their very nature, the elasticities estimated in our analysis are bound to be much smaller, since they do not account for extensive margin effects. Additionally, Sasaki and Yoshida (2018) use long-term data spanning a period of 26 years from 1988 to 2014, during which the yen's exchange rate fluctuated significantly, whereas our analysis covers the considerable shorter period with relatively stable exchanges rates from 2014 to 2020.

INSERT Table 6

In addition, we estimate equation (5) for the subsets of intermediate goods and final goods, with the results presented in Table 7. The magnitude of the estimated elasticity is much larger for final goods than for intermediate goods. As can be seen in Figure 1, which plots the estimated elasticity θ_h for intermediate goods and for final goods, the elasticity gradually increases in absolute value and becomes statistically significant around the 10-month horizon in the case of final goods. However, in the case of

[18] Without a more detailed analysis, we do not know why our elasticity estimates for Japan are substantially lower than Amiti et al.'s (2022) estimates for Belgium. However, one possible explanation is that Amiti et al.'s analysis for Belgium does not include exports to the eurozone, which account for about 70% of Belgium's total exports, so that their analysis is somewhat limited. In contrast, our analysis for Japan includes exports to all destinations. If Belgian firms' exports to the eurozone have substantially different product characteristic than those outside the eurozone, and Belgian firms use considerably different pricing strategies for these exports, Amiti et al.'s (2022) results may be biased, as they are based solely on exports outside the eurozone.

intermediate goods, the elasticity remains very small in absolute terms even over long horizons, although the point estimates become significantly different from zero around the 18-month horizon.

INSERT Table 7

INSERT Figure 1

The finding that the price elasticity of export volumes is much smaller for intermediate goods than for final goods suggests that participation in GVCs weakens the relationship between exchange rates and export volumes. Final goods are more likely to be sold to end consumers such as households in the destination country, while intermediate goods are often further processed in the destination country and exported to third countries, serving as complementary goods to other intermediate goods. Therefore, it is natural that the demand for intermediate goods does not respond immediately to price changes in the destination country. Particularly for intermediate goods where alternative suppliers are not readily available, the elasticity is likely to be even lower.[19]

Our estimation results in Table 7 suggest that participation in GVCs, by increasing firms' share of intermediate goods exports in their total exports, may weaken the response of export volumes to exchange rate changes. On the other hand, the expansion of GVCs means that production processes have become more fragmented and span across more countries, resulting in greater chain lengths in relation to both endpoints of production chains, i.e., in a greater distance from final demand or from the economy's primary factors of production. In this context, Mancini et al. (2024) show that both the distance of a production sector from final demand (i.e., its upstreamness) and the distance of a given sector from the economy's primary factors of production (i.e., its downstreamness) increased from the mid-1990s to around the early 2010s. To examine this issue, Figure 2 shows GVC upstreamness and downstreamness measures over time for Japan and the OECD countries excluding Japan. Both the upstreamness and downstreamness measures have increased substantially since the mid-1990s, with Japan

[19] It is necessary to further analyze differences in export elasticity not only based on product characteristics but also taking into account factors such as the relationship with trading partners, the substitutability with other products, and the duration and other terms of trade contracts, which may differ between intermediate and final goods.

displaying particularly pronounced increases in both upstreamness and downstreamness compared to other OECD countries.

INSERT Figure 2

To examine whether this expansion in GVCs also influences the magnitude of the exchange rate elasticity of exports, we add two alternative interaction terms to equation (5). The first is an interaction term of the change in the export unit price of a product and an indicator of the upstreamness of the industry the product belongs to, while the second uses an indicator of the downstreamness of the industry instead. The GVC upstreamness and downstreamness measures are calculated at the ISIC (revision 4) 2-digit industry level for Japan, using data taken from Mancini et al. (2024).[20] Similar to the estimation of equations (4) and (5), we estimate the export unit price change of a particular product in the first stage. Then, using the predicted value of the export unit price change, we construct the interaction terms of the price change and the GVC upstreamness or downstreamness measure for that product. The estimation results, presented in Table 8, indicate that the elasticity is smaller (i.e., exports are less responsive to price changes) for products in more upstream or downstream industries. In other words, the results suggest that greater production chain length tends to reduce the responsiveness of exports to exchange rate movements and export volumes.

INSERT Table 8

6. Conclusion

This paper, utilizing detailed trade data at the firm level for Japan, estimates the exchange rate pass-through (ERPT) and the elasticity of export volumes in response to exchange rate movements. Consistent with Amiti et al.'s (2022) results for Belgium, we find that foreign currency invoicing without price adjustment leads to a smaller ERPT.

[20] We use the TiVA industry-level upstreamness and downstreamness measures for Japan provided by Mancini et al. (2024) to construct the GVC upstreamness and downstreamness variables for the estimation. We take the simple average of the upstreamness or downstreamness measure for the period from 2010 to 2013 and use these time-invariant upstreamness/downstreamness measures for the analysis.

On the other hand, adjustments in marginal costs and/or markups only play a small role in reducing Japanese exporters' ERPT. Importantly, firms with a high ratio of imported intermediate goods tend to choose foreign currency invoicing and adjust their export prices only infrequently.

This pricing behavior of Japanese exporters may at least partly explain why Japan's exports did not substantially increase during the phase of yen depreciation from 2012 to 2015. In addition, we find that it takes over a year for changes in export prices due to exchange rate changes to begin affecting export quantities, and that the absolute value of the price elasticity of export volumes is very small even over a 24-month horizon, particularly for intermediate goods. The smaller elasticity of intermediate goods exports is consistent with previous empirical studies arguing that participation in GVCs weakens the link between exchange rates and export volumes.

The results of this paper suggest that, fundamentally, exchange rate movements are not strongly transmitted to export prices due to price stickiness and foreign currency invoicing. Moreover, even when export prices do change, we found that it took over a year for changes in export prices to begin affecting export volumes. In particular, the elasticity of exports in response to price changes due to exchange rate changes is much smaller for intermediate goods than for final goods. The elasticity is also smaller for more upstream or more downstream products, i.e., products produced in industries where stages of production are increasingly interconnected, extended, and span across borders. The results support the recent argument based on the country-sector-level studies mentioned in Section 1 that GVCs reduce the responsiveness of exports to exchange rate fluctuations.

However, it should be noted that during the period this study focuses on, the yen-dollar exchange rate was relatively stable and tended toward yen depreciation. Firms' pricing behavior may differ during periods of domestic currency appreciation or when exchange rate fluctuations are large and uncertainty is high. To fully understand these dynamics, it would be necessary to conduct a similar analysis for periods characterized by substantial exchange rate fluctuations or periods of yen appreciation, in order to examine whether different patterns emerge.

Moreover, previous studies suggest that pricing behavior and the magnitude of pass-through differ between intra-firm trade and arm's-length trade, resulting in different responses of exporters to exchange rate changes. For instance, Bernard et al. (2006) suggest that in the case of intra-firm trade, firms likely set prices considering which entity

-- either the parent firm or the subsidiary – bears the exchange rate risk, taking transfer pricing considerations into account. Japanese multinational firms are heavily involved in GVCs and engage intensively in intra-firm trade, and trade in intermediate goods and intra-firm trade have been increasing in parallel with expansion of GVCs. Further analysis is warranted on which kind of goods are traded through what types of transactions in GVCs, and how trade values and volumes respond to exchange rate fluctuations.

Last but not least, it should be noted that this study focuses on the intensive margin of trade, examining ERPT and export elasticity for firms that continuously export the same product to the same destination country. While exchange rate depreciation or appreciation is likely to promote entry or exit from export markets (see, e.g., Frohm 2023), this study does not explore such extensive margin effects of exchange rate changes. However, because the intensive margin, which reflects changes in trade for continuing exporters and importers, on average accounted for 84% of the year-on-year changes in Japan's exports during the period from 2014 to 2020 (Ito et al. 2025), focusing on the intensive margin is broadly sufficient for explaining developments in macro-level trade. Nevertheless, the extensive margin plays a critical role in learning-by-exporting effects – i.e., improvements in firms' productivity and the acquisition of new technological knowledge after they start exporting. Therefore, an interesting and important avenue for future research would be to examine the effect of exchange rate changes on the extensive margin in trade.

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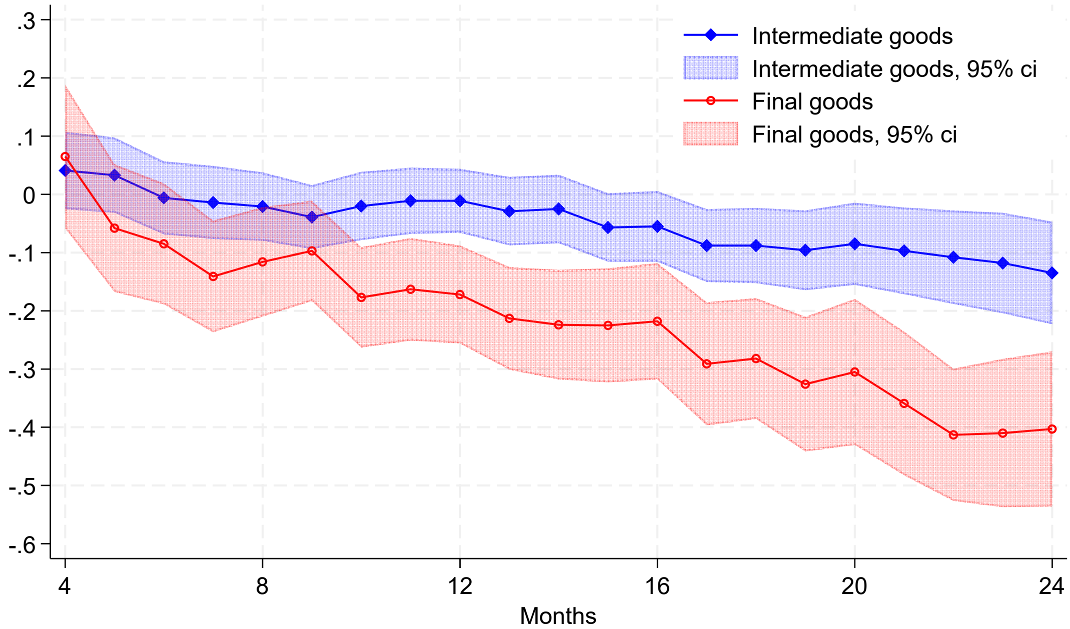
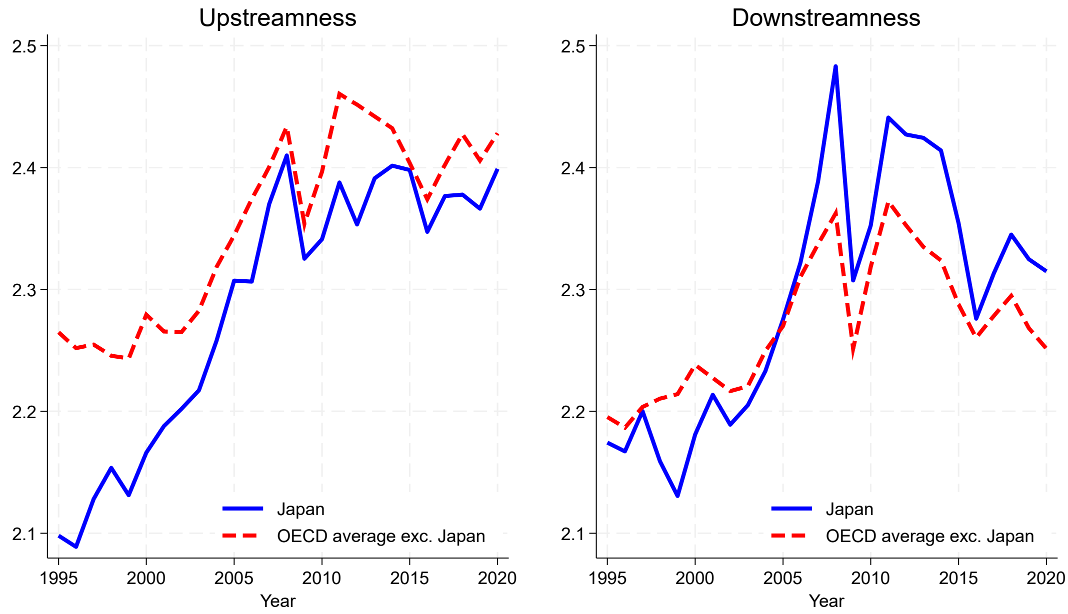
Figure 1. Exchange rate elasticity of exports: Intermediate goods vs. final goods



Notes: The figure plots the estimates of elasticity θ_h over varying time horizons h in the second stage estimation of equation (5) for intermediate goods and for final goods. The shaded areas represent 95% confidence intervals.

Figure 2. GVC upstreamness and downstreamness for Japan and OECD countries



Note: Country-level GVC upstreamness and downstreamness is calculated by the authors as the weighted average of the country-industry-level GVC upstreamness or downstreamness taken from Mancini et al. (2024), using each country-industry's share of gross exports as weights.

Source: Authors' calculations based on the GVC position data provided by Mancini et al. (2024) and the OECD TiVA database 2023 edition.

Table 1. Japanese firms' exports by invoice currency and type of goods

	No. of firms	Exports (bil. yen)	Share
To the World (General trade total)	59,161	53,959	
To the World (BSJBSA firms only)	9,658	44,478	(100.0%)
By invoice currency			
Japanese yen	8,760	15,220	(34.2%)
US dollar	5,810	24,193	(54.4%)
Euro	2,105	2,769	(6.2%)
Other currencies	1,893	2,296	(5.2%)
By type of goods			
Intermediate goods	**8,475**	**31,616**	**(71.1%)**
Japanese yen	7,615	9,422	(21.2%)
US dollar	5,043	18,892	(42.5%)
Euro	1,724	1,727	(3.9%)
Other currencies	1,558	1,575	(3.5%)
Final goods	**7,501**	**12,367**	**(27.8%)**
Japanese yen	6,559	5,665	(12.7%)
US dollar	3,936	4,949	(11.1%)
Euro	1,286	1,037	(2.3%)
Other currencies	1,208	716	(1.6%)
Differentiated goods	**9,267**	**34,983**	**(78.7%)**
Japanese yen	8,390	13,333	(30.0%)
US dollar	5,456	16,993	(38.2%)
Euro	1,967	2,513	(5.7%)
Other currencies	1,794	2,144	(4.8%)
Homogeneous goods	**4,898**	**9,496**	**(21.3%)**
Japanese yen	4,077	1,887	(4.2%)
US dollar	2,538	7,200	(16.2%)
Euro	618	256	(0.6%)
Other currencies	633	152	(0.3%)

Notes: The figures for "General trade total" are for general trade where an exporter's corporate number and export volumes in kilograms are available. The column labeled "Share" shows the share of the value of each type of exports in the total export value shown in the second row of the table. The sum of exports of intermediate goods and final goods is less than the total export value, with the difference reflecting exports of primary goods. The figures are the simple averages of annual values over the period from 2014 to 2020.

Table 2. Characteristics of exporters: Mean values for BSJBSA firms for the period 2014–2020

	All firms	Exporters	Importing exporters	Non-importing exporters	Non-exporters
Total number of observations (2014-2020)	201,469	67,605	57,203	10,402	134,040
Average number of observations (annual)	28,781	9,658	8,172	1,486	19,149
(share, %)	(100.0%)	(33.6%)	(28.4%)	(5.2%)	(66.5%)
Exports to sales ratio (%)					
All exports	2.6	7.8	8.8	2.3	0
Exports in JPY	1.5	4.4	4.9	1.7	0
Exports in Non-JPY	1.1	3.4	3.9	0.6	0
Exports in USD	0.9	2.8	3.2	0.5	0
Exports in EUR	0.1	0.3	0.4	0.1	0
Share of imports in total cost (%)					
All imports	3.1	8.2	9.7	0	0.5
Imports in JPY	1.0	2.7	3.1	0	0.1
Impors in Non-JPY	2.1	5.6	6.6	0	0.3
Imports in USD	1.7	4.5	5.3	0	0.3
Imports in EUR	0.2	0.6	0.7	0	0.0
Firm characteristics					
Number of employess	512.8	691.3	740.0	423.2	422.8
Output (real, in log)	8.6	9.2	9.3	8.6	8.4
Intermediate input costs (real, in log)	8.3	8.9	9.0	8.3	8.0
Value added (real, in log)	7.1	7.5	7.6	7.1	6.9
Labor productivity (real, in log)	1.8	2.0	2.1	1.9	1.7
Number of export destination countries	2.8	8.3	9.3	2.5	0
Number of HS-6 products exported	9.2	27.5	31.7	4.9	0
Number of import source countries	2.1	5.6	6.6	0	0.3
Number of HS-6 products imported	7.4	20.7	24.5	0	0.7

Notes: The figures are the simple averages of firm-year-level variables for the years from 2014 to 2020. Although the BSJBSA includes firm-level annual exports and imports, we use the export and import data taken from the customs data. While export and import data are on a calendar year basis, other firm-level data such as sales, costs, and employment taken from the BSJBSA are on a fiscal year basis.

Table 3. Exchange rate pass-through: Annual data 2014–2016, 2017–2020

	(1) Baseline Δp^*_{ikt}	(2) Only flexible Δp^*_{ikt}	(3) Only sticky Δp^*_{ikt}	(4) Intermediate Δp^*_{ikt}	(5) Final Δp^*_{ikt}	(6) Differentiated Δp^*_{ikt}	(7) Homogeneous Δp^*_{ikt}
Δe_{kt}	0.958***	0.908***	0.978***	0.940***	1.025***	0.937***	1.206***
	(0.047)	(0.068)	(0.036)	(0.054)	(0.056)	(0.057)	(0.083)
Δe_{kt}×IMP_share$_{it}$	-0.080*	-0.170***		-0.082	-0.075*	-0.074*	-0.085
	(0.043)	(0.055)		(0.070)	(0.043)	(0.045)	(0.067)
Δe^D_{kt}×IMP_share$_{it}$	0.012	0.052		0.035	-0.002	0.019	-0.082
	(0.037)	(0.039)		(0.052)	(0.039)	(0.036)	(0.103)
Δe_{kt}×logL$_{it}$	0.001	-0.027***		-0.001	0.006	0.003	-0.023*
	(0.006)	(0.007)		(0.007)	(0.009)	(0.006)	(0.013)
Δe^D_{kt}×logL$_{it}$	0.002	0.023**		0.008	-0.014	0.001	0.005
	(0.006)	(0.009)		(0.008)	(0.010)	(0.007)	(0.016)
Δe_{kt}×Non_JPY$_{ikt}$	-0.612***		-0.614***	-0.616***	-0.594***	-0.606***	-0.644***
	(0.046)		(0.044)	(0.049)	(0.045)	(0.045)	(0.057)
Δe^D_{kt}×USD$_{ikt}$	0.515***		0.521***	0.510***	0.534***	0.524***	0.447***
	(0.053)		(0.053)	(0.055)	(0.055)	(0.053)	(0.055)
Fixed effects:							
Firm	No	No	No	No	No	No	No
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry (HS4)×destination	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry (HS4)×destination×year	No	No	No	No	No	No	No
Number of observations	1,912,253	1,912,253	1,927,878	1,366,913	503,986	1,579,822	332,165
R-squared	0.022	0.021	0.022	0.023	0.023	0.021	0.041

Notes: Columns (2) and (3) show the result including only variables capturing the effect of price adjustments (the flexible price case) and that including only variables capturing the effect of price stickiness (the sticky price case). Columns (4) to (7) present the estimation results using observations for intermediate goods only, final goods only, differentiated goods only, and homogeneous goods only, respectively.

Standard errors clustered at the destination-year level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 4. Exchange rate pass-through: Monthly data 2014–2016, 2017–2020

	(1)	(2)	(3)	(4)
	$\Delta_h p^*_{ikt}$	$\Delta_h p^*_{ikt}$	$\Delta_h p^*_{ikt}$	$\Delta_h p^*_{ikt}$
	h=6	h=12	h=18	h=24
Δe_{kt}	1.016***	1.048***	1.024***	0.973***
	(0.022)	(0.021)	(0.026)	(0.021)
Δe_{kt}×IMP_share$_{it}$	-0.038	-0.020	-0.025	-0.094*
	(0.033)	(0.026)	(0.029)	(0.048)
Δe^D_{kt}×IMP_share$_{it}$	-0.015	-0.094***	-0.075**	0.063
	(0.045)	(0.032)	(0.036)	(0.053)
Δe_{kt}×logL$_{it}$	-0.006**	-0.003	-0.004	0.002
	(0.003)	(0.002)	(0.003)	(0.004)
Δe^D_{kt}×logL$_{it}$	0.009***	0.005*	0.010***	0.010**
	(0.003)	(0.003)	(0.004)	(0.004)
Δe_{kt}×Non_JPY$_{ikt}$	-0.778***	-0.731***	-0.687***	-0.646***
	(0.015)	(0.014)	(0.017)	(0.016)
Δe^D_{kt}×USD$_{ikt}$	0.716***	0.595***	0.491***	0.444***
	(0.014)	(0.014)	(0.015)	(0.017)
Firm FE	Yes	Yes	Yes	Yes
Industry (HS4)*destination FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
No. of observations	8,679,799	7,607,276	6,526,295	5,697,039
Adj. R-squared	0.008	0.016	0.021	0.024

Note: Standard errors clustered at the destination-year level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 5. Response of export volumes: Annual data 2014–2016, 2017–2020

	(1)	(2)	(3)	(4)	(5)
	All	Intermediate	Final	Differentiated	Homogeneous
	Δq^*_{ikt}	Δq^*_{ikt}	Δq^*_{ikt}	Δq^*_{ikt}	Δq^*_{ikt}
Δp^*_{ikt}	-0.060	-0.033	-0.107	-0.044	-0.118
	(0.075)	(0.082)	(0.107)	(0.087)	(0.118)
Kleibergen-Paap rk LM	41.907***	42.765***	39.566***	41.491***	28.358***
No. of observations	1872942	1338482	488797	1551085	319380
R-squared	0.035	0.020	0.057	0.027	0.037

Notes: Standard errors clustered at the destination-month level in parentheses. *** denotes significance at the 1% level. All equations include firm fixed effects and industry (HS 4-digit) × destination × year fixed effects.

Table 6. Response of export volumes: Monthly data 2014–2016, 2017–2020

	(1)	(2)	(3)	(4)
	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$
	h=6	h=12	h=18	h=24
$\Delta_h p^*_{ikt}$	-0.026	-0.044*	-0.130***	-0.197***
	(0.030)	(0.026)	(0.032)	(0.044)
Kleibergen-Paap rk LM	395.0***	441.6***	411.3***	417.9***
No. of observations	8,292,059	7,255,264	6,215,866	5,419,061
R-squared	0.015	0.025	0.068	0.101

Notes: Standard errors clustered at the destination-month level in parentheses. * and *** denote significance at the 10% and 1% levels, respectively. All equations include firm fixed effects and industry (HS 4-digit) × destination × time fixed effects.

Table 7. Response of export volumes: Monthly data 2014–2016, 2017–2020

Intermediate goods vs. Final goods

(a) Intermediate goods

	(1)	(2)	(3)	(4)
	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$
	h=6	h=12	h=18	h=24
$\Delta_h p^*_{ikt}$	-0.006	-0.011	-0.088***	-0.135***
	(0.032)	(0.028)	(0.033)	(0.045)
Kleibergen-Paap rk LM	376.9***	408.6***	379.7***	386.9***
No. of observations	6,460,301	5,647,769	4,850,103	4,225,204
R-squared	0.003	0.007	0.048	0.073

(b) Final goods

	(1)	(2)	(3)	(4)
	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$
	h=6	h=12	h=18	h=24
$\Delta_h p^*_{ikt}$	-0.085	-0.172***	-0.282***	-0.403***
	(0.053)	(0.043)	(0.058)	(0.068)
Kleibergen-Paap rk LM	318.5***	348.5***	332.6***	334.4***
No. of observations	1,704,469	1,493,781	1,267,434	1,106,984
R-squared	0.044	0.085	0.131	0.176

Notes: Standard errors clustered at the destination-month level in parentheses. *** denotes significance at the 1% level. All equations include firm fixed effects and industry (HS 4-digit) × destination ×time fixed effects.

Table 8. GVCs and response of export volumes

(a) GVC upstreamness

	(1) $\Delta_h q^*_{ikt}$ h=6	(2) $\Delta_h q^*_{ikt}$ h=12	(3) $\Delta_h q^*_{ikt}$ h=18	(4) $\Delta_h q^*_{ikt}$ h=24
$\Delta_h p^*_{ikt}$	-0.104	-0.186**	-0.368***	-0.822***
	(0.093)	(0.080)	(0.089)	(0.085)
$\Delta_h p^*_{ikt} \times GVC\_upstreamness$	0.032	0.058**	0.099***	0.264***
	(0.032)	(0.028)	(0.029)	(0.027)
No. of observations	8,292,059	7,255,264	6,215,866	5,419,061
R-squared	0.089	0.087	0.096	0.097

(b) GVC downstreamness

	(1) $\Delta_h q^*_{ikt}$ h=6	(2) $\Delta_h q^*_{ikt}$ h=12	(3) $\Delta_h q^*_{ikt}$ h=18	(4) $\Delta_h q^*_{ikt}$ h=24
$\Delta_h p^*_{ikt}$	-0.554**	-0.608***	-0.939***	-1.358***
	(0.217)	(0.179)	(0.183)	(0.192)
$\Delta_h p^*_{ikt} \times GVC\_downstreamness$	0.203**	0.216***	0.311***	0.445***
	(0.083)	(0.068)	(0.069)	(0.072)
No. of observations	8,292,059	7,255,264	6,215,866	5,419,061
R-squared	0.089	0.087	0.096	0.097

Notes: Standard errors clustered at the destination-month level in parentheses. ** and *** denote significance at the 5% and 1% levels, respectively. All equations include firm fixed effects and industry (HS 4-digit) × destination × year time fixed effects.

Appendix A: Invoice Currency Choice

As argued by Amiti et al. (2022), exporters' price setting and choice of invoice currency are likely to be closely related. This appendix therefore examines the determinants of Japanese exporters' choice of invoice currency and presents the estimation results.

Following Amiti et al. (2022), we estimate a linear probability regression:

$$\mathbb{P}\{\iota_{ikt} = 1\} = a_{t,sk} + b\varphi_{it} + c_S S_{ikt} + c_L logL_{it} + d\bar{\iota}_{-ikt} \quad \text{(A)}$$

The dependent variable takes 0 if the export transaction is invoiced in Japanese yen and 1 otherwise. As in the ERPT estimation in Section 3, φ_{it} is firm i's import intensity. S_{ikt} is firm i's industry-destination sales share in Japanese exporters' sales in that industry to that destination. $logL_{it}$ is firm i's employment in logarithm. $\bar{\iota}_{-ikt}$ is the export-weighted average foreign currency use of firm i's Japanese competitors in a given destination-industry (HS 4-digit), which is used to capture strategic complementarities in currency choice. However, competitors' choice of invoice currency is possibly affected by firm i's currency choice, which may cause simultaneity and reflection problems. In order to address such problems, we also conduct instrumental variable (IV) estimations.

The estimation results are shown in Appendix Table A1. In the table, IMP_share_{it} represents the import intensity, φ_{it}, in equation (A) above. MKT_share_{ikt} represents the market share, S_{ikt}, in equation (A). Column (2) splits the import intensity into yen and non-yen components, $IMP\_YEN\_share_{it}$ and $IMP\_NYEN\_share_{it}$. These variables are as defined in Section 3. $NonYEN\_comp_{ikt}$ represents competitors' currency choice, $\bar{\iota}_{-ik}$, in equation (A). $High\_MS_{ikt}$ is a dummy representing whether MKT_share_{ikt} is above 0.1.

Columns (6) and (7) in Appendix Table A1 show the IV estimation results. We prepare two types of instruments for import intensity and market share. The first type of instruments proxies for the marginal costs and markups of a firm's Japanese competitors. Specifically, we calculate the export-weighted average import intensity (IMP_share_{it}) and log employment of all other Japanese firms within the same (HS 4-digit) industry destination as firm i and use these as instruments. These instruments should correlate with the choice of invoicing currency of the firm's competitors but should not *directly* affect the firm's choice of invoicing currency. The second type of instrument captures the trade patterns of non-Japanese competitors. We use annual bilateral trade data at the HS 4-digit industry level for 2014 to 2020 from the Harvard Atlas International Trade Data. Employing data excluding Japan, we construct the share of exports from the United States, China, and other countries using a dollar peg to destination country k at the HS 4-digit industry level. For example, for a Japanese firm exporting to country k, an increase in the share of country k's imports from the U.S., China, and other countries using a dollar peg is expected to increase the likelihood that the Japanese firm's competitors will use dollar invoicing. The variation in this instrument stems from countries' monetary policy decisions to peg their exchange rates, which should be exogenous to the variation in currency choice across Japanese exports within industries. Following Amiti et al.

(2022), we classify countries as having adopted a dollar peg if the annualized root mean squared error of changes in the exchange rate of their currency against the dollar is below 5%. 66 countries/economies are identified as having adopted a dollar peg.

Appendix Table A1. Determinants of foreign currency invoicing

	(1) NonYEN	(2) NonYEN	(3) NonYEN	(4) NonYEN	(5) NonYEN	(6) NonYEN	(7) NonYEN
IMP_share_{it}	0.112***		0.166***	0.173***	0.168**	0.275***	0.275***
	(0.039)		(0.044)	(0.045)	(0.076)	(0.001)	(0.001)
MKT_share_{ikt}	0.329***	0.329***	0.234***	0.223***	0.205***	0.226***	0.147***
	(0.037)	(0.037)	(0.025)	(0.019)	(0.023)	(0.001)	(0.001)
$IMP\_YEN\_share_{it}$		-0.309*					
		(0.177)					
$IMP\_NYEN\_share_{it}$		0.256*					
		(0.133)					
$\log L_{it}$			0.057***	0.056***	0.058***	0.057***	0.056***
			(0.006)	(0.007)	(0.008)	(0.000)	(0.000)
$NonYEN\_comp_{ikt}$				0.108***	0.066***	0.130***	0.034***
				(0.012)	(0.014)	(0.003)	(0.003)
$NonYEN\_comp_{ikt} \times High\_MS_{ikt}$							0.101***
							(0.001)
Fixed effects:							
Year×month	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry (HS4)	No	No	No	Yes	Yes	Yes	Yes
Destination	No	No	No	Yes	Yes	Yes	Yes
Industry (HS4)×destination	Yes	Yes	Yes	No	No	No	No
Number of observations	15,457,532	15,457,532	13,411,539	13,421,411	8,600,402	13,177,637	13,177,637

Notes: Observations are at the firm-product (HS 9 digit)-destination-month level for the period from January 2014 to December 2020. Columns (1) to (5) employ OLS estimation, while columns (6) and (7) use IV estimation. Column (5) is estimated for exporting firms in the manufacturing sector only. Standard errors clustered at the firm level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Appendix Table A1 shows that firms with a higher import intensity and a larger market share are more likely to invoice their exports in foreign currencies.

We further examine exporters' currency choice between the dominant currency (US dollar) and other foreign currencies, focusing on the subsample of firms that chose foreign currencies in their export pricing. The dependent variable in this estimation is a currency choice dummy which takes 1 for exports invoiced in US dollars and 0 for those in other currencies. The estimation results are shown in Appendix Table A2.

Appendix Table A2. Determinants of US dollar invoicing

	(1) USD	(2) USD	(3) USD	(4) USD
IMP_share_{it}	0.095**			
	(0.041)			
$IMP\_YEN\_share_{it}$		0.189***	0.172***	0.039
		(0.066)	(0.060)	(0.097)
$IMP\_NYEN\_share_{it}$		0.075**		
		(0.032)		
$IMP\_USD\_share_{it}$			0.142*	0.466***
			(0.080)	(0.072)
$IMP\_OTH\_share_{it}$			-1.104***	-1.115***
			(0.225)	(0.230)
$logL_{it}$	-0.023***	-0.023***	-0.027***	-0.027***
	(0.006)	(0.006)	(0.006)	(0.006)
USD_comp_{ikt}				-0.029
				(0.022)
MKT_share_{ikt}	-0.016	-0.016	-0.016	-0.014
	(0.014)	(0.014)	(0.014)	(0.014)
Fixed effects:				
Year×month	Yes	Yes	Yes	Yes
Industry (HS4)	No	No	No	Yes
Destination	No	No	No	Yes
Industry (HS4)×destination	Yes	Yes	Yes	No
N	2,366,884	2,366,884	2,366,884	2,342,489
R-sq	0.634	0.634	0.641	0.04

Notes: Observations are at the firm-product (HS 9 digit)-destination-month level for the subsample of exports that are invoiced in a currency other than yen to destinations that do not use a US dollar peg and cover the period from January 2014 to December 2020.

In other words, exports to the United States and countries using a US dollar peg are excluded from the estimations. Columns (1) to (3) employ OLS estimation, while column (4) uses IV estimation. In column (2), firms' import intensity is split into its yen and non-yen components, while in columns (3) and (4) firms' non-yen import intensity is further split into its dollar and non-dollar components. Standard errors clustered at the firm level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Appendix B: Additional Tables

Appendix Table B1. Exports of Japanese firms by invoice currency and type of goods ("General trade" exports including exports by firms not included in the BSJBSA)

	No. of firms	Exports (bil. yen)	Share
To the World (General trade total)	59,161	53,959	(100.0%)
By invoice currency			
Japanese yen	50,076	20,139	(37.3%)
US dollar	22,805	28,238	(52.3%)
Euro	5,321	3,064	(5.7%)
Other currencies	4,245	2,517	(4.7%)
By type of goods			
Intermediate goods	**42,325**	**37,342**	**(69.2%)**
Japanese yen	35,926	11,834	(21.9%)
US dollar	16,266	21,915	(40.6%)
Euro	3,647	1,883	(3.5%)
Other currencies	2,889	1,710	(3.2%)
Final goods	**40,653**	**15,570**	**(28.8%)**
Japanese yen	33,724	7,812	(14.5%)
US dollar	13,864	5,782	(10.7%)
Euro	3,287	1,175	(10.7%)
Other currencies	2,761	801	(10.7%)
Differentiated goods	**55,301**	**42,319**	**(78.4%)**
Japanese yen	46,768	17,214	(31.9%)
US dollar	20,778	19,988	(37.0%)
Euro	4,992	2,777	(5.1%)
Other currencies	4,009	2,339	(4.3%)
Homogeneous goods	**18,819**	**11,640**	**(21.6%)**
Japanese yen	15,510	2,925	(5.4%)
US dollar	6,970	8,250	(15.3%)
Euro	1,025	287	(0.5%)
Other currencies	1,016	178	(0.3%)

Notes: The figures for "General trade total" are for general trade where an exporter's corporate number and export volumes in kilograms are available. The column labeled "Share" shows the share of the value of each type of exports in the total export value shown in the second row of the table. The sum of exports of intermediate goods and final goods is less than the total export value, with the difference reflecting exports of primary goods. The figures are the simple averages of annual values over the period from 2014 to 2020.

Appendix Table B2. Characteristics of exporters by sector

(a) Manufacturing sector

	All firms	Exporters	Importing exporters	Non-importing exporters	Non-exporters
Total number of observations	88,433	42,663	36,469	6,194	45,770
Average number of observations (annual)	12,633	6,095	5,210	885	6,539
(share, %)	(100.0%)	(48.2%)	(41.2%)	(7.0%)	(51.8%)
Exports to sales ratio					
All exports	4.7	9.8	10.9	3.0	0
Exports in JPY	2.7	5.6	6.1	2.1	0
Exports in Non-JPY	2.0	4.2	4.8	0.9	0
Exports in USD	1.7	3.4	3.9	0.7	0
Exports in EUR	0.2	0.5	0.5	0.1	0
Share of imports in total cost					
All imports	3.7	7.0	8.2	0	0.7
Imports in JPY	1.3	2.5	2.9	0	0.2
Impors in Non-JPY	2.4	4.5	5.3	0	0.5
Imports in USD	1.9	3.6	4.2	0	0.4
Imports in EUR	0.2	0.4	0.4	0	0.0
Firm characteristics					
Number of employess	415.0	627.8	696.1	225.5	216.6
Output (real, in log)	8.5	8.9	9.1	8.2	8.1
Intermediate input costs (real, in log)	8.2	8.6	8.8	7.9	7.7
Value added (real, in log)	7.1	7.5	7.6	6.9	6.7
Labor productivity (real, in log)	1.9	2.0	2.0	1.9	1.7
Number of export destination countries	4.2	8.7	9.7	2.6	0
Number of HS-6 products exported	12.5	26.0	29.7	4.1	0
Number of import source countries	2.5	4.8	5.6	0	0.3
Number of HS-6 products imported	7.8	15.6	18.2	0	0.6

(b) Wholesale and retail trade sector

	All firms	Exporters	Importing exporters	Non-importing exporters	Non-exporters
Total number of observations	38,594	16,819	14,714	2,105	21,775
Average number of observations (annual)	5,513	2,403	2,102	301	3,111
(share, %)	(100.0%)	(43.6%)	(38.1%)	(5.5%)	(56.4%)
Exports to sales ratio					
All exports	2.5	5.7	6.2	2.0	0
Exports in JPY	1.4	3.2	3.4	1.6	0
Exports in Non-JPY	1.1	2.5	2.8	0.4	0
Exports in USD	0.9	2.1	2.4	0.4	0
Exports in EUR	0.1	0.2	0.2	0.0	0
Share of imports in total cost					
All imports	6.3	13.2	15.1	0	1.0
Imports in JPY	1.7	3.6	4.2	0	0.2
Impors in Non-JPY	4.6	9.5	10.9	0	0.8
Imports in USD	3.7	7.7	8.8	0	0.6
Imports in EUR	0.6	1.2	1.4	0	0.1
Firm characteristics					
Number of employess	272.4	341.5	356.0	240.3	219.1
Output (real, in log)	9.3	9.6	9.7	9.1	9.0
Intermediate input costs (real, in log)	9.2	9.5	9.5	9.0	8.9
Value added (real, in log)	7.0	7.3	7.4	6.9	6.7
Labor productivity (real, in log)	1.9	2.1	2.2	2.0	1.8
Number of export destination countries	3.9	9.1	10.0	2.7	0
Number of HS-6 products exported	16.5	37.9	42.3	7.5	0
Number of import source countries	3.7	7.9	9.0	0	0.5
Number of HS-6 products imported	15.6	34.0	38.8	0	1.4

Appendix Table B3. Basic Statistics

Variable	Obs.	Mean	Std. dev.	Minimun	Maximum
Δp^{*}_{ikt}	1,917,508	0.0396	0.7257	-8.7314	9.7495
Δe_{kt}	1,917,508	0.0322	0.1020	-1.1931	8.4654
Δe^{D}_{kt}	1,917,508	0.0274	0.0818	-1.0591	8.4338
IMP_share_{it}	1,917,508	0.0994	0.2121	0.0000	4.1291
$IMP\_YEN\_share_{it}$	1,917,508	0.0271	0.0850	0.0000	1.9524
$IMP\_NYEN\_share_{it}$	1,917,508	0.0723	0.1866	0.0000	3.1570
$logL_{it}$	1,917,508	7.0386	1.7064	3.9120	10.9614
Non_JPY_{ikt}	1,917,508	0.4432	0.4968	0.0000	1.0000
USD_{ikt}	1,917,508	0.3334	0.4714	0.0000	1.0000
$\Delta e_{kt} \times IMP\_share_{it}$	1,917,508	0.0027	0.0187	-0.6486	0.9046
$\Delta e^{D}_{kt} \times IMP\_share_{it}$	1,917,508	0.0026	0.0169	-0.3568	1.1188
$\Delta e_{kt} \times logL_{it}$	1,917,508	0.2348	0.8257	-11.1458	78.8822
$\Delta e^{D}_{kt} \times logL_{it}$	1,917,508	0.2005	0.7024	-9.8945	78.5875
$\Delta e_{kt} \times Non\_JPY_{ikt}$	1,917,508	0.0148	0.0794	-1.1931	8.4654
$\Delta e^{D}_{kt} \times USD_{ikt}$	1,917,508	0.0089	0.0630	-1.0591	8.4338
$\Delta e_{kt} \times IMP\_YEN\_share_{it}$	1,917,508	0.0007	0.0065	-0.2842	0.4392
$\Delta e_{kt} \times IMP\_NYEN\_share_{it}$	1,917,508	0.0020	0.0162	-0.4973	0.6378
$\Delta e^{D}_{kt} \times IMP\_YEN\_share_{it}$	1,917,508	0.0006	0.0045	-0.1897	0.4623
$\Delta e^{D}_{kt} \times IMP\_NYEN\_share_{it}$	1,917,508	0.0020	0.0155	-0.2690	0.8604

Notes: The “minimum” in the table represents the average of the 10 firms with the smallest figures, while the “maximum” represents the average of the 10 firms with the largest figures. This approach is employed to protect the confidentiality of individual firm data.

Appendix Table B4. Correlation matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1) Δp^{*}_{ikt}	1																		
(2) Δe_{kt}	0.109	1																	
(3) Δe^{D}_{kt}	0.085	0.659	1																
(4) IMP_share$_{it}$	-0.001	-0.023	-0.007	1															
(5) IMP_YEN_share$_{it}$	-0.001	-0.016	-0.014	0.482	1														
(6) IMP_NYEN_share$_{it}$	-0.001	-0.019	-0.001	0.917	0.092	1													
(7) logL$_{it}$	0.003	0.046	0.057	-0.093	-0.048	-0.084	1												
(8) Non_JPY$_{ikt}$	-0.017	0.010	0.011	0.046	-0.028	0.065	0.189	1											
(9) USD$_{ikt}$	-0.012	-0.008	-0.006	0.059	-0.010	0.072	0.096	0.793	1										
(10) $\Delta e_{kt}\times$IMP_share$_{it}$	0.045	0.457	0.249	-0.035	0.049	-0.062	-0.003	0.011	0.003	1									
(11) $\Delta e^{D}_{kt}\times$IMP_share$_{it}$	0.028	0.216	0.363	0.405	0.050	0.437	-0.007	0.019	0.014	0.336	1								
(12) $\Delta e_{kt}\times$logL$_{it}$	0.106	0.965	0.696	-0.025	-0.017	-0.020	0.113	0.025	0.001	0.402	0.207	1							
(13) $\Delta e^{D}_{kt}\times$logL$_{it}$	0.084	0.655	0.969	-0.012	-0.014	-0.007	0.121	0.025	0.003	0.225	0.319	0.736	1						
(14) $\Delta e_{kt}\times$Non_JPY$_{ikt}$	0.067	0.746	0.600	-0.010	-0.015	-0.004	0.073	0.209	0.145	0.331	0.189	0.777	0.630	1					
(15) $\Delta e^{D}_{kt}\times$USD$_{ikt}$	0.072	0.551	0.739	0.007	-0.009	0.012	0.049	0.158	0.200	0.191	0.249	0.619	0.771	0.739	1				
(16) $\Delta e_{kt}\times$IMP_YEN_share$_{it}$	0.034	0.329	0.163	0.057	0.123	0.008	-0.001	-0.009	-0.010	0.535	0.193	0.287	0.144	0.195	0.111	1			
(17) $\Delta e_{kt}\times$IMP_NYEN_share$_{it}$	0.039	0.396	0.223	-0.063	0.007	-0.075	-0.003	0.017	0.008	0.942	0.311	0.350	0.202	0.304	0.177	0.220	1		
(18) $\Delta e^{D}_{kt}\times$IMP_YEN_share$_{it}$	0.025	0.185	0.316	0.081	0.157	0.021	0.006	-0.010	-0.011	0.250	0.431	0.173	0.276	0.142	0.188	0.441	0.113	1	
(19) $\Delta e^{D}_{kt}\times$IMP_NYEN_share$_{it}$	0.023	0.181	0.303	0.417	0.008	0.470	-0.009	0.024	0.018	0.293	0.965	0.175	0.268	0.165	0.217	0.081	0.306	0.178	1

Appendix Table B5. Exchange rate pass-through: Robustness checks, annual data 2014–2016, 2017–2020

	(1) Firm FE Δp^{*}_{ikt}	(2) Detailed FE Δp^{*}_{ikt}	(3) Yen imports Δp^{*}_{ikt}	(4) US & pegs Δp^{*}_{ikt}	(5) Nonpegs Δp^{*}_{ikt}	(6) Nonpegs Δp^{*}_{ikt}
Δe_{kt}	0.955***		0.954***	1.219***	0.928***	0.951***
	(0.048)		(0.048)	(0.051)	(0.056)	(0.043)
Δe_{kt}×IMP_share$_{it}$	-0.054	-0.076*		-0.060	-0.202**	-0.204**
	(0.049)	(0.046)		(0.046)	(0.094)	(0.087)
Δe_{kt}×IMP_YEN_share$_{it}$			-0.266*			
			(0.152)			
Δe_{kt}×IMP_NYEN_share$_{it}$			-0.055			
			(0.039)			
Δe^{D}_{kt}×IMP_share$_{it}$	-0.035	-0.000			0.044	
	(0.049)	(0.039)			(0.041)	
Δe^{D}_{kt}×IMP_YEN_share$_{it}$			0.329*			
			(0.175)			
Δe^{D}_{kt}×IMP_NYEN_share$_{it}$			-0.015			
			(0.036)			
Δe_{kt}×logL$_{it}$	-0.001	-0.002	0.001	-0.008	0.013*	0.015***
	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.005)
Δe^{D}_{kt}×logL$_{it}$	0.003	-0.006	0.003		-0.008	
	(0.006)	(0.008)	(0.006)		(0.007)	
Δe_{kt}×Non_JPY$_{ikt}$	-0.605***	-0.595***	-0.613***	-0.596***	-0.599***	-0.261***
	(0.042)	(0.048)	(0.045)	(0.050)	(0.051)	(0.094)
Δe^{D}_{kt}×USD$_{ikt}$	0.524***	0.453***	0.516***		0.533***	
	(0.050)	(0.060)	(0.053)		(0.049)	
Fixed effects:						
Firm	Yes	No	No	No	No	No
Year	Yes	No	Yes	Yes	Yes	Yes
Industry (HS4)×destination	Yes	No	Yes	Yes	Yes	Yes
Industry (HS4)×destination×year	No	Yes	No	No	No	No
Number of observations	1,911,486	1,873,742	1,912,253	1,238,384	673,869	673,869
R-squared	0.027	0.046	0.022	0.012	0.04	0.039

Notes: Column (1) shows the estimation result including firm-level fixed effects, while column (2) shows the result including a full set of industry (HS 4-digit) × destination × year fixed effects. For column (3), we include variables separately constructed for the share of yen-denominated imports and the share of foreign currency-denominated imports. In column (4), "US & pegs" refers to exports to the United States and countries with a US dollar peg, and we estimate the model using a subsample consisting of exports to these destinations. In columns (5) and (6), "Non-peg" refers to exports to countries with no US dollar peg, and we estimate the model using a subsample consisting of exports to the non-pegged destinations.

Standard errors clustered at the destination-year level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Appendix Table B6. Exchange rate pass-through: Predicted versus actual currency choice

	Predicted currency		Competitor currency	
	(1)	(2)	(3)	(4)
	Δp^*_{ikt}	Δp^*_{ikt}	Δp^*_{ikt}	Δp^*_{ikt}
Δe_{kt}	0.553***	1.096***	0.979***	0.968***
	(0.075)	(0.089)	(0.081)	(0.054)
$\Delta e_{kt} \times IMP\_share_{it}$	-0.065	-0.080*	-0.191***	-0.108**
	(0.047)	(0.048)	(0.063)	(0.046)
$\Delta e^D_{kt} \times IMP\_share_{it}$	-0.029	-0.009	0.049	0.006
	(0.038)	(0.040)	(0.042)	(0.039)
$\Delta e_{kt} \times Non\_JPY_{ikt}$		-0.649***		-0.612***
		(0.067)		(0.048)
$\Delta e^D_{kt} \times USD_{ikt}$		0.415***		0.496***
		(0.052)		(0.059)
$\Delta e_{kt} \times Z_{ikt}$	-0.307***	-0.196***	-0.267***	-0.011
	(0.041)	(0.037)	(0.039)	(0.027)
$\Delta e^D_{kt} \times Z^D_{ikt}$	0.456***	0.095	0.308***	0.046
	(0.048)	(0.067)	(0.037)	(0.028)
$\Delta e_{kt} \times logL_{it}$	0.015**	0.008	-0.027***	0.000
	(0.006)	(0.007)	(0.006)	(0.006)
$\Delta e^D_{kt} \times logL_{it}$	0.005	0.006	0.017*	0.002
	(0.009)	(0.009)	(0.009)	(0.006)
Fixed effects:				
Year	Yes	Yes	Yes	Yes
Industry (HS4)×destination	Yes	Yes	Yes	Yes
Number of observations	729,849	729,849	1,516,155	1,516,155
R-squared	0.035	0.035	0.025	0.026

Notes: The sample consists of firm-product (HS 9-digit)-destination-year level observations for the period from 2014 to 2020. The Z_{ikt} in columns 1 and 2 is the predicted currency choice estimated from column (3) in Appendix Tables A1 and A2. The Z_{ikt} in columns (3) and (4) is the competitor currency choice in non-JPY and in US dollars. Standard errors clustered at the destination-year level in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

The results in columns (2) and (4) in Appendix Table B6 show that the coefficients on the actual currency choice variables, $\Delta e_{kt} \times Non\_JPY_{ikt}$ and $\Delta e_{kt} \times USD_{ikt}$, are not significantly different from those reported in the baseline specification (column (1)) in

Table 3. This evidence suggests that it is the actual realized currency choice that directly matters for ERPT.

Appendix Table B7. Response of export volumes: Monthly data 2014–2016, 2017–2020

Differentiated goods vs. Homogeneous goods

(a) Differentiated goods

	(1)	(2)	(3)	(4)
	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$
	h=6	h=12	h=18	h=24
$\Delta_h p^*_{ikt}$	-0.006	-0.035	-0.116***	-0.232***
	(0.035)	(0.030)	(0.038)	(0.049)
Kleibergen-Paap rk LM	414.6***	459.3***	420.4***	423.3***
No. of observations	6,828,389	5,975,193	5,123,180	4,467,163
R-squared	0.003	0.021	0.066	0.124

(b) Homogeneous goods

	(1)	(2)	(3)	(4)
	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$	$\Delta_h q^*_{ikt}$
	h=6	h=12	h=18	h=24
$\Delta_h p^*_{ikt}$	-0.148***	-0.106**	-0.245***	0.001
	(0.044)	(0.043)	(0.055)	(0.075)
Kleibergen-Paap rk LM	209.9***	216.4***	194.4***	193.0***
No. of observations	1,453,825	1,271,213	1,084,999	945,238
R-squared	0.045	0.034	0.073	0.000

Notes: Standard errors clustered at the destination-month level in parentheses. ** and *** denote significance at the 5% and 1% levels, respectively. All equations include firm fixed effects and industry (HS 4-digit)-destination-year fixed effects.