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Invoice Currency Choice in Intra-Firm Trade: A Transaction-Level Analysis of Japanese Automobile Exports

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ABSTRACT

This study empirically investigates how the invoice currency choice differs between intra-firm and arm's-length exports. We also examine whether other firm- and product-level characteristics affect the choice of invoice currency. This study is the first to be granted access to highly disaggregated transaction-level trade data for Japan. Focusing on Japanese automobile exports to France, we demonstrate that the importer's currency tends to be chosen in intra-firm export invoicing based on a panel logit estimation. Our empirical findings remain robust when different types of intra-firm export variables and other conventional explanatory variables are introduced, such as firm and product market share, exchange rate volatility, euro-invoiced imports, labor productivity, and research and development intensity. Given growing intra-firm trade and expanding global value chains, Japanese parent firms tend to invoice in the importers' currency, assuming the foreign exchange risk that arises from intra-firm trade. Thus, exchange rate risk management is a significant consideration for Japanese parent firms.

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1. Introduction

The choice of invoice currency has attracted considerable attention in the field of international economics. As demonstrated by Obstfeld and Rogoff (2000), when considering the impact of macroeconomic policy across countries, the invoice currency choice (i.e., whether exporters choose the producer's currency pricing (PCP), local currency pricing (LCP), or third-currency pricing) determines the extent of international shock transmission. As a result, optimal monetary and exchange rate policies significantly depend on firms' chosen invoice currency for exports and imports (e.g., Devereux and Engel, 2003).

Numerous research studies have assessed the determinants of invoice currency choice. Many recent studies have empirically analyzed how the invoice currency choice is affected by micro- and macroeconomic factors using highly disaggregated transaction-level customs data to determine invoice currency in each export/import transaction. For instance, using unpublished microdata on Canadian imports, Goldberg and Tille (2016) revealed a correlation between the size of individual transactions and invoice currency and the impact of conventional macroeconomic factors, such as exchange rate volatility and exchange rate regime. Devereux et al. (2017) also used Canadian data to investigate the effect of exporters' and importers' market share on the chosen invoice currency.[1] This study is the first to employ Japan Customs' transaction-level data, previously undisclosed to researchers. In early 2022, the Japanese Ministry of Finance (MOF) began allowing the use of large-scale customs transaction-level data for empirical research, including detailed information on Japanese export and import transactions, on the condition of maintaining the anonymity of the firms that made customs declarations in exports and/or imports. Our research group was approved for this study and granted the use of the transaction-level data of exports and imports for the 2014–2020 period.

The novelty of this study is its rigorous investigation of whether invoice currency choice differs between intra-firm and arm's-length trade. We use a panel dataset constructed using Japanese transaction-level customs data. Although global value chains (GVCs) have become an important consideration in the empirics of international economics (e.g., Timmer et al., 2014), few studies have investigated invoice currency choice along GVCs. For instance, motivated by recent research on GVCs, Chung (2016) and Amiti et al. (2022) considered the effect of imported intermediate inputs on exporting firms' invoice currency choice.[2] These studies demonstrated that when more intermediate inputs are imported from abroad and invoiced in foreign currencies, exporting firms are more likely to use foreign currencies in their exports of production goods. Such trade transactions along production chains are usually expected to be conducted via intra-firm trade between group companies; however, these studies did not clearly distinguish intra-firm trade from arm's-length trade when analyzing the effect of invoice currency choice. Another example is Ito et al. (2018), who conducted a questionnaire survey of Japanese export firms, revealing that invoice currency choice significantly differed between intra-firm and arm's-length exports. While the authors presented notable findings on Japanese firms' invoice currency choice, only 227 firms' valid responses to the questionnaire survey were included, and the

[1] Many other examples can be cited, including Gopinath, Itskhoki, and Rigobon et al. (2010) for the US; Casas et al. (2017) and Gopinath et al. (2020) for Colombia; Hayakawa et al. (2019b) for Thailand; Chen et al. (2022) and Corsetti et al. (2022) for the UK; Montfaucon et al. (2021) for Malawi; Amiti et al. (2022) for Belgium; and Saygılı (2023) for Turkey.

[2] We also identify several studies in the literature on exchange rate pass-through (ERPT) that considered GVCs, which are closely related to invoice currency choice. Gopinath and Rigobon (2008) empirically examined possible differences in price stickiness and ERPT between intra-firm and arm's-length trade using monthly trade price data obtained from the U.S Bureau of Labor Statistics (BLS), revealing that ERPT between intra-firm and arm's-length import transactions differs significantly. Neiman (2010) also used transaction-level BLS data to study the difference in ERPT between intra-firm and arm's-length trade. Rondeau and Yoshida (2023) investigated the effect of value-added contributions of exporters and importers on the degree of ERPT to Japanese imports, demonstrating that the degree of ERPT increases for industries with higher contributions from exporting countries' value-added and/or lower contributions from importing countries' value-added.

empirical results are based on pooled cross-section data representing a limited number of observations.[3]

We examine Japanese automobile exports to France to investigate how invoice currency choice differs between intra-firm and arm's-length trade. The automobile sector is one of Japan's largest export sectors. Japanese automobile firms have established many overseas subsidiaries to export products actively. Intra-firm trade plays a significant role in such transactions. We choose France as the destination country because the proportion of arm's-length exports accounts for approximately 20%–30% of the trade flow, enabling us to conduct a rigorous empirical examination of possible differences in invoice currency choice between intra-firm and arm's-length exports.[4]

Identifying intra-firm trade is the key issue in this research. Invoice currency choice in intra-firm trade has not been rigorously examined because it is difficult to determine whether import firms are overseas subsidiaries or independent firms without capital ties without having detailed information on exporters and importers, such as names and addresses, even when we use transaction-level customs data. In this case, we matched Japan Customs' data with external sources of overseas subsidiaries and capital relationships. Focusing on Japanese automobile exports to France, we can precisely identify capital ties between Japanese exporters and importers in France. In the empirical analysis, we use alternative definitions of intra-firm exports considering the degree of capital ties. We present the details of this approach in Section 2.

Our research finds that the euro is more likely to be chosen for intra-firm exports than arm's-length exports, indicating that Japanese automobile firms tend to stabilize the euro-based export price in intra-firm exports to France, assuming all exchange rate risks arising from euro-invoiced transactions. This result indicates that it is efficient to centralize foreign exchange risk management in Japan's head office without allocating foreign exchange risk management personnel to local subsidiaries. In arm's-length exports to France, Japanese firms prefer invoicing in yen, passing on the exchange rate risk to French importers. This result remains robust when using alternative definitions of intra-firm trade. We also find that exporters tend to use the euro when the proportion of the euro in imports is high, the firms' market share in France is high, the exporting product's market share is low, or when the yen is more volatile against the euro. Furthermore, regarding firm characteristics, we find that labor productivity and research and development (R&D) investment, considered sources of nonprice export competitiveness, negatively affect the likelihood of euro-invoiced transactions. We interpret this result to mean that exporters use the home currency in invoicing when they hold significant bargaining power generated by competitiveness in the destination country.

The remainder of this paper is organized as follows. Section 2 describes the Japanese customs data and the transaction-level panel dataset constructed for this study. Section 3 presents the empirical framework and baseline results. Section 4 checks the robustness of the empirical findings. Finally, Section 5 concludes this paper.

2. Data

2.1. Matching Methodology

We use the newly disclosed transaction data collected by Japanese customs to conduct this research. The data contain the following information for each export and import transaction: (i) trade value (in invoice currency), (ii) quantity in corresponding units (numbers of units and/or weight), (iii) invoice currency, (iv)

[3] Friberg and Wilander (2008) also conducted a questionnaire survey of Swedish exporters, which provided us with useful information on firm-level Swedish export invoicing decisions; however, the study did not identify significant differences between intra-firm and arm's-length trade in invoice currency choice. Ito et al. (2018) conducted two questionnaire surveys of Japanese listed firms in 2009 and 2013 for their empirical analysis; however, as noted previously, panel estimation was not conducted because a limited number of firms responded to the surveys twice.

[4] In fact, the proportion of arm's-length trade in this sector is extremely low for some importing countries.

product information (Harmonized System (HS) nine-digit classification), (v) identification information for Japanese exporters and importers (ID number, name, address, and telephone number), (vi) destination or source country, (vii) trade partners' information (name and address), and (viii) transaction date, time, and other relevant details. The sample period is from January 1, 2014 to December 31, 2020.

Although the data allows access to all transactions of all products for all partner countries, this paper focuses on Japanese automobile exports to France to precisely identify the degree of capital ties between exporters and importers. Because we cannot directly obtain information on capital ties to differentiate intra-firm and arm's-length trade from Japanese customs data, we identify importers with financial ties to Japanese exporters matching by program codes. Machine matching was conducted based on firm-level capital relationship data provided by the Teikoku Data Bank (the original source is the Bureau van Dijk's Orbis database) and the names and addresses of exporters and importers obtained from the customs data. Japanese exporters or customs brokers submit French importers' names and addresses to the customs. Unfortunately, this information is not recorded consistently, and typographical errors are observed. This issue could reduce the accuracy of the machine matching procedure; therefore, for validation and accuracy, we also match importers and exporters manually.

Furthermore, to construct the most comprehensive list of overseas companies of Japanese automobile exporters possible, we prepare additional lists of overseas subsidiaries from two other databases: that of Japanese companies expanding business abroad (Kaigai Shinshutsu Kigyo Soran), published by Toyo Keizai Inc., and the MarkLines Information Platform, which includes extremely detailed and comprehensive data on automobile production from countries around the world.[5] These databases are also included in our manual matching procedure, significantly increasing the number of matches. Given manual matching's role in compensating for machine matching, dealing with all sample countries and industries is not a viable option.[6]

We focus on Japanese automobile exporters because automobiles are one of Japan's largest export products and have a significant macroeconomic impact on the Japanese economy. In addition, Japanese automobile firms have established many overseas subsidiaries, indicating the significance of intra-firm trade in the sector. To ensure enough Japanese export firms, we chose 12 parent firms that produce completed automobiles and/or motorcycles. We also include five domestic subsidiaries in Japan that the above parent firms directly own with at least a 50% ownership stake. Therefore, we examine data from 17 Japanese auto firms that export the final products of automobiles, motorcycles, and related parts and components to France.[7]

We chose France as the sample destination country for two reasons. First, the yen and the euro (i.e., the local currency) are predominantly used in Japanese automobile exports to France, and the proportion of other currencies is negligible. Therefore, the invoice currency choice in our target trade flow is more immune to the dominant currency paradigm (DCP) proposed by Gopinath et al. (2020). This allows us to focus on the binary invoice currency choice between PCP and LCP, which is theoretically simpler than including a third dominant currency, such as the USD. For comparison, panels (a) and (b) in Figure 1 illustrate the share of yen, trade partner's currencies (i.e., the local currency in exports and producer's currency in imports), and other currencies in Japan's exports and imports to/from the world for all industries, respectively. These panels reveal that currencies other than the yen and trade partner's currencies have a considerable share in Japanese overall trade. Thus, we must consider the ternary invoice currency choice if all export transactions are used for our sample.

[5] In addition to the above three data sources, when necessary, we double-checked the websites of import firms to confirm our findings.

[6] For instance, in April 2014, more than 1.6 million export transactions to the world were conducted by more than 50 thousand firms. Covering all these samples is not reasonable to conduct manual matching to compensate for machine matching.

[7] The share of our sample exporters out of total automobile exports (i.e., exports of HS 87 products) from Japan to France is 47.3% and 73.6% in terms of the number of transactions and value, respectively.

One may think that we can focus on EU countries because two currencies, i.e., the yen and the euro, are expected to be dominant for EU countries. Panels (c) and (d) in Figure 1 show the share of the yen, trade partner's currencies (including the euro), and other currencies in our sample firms' exports and imports to/from EU countries, respectively. The proportion of other currencies exceeds 20% in both exports and imports. Thus, we subsequently focused on Japanese automobile exports to France because only the yen and euro are used in most transactions. The share of other currencies, including the USD, is used in less than 0.1% of transactions.

The second reason for choosing this trade flow is that the share of arm's-length exports is significant, allowing us to reasonably compare intra-firm and arm's-length trade with sufficient samples for both types of trade.[8] Additionally, Figure 2 illustrates the sales of Japanese automakers in major destination countries obtained from the MarkLines database,[9] indicating that France is the fifth-largest overseas market for Japanese automakers. Furthermore, Figure 3 presents foreign automaker sales in France, showing that Japanese automakers have the second-largest share of the French market, indicating a strong presence of Japanese automakers in France.

=== Figures 1, 2, and 3 ===

2.2. Definitions of Intra-Firm Exports

One challenge in identifying intra-firm and arm's-length exports is defining overseas subsidiaries based on the degree of capital ties between Japanese and French importers. We consider the following five types of overseas subsidiaries for inclusion in intra-firm exports, illustrated in Figure 4.

Sub-1 firm: Overseas firms directly owned by a parent firm in Japan with at least a 10% ownership stake.
Sub-2 firm: Overseas firms directly owned by a Sub-1 firm with at least a 50% ownership stake.
Sub-3 firm: Overseas firms directly owned by a Sub-2 firm with at least a 50% ownership stake.
Sub-Sub-1 firm: Overseas firms directly owned by domestic subsidiaries (i.e., the parent firm's subsidiaries in Japan) with at least a 10% ownership stake.
Sub-Sub-2 firm: Overseas firms directly owned by a Sub-Sub-1 firm with at least a 50% ownership stake.

=== Figure 4 ===

As previously noted, we consider the exports of 17 Japanese firms, comprising 12 parent firms and five domestic subsidiaries. We define the four types of intra-firm exports as follows:

Intra-firm 1: 17 Japanese firms' exports to Sub-1 and Sub-2 firms.
Intra-firm 2: 17 Japanese firms' exports to Sub-1, Sub-2, and Sub-3 firms.
Intra-firm 3: 17 Japanese firms' exports to Sub-1, Sub-2, Sub-Sub 1, and Sub-Sub 2 firms.
Intra-firm 4: 17 Japanese firms' exports to Sub-1, Sub-2, Sub-3, Sub-Sub 1, and Sub-Sub 2 firms.

Intra-firm exports are defined as the narrowest in Intra-firm 1 and the broadest in Intra-firm 4. Intra-firm 2

[8] As shown in Table 1, the share of intra-firm exports is 73.4% based on our narrowest definition. Thus, there is a decent share of arm's-length trade, while many transactions are conducted between companies with financial ties.
[9] Figures 2 and 3 represent the value of sales because the MarkLines database only provides this information, whereas our empirical analysis is conducted for each transaction (not the transaction value).

adds Sub-3 firms to Intra-firm 1, whereas Intra-firm 3 adds Sub-Sub 1 and Sub-Sub 2 firms to Intra-firm 1 without including Sub-3 firms. In this sense, Intra-firm 2 and Intra-firm 3 complement one another. We include all 114,335 export transactions by the 17 selected Japanese exporters in the automobile industry for the entire sample period (2014–2020). Of these, the share of intra-firm exports ranges from 73.4% to 81.2%, depending on the definition of intra-firm trade, as shown in the last column of Table 1. Figure 5 presents the proportion of intra-firm trade for each definition and the annual share of intra-firm and arm's-length trade.

=== Table 1 ===

=== Figure 5 ===

Table 2 presents the number and share of transactions using the yen and euro. We excluded transactions with other currencies because they accounted for 0.1% of the total transactions and were omitted from our empirical investigation. The upper panel shows the number of shares in the full sample. Our sample's total number of transactions ranges from 14.8 thousand to 18.7 thousand, depending on the year. The euro share was more significant than the yen in all sample years. Nevertheless, the yen had a significant share yearly.[10] The lower panel shows the number and share by trade type. We counted the number and calculated the share based on the four alternative classifications of intra-firm trade introduced in Table 1. A clear contrast between intra-firm and arm's-length trade is evident, revealing that the euro had a dominant share in intra-firm trade. In contrast, the yen had a dominant share in arm's-length trade for all four intra-firm trade classifications. Notably, the local currency (i.e., the euro) is used more in intra-firm trade than in arm's-length trade.

=== Table 2 ===

3. Empirical Analysis

3.1. Empirical Framework

To examine the difference in the invoice currency choice between intra-firm trade and arm's-length trade, we estimate the following empirical equation for Japanese firm *i*'s export transaction *k* of product *p* defined at the HS nine-digit level in year *t* to France using the ordinary least squares (OLS) method:[11]

$$y_{i,k,p,t} = a + bIntra_{i,k} + e_{i,s,t} + \varepsilon_{i,k,p,t} \quad (1)$$

$y_{i,k,p,t}$ is a dummy variable that takes a value of one for transactions invoiced in euros and zero for those invoiced in yen. As noted above, we excluded samples with other types of invoice currency because most transactions are conducted in terms of either the euro or yen. $Intra_{i,k}$ is a dummy variable that takes a value of one for intra-firm export transactions, and zero otherwise. $e_{i,s,t}$ is the firm-product-year fixed effect (FE), for which the product (s) is defined at the HS six-digit level to mitigate sample size reduction. We use robust standard errors in all estimations shown in the main body of the paper, while we present the results in the Appendix with standard errors clustered at the firm level.[12] We hypothesize that the euro is more likely to be chosen in intra-firm trade,

[10] Table 2 shows that the yen share is higher in 2020 for intra-firm trade than in other sample years. One possible cause of this observation is the outbreak of the COVID-19 pandemic; therefore, 2020 samples may be biased observations. Table A1 in the Appendix shows that our results do not change even if we omit 2020 samples.

[11] Because of sample size reduction, we could not obtain convergence when we used the logit method with the firm-product-year fixed effect; therefore, we used the OLS method in our baseline case. It should also be noted that we exclude HS8710 (Tanks and other armored fighting vehicles, motorized, whether or not fitted with weapons, and parts of such vehicles) and HS8715 (Baby carriages and parts thereof), as they are irrelevant to this study.

[12] See Tables A2–A4 in the Appendix.

implying a positive sign of b. We use the alternative definitions of intra-firm trade interchangeably to validate the robustness of the results, as shown in Table 1.

We also examine the impact of other conventional variables by employing the logit method with rougher FEs:

$$y_{i,k,p,t} = \alpha + \beta Intra_{i,k} + \gamma X + e_i + e_s + e_t + \epsilon_{i,k,p,t} \quad (2)$$

where e_i, e_s, and e_t are firm, product (HS six-digit), and year FEs, respectively. β is expected to be positive. X is the vector of the explanatory variables. Specifically, we employ two variables in our baseline analysis. First, we consider the share of invoice currency in imports, capturing this variable ($IIS_{i,t}$) by using the natural log of the share of import transactions invoiced in euros in the total number of import transactions conducted by the firm yearly. Although we can use Japan's transaction-level customs import data, we focus on firms' export behavior. We use this import information to examine the possible effect of invoice currency share in imports on exporters' invoice currency decisions, which has been well documented for UK exporters in Chung (2016).[13] Firms tend to choose the same currency for exports and imports of intermediate inputs to offset the exchange rate risk arising from export and import transactions; therefore, we expect a positive coefficient for this variable.

Second, we use the natural log of each firm's market share in each product category at the HS six-digit level yearly ($FirmMS_{i,s,t}$). The numerator of this market share variable is calculated based on the export value of the HS six-digit product from Japan to France, which is obtained from Japanese customs data. The denominator is the total global export value, including Japan, to France, calculated based on data obtained from the UN Comtrade database. Previous studies have demonstrated that invoicing currency relates to exporters' market share. For instance, Devereux et al. (2017) showed that exporters' market share has a nonlinear impact on the invoice currency choice using transaction-level Canadian import data, determining that small exporters are more likely to choose LCP as market share rises; however, when the market share reaches a certain threshold, increased market share makes exporters more likely to choose PCP. We construct the market share variable by dividing the total exports of each product by each exporter by the total exports of that product from the world to France. Table 3 presents the descriptive statistics of our empirical variables for the entire sample, intra-firm trade, and arm's-length trade. The table identifies intra-firm trade and arm's-length trade based on Intra-firm-1.

=== Table 3 ===

3.2. Baseline Results

We examine how invoice currency choice in intra-firm trade differs from that in arm's-length trade. Table 4 presents the estimation results for equation (1). $Intra1_{i,k}$ to $Intra4_{i,k}$ are constructed based on Intra-firm 1 to Intra-firm 4, respectively, and are interchangeably used in regressions. All estimations were conducted using the OLS method. The table presents the marginal effect, which is evaluated using the mean value of intra-firm trade dummies. We employ the firm-product-year FE in columns (I)–(IV), while we use firm-year, product-year, and firm-product FEs in columns (V)–(VII), respectively.[14] In column (I), we find that $Intra1_{i,k}$ has a positive impact, implying that the euro is more likely to be chosen in intra-firm trade. Regarding the magnitude of the

[13] The impact of the import side variable on export performance has been examined in previous research. For example, using Belgian firm-product-level data, Amiti et al. (2014) showed that more import-intensive exporters have significantly lower exchange rate pass-through into their export prices, as they face offsetting exchange rate effects on their marginal costs. In the context of trade facilitation, Hayakawa et al. (2019a) documented that import processing time affects export performance using Thai customs data.

[14] Columns (V)–(VII) show only the results for $Intra1_{i,k}$. We present the results with $Intra2_{i,k}$ to $Intra4_{i,k}$ in Table A5 in the Appendix. The results do not change qualitatively.

impact, the probability of choosing the euro is 24.7% higher in intra-firm trade than in arm's-length trade. As we introduce a detailed FE, the adjusted R-squared is high (0.932). $Intra1_{i,k}$ to $Intra4_{i,k}$ also have significantly positive impacts. Columns (V) to (VII) show that the positive impact of the intra-firm trade dummy is robust when employing other types of FEs. The magnitude is estimated to be prominent in the case with the firm-year FE (0.684) shown in column (VI), as the intra-firm trade dummy comes from the firm dimension.

=== Table 4 ===

Table 5 shows the results for equation (2) and presents the impact of other explanatory variables in addition to the intra-firm trade dummy. All estimations were conducted using the logit model with firm, product, and year FEs, and the table presents the marginal effect for all explanatory variables. The mean value of all explanatory variables was used to evaluate the marginal effect. Examining column (I), we find that $Intra1_{i,k}$ has a positive impact, indicating that the euro is more likely to be chosen in intra-firm trade. The marginal effect is estimated to be smaller (0.099) than the OLS cases shown in Table 4, suggesting that Japanese automobile firms tend to use the euro more in intra-firm exports to France, with the parent firm in Japan assuming all exchange rate risks arising from LCP. In arm's-length exports to France, Japanese firms prefer invoicing in yen, passing on the exchange rate risk to French importers. Regarding the share of the euro in imports, $IIS_{i,t}$ positively affects the likelihood of using the euro in exports; thus, Japanese automobile firms tend to choose the same invoice currency for both exports and imports to offset the exchange rate risk. $FirmMS_{i,s,t}$ has a positive impact, indicating that firms with a larger market share in the destination market tend to use the euro, suggesting that Japanese automobile exporters may invoice exports in euros to increase their market share in France. As proposed by Devereux et al. (2017), we examine the possibility that market share has a nonlinear impact in the robustness checks below (Section 4). The results remain nearly unchanged when we employ alternative definitions of the intra-firm trade dummy, as shown in columns (II)–(IV).[15]

=== Table 5 ===

4. Additional Analyses

We conduct various robustness tests in this section, including (a) the nonlinear impact of firm market share and product market share, (b) alternative definitions of the invoice currency share of imports, (c) the impact of firm productivity and R&D investment, (d) the ownership ratio as an alternative to intra-firm trade dummies, and (e) the exchange rate and its volatility.

4.1. Market Share Variables

Devereux et al. (2017) asserted that firms' market share has a nonlinear impact on the choice of invoice currency. Referencing this assumption, we examine the nonlinear impact of $FirmMS_{i,s,t}$ by introducing its squared term $sq(FirmMS_{i,s,t})$. The result is shown in column (I) of Table 6, and the impact for the squared term is insignificant, whereas the impact of firms' market share remains significantly positive. Thus, we do not find a nonlinear impact of $FirmMS_{i,s,t}$ in our sample.

=== Table 6 ===

[15] Notably, the impact of $Intra2_{i,k}$ and $Intra4_{i,k}$ becomes insignificant when we use clustered standard errors, as shown in Table A2 in the Appendix. This consequence might come from these two measures, including Sub-3 firms with thin capital ties with sample Japanese exporters.

We also investigate the impact of (the natural log of) Japanese exporters' market share on total exports from the world to France for each HS6 product category ($ProductMS_{s,t}$), which is calculated based on the export value and total exports from the rest of the world to France obtained from the UN Comtrade database. This variable modestly captures Japanese products' competitiveness in the French market. We use product and firm market share separately because we use the same data (i.e., product-level total exports to France) for the denominator of both measures, leading to a systematically positive correlation between the measures. Column (II) of Table 6 shows that product market share has a significant negative impact, indicating that the yen is more likely to be chosen when the exported product is competitive in the French market. This is consistent with the findings of Ito et al. (2012) regarding the invoicing decisions of Japanese exporters in automobile, electrical machinery, and general machinery industries and Goto et al.'s (2021) findings for Japanese small and medium manufacturing enterprises. This result indicates that Japanese firms that export highly differentiated products tend to use the yen in export invoicing. Regarding nonlinearity, the squared term of this variable $sq(ProductMS_{s,t})$, has a significant negative impact, as shown in column (III). This indicates that the effect of product-level market competitiveness increases with product market share; that is, a higher market share makes it easier for exporters to implement home currency invoicing (PCP) to avoid exchange rate risk.

4.2. Share of Invoice Currency in Imports Based on the Import Value

As noted by Chung (2016), firms may offset payments for imports and receipts from exports denominated in a foreign currency to minimize exposure to exchange rate fluctuations. To examine this offsetting behavior, we employed $IIS_{i,t}$ in the baseline analysis, the share of euro invoicing in imports is calculated based on the number of transactions. In this subsection, we employ the euro invoicing share of imports, calculated based on the import value ($IIS\_value_{i,t}$) to assess robustness. The invoice currency share used in high-value transactions is reflected more significantly using this definition than the baseline measure. The results are presented in column (IV) of Table 6. The impact of this measure is significantly positive, similar to the baseline results in column (I) of Table 5. Compared with the baseline findings, the impact is somewhat lower ($0.030 > 0.021$), indicating that the transaction-based import invoice share is more closely related to the invoice currency choice in export transactions than the value-based import invoice share.

4.3. Firm Productivity and R&D Investment

Numerous studies have argued that firm characteristics affect invoice currency choice. For example, using a Belgian firm-level dataset, Amiti et al. (2022) determined that the invoice currency choice is "an active firm-level decision" and that firms' size, exposure to imported inputs, and competitors' choice significantly impact invoice currency choice. We consider the firm characteristics of labor productivity ($LaborProd_{i,t}$) and R&D investment ($R\&D/Sales_{i,t}$). We define the former variable as the natural log of total sales divided by the number of employees, and the latter variable as the natural log of R&D expenditures divided by total sales.[16] We introduce these two variables separately because total sales are used to define both variables, and there is a systematic negative correlation between them. Despite time-series variation, both variables were relatively stable during our sample period and had a notably high correlation with firm FE. Additionally, the number of samples (especially the number of exporters) significantly decreases when detailed FEs are introduced. To avoid these issues, we define quartile dummy variables that take a value of one for each quartile of firm sales and zero

[16] Data on total sales, R&D expenditure, and the number of employees are obtained from the Annual Securities Reports of sample exporting firms.

otherwise. We employ these dummies instead of firm FE. We also use the HS two-digit FE for product FE instead of the HS six-digit FE to mitigate sample number reduction.

Referring to previous research, we can expect either sign of productivity.[17] Based on the endogenous price model, higher productivity leads to higher price markup through improvement in product quality (e.g., Antoniades, 2015). In flexible price equilibrium, the elasticity of the trade price increases for changes in production cost caused by exchange rate fluctuations when the price markup is higher. Considering the case in which a profit-maximizing exporter chooses invoice currency, replicating flexible price allocation in the presence of price stickiness (Gopinath and Itskhoki, 2010), productive exporters may prefer the foreign currency, implying a positive coefficient for our productivity measure. In contrast, if productivity captures firm-level competitiveness in the destination market, productive exporters may use their own currency for trade invoicing, as Ito et al. (2013, 2018) demonstrated with a product-level analysis. Column (V) of Table 6 reveals the impact of $LaborProd_{i,t}$ is significantly negative, supporting the latter scenario. Furthermore, $R\&D/Sales_{i,t}$ is also interpreted as a source of firms' nonprice export competitiveness. Column (VI) indicates that the impact of this variable is significantly negative.

4.4. Ownership Ratio

We defined intra-firm dummies using the ownership ratio between exporters in Japan and importers in France, as the parent firm's controlling power for the foreign subsidiary may work discontinuously when the ownership ratio exceeds a certain threshold. Nevertheless, the ownership ratio can be directly used to investigate how each transaction is likely traded between group companies. Column (I) of Table 7 shows that the ownership ratio significantly positively impacts the choice of the euro. Regarding the magnitude, a one-point rise in the ownership ratio (i.e., a rise from 0% to 100% ownership) leads to a 14.6% increase in the probability of euro invoicing. Thus, the magnitude is estimated to be more prominent when we use the ownership ratio than intra-firm trade dummies.

=== Table 7 ===

4.5. Exchange Rate

Firms may consider the exchange rate and its risk when they decide on invoice currency. For instance, Bacchetta and van Wincoop (2005) theoretically show that the invoice currency choice depends on exchange rate volatility, measured by the variance of the nominal exchange rate. Goldberg and Tille (2016) empirically investigate whether bilateral exchange rate volatility explains the invoice currency choice. To investigate how the currency choice depends on the exchange rate and its risk, we introduce the natural log of the mean of the daily average nominal exchange rate of the yen vis-à-vis the euro (ER_t) and the standard deviation (SD) of ER_t (Vol_t). The exchange rate data were obtained from the Pacific Exchange Rate Service of the University of British Columbia. We employ these two exchange rate variables separately, given the significance of their correlation. For the level of the exchange rate, we predict a positive impact because exporters may be eager to gain foreign exchange profit arising from home currency depreciation. As shown in column (II) of Table 7, this view is empirically supported. For volatility, either sign can be expected. Devereux et al. (2004) noted that risk-averse exporters prefer the exporters' currency when its value is volatile against the importers' currency. Thus, we predict a negative sign. In contrast, given that a sizable part of the trade is conducted between group companies

[17] To the best of our knowledge, no studies have directly examined the impact of productivity on the choice of invoice currency, whereas several studies have investigated the relationship between exchange rate pass-through and productivity (e.g., Berman et al., 2012).

in our sample, we expect a positive sign because parent companies may try to collect exchange rate risk on their side, especially when the exchange rate is volatile. As shown in column (III), exchange rate volatility has a positive impact, indicating that the latter scenario dominates the former in our sample. Notably, as shown in column (IV), the impact of Vol_t becomes insignificant once we consider the interaction term between Vol_t and the intra-trade dummy. Furthermore, the interaction term has a significantly positive impact, supporting our view that parent companies collect exchange rate risk from local subsidiaries, especially during exchange rate volatility.

5. Concluding Remarks

Recent empirical research in international economics and finance has emphasized GVCs in intra-firm trade transactions between group companies; however, rigorous empirical analysis regarding the invoice currency choice in intra-firm trade is limited. The contributions of this study are twofold. First, we examine which invoice currency is chosen and the factors related to the choice of invoice currency in intra-firm trade. Second, this study uses detailed transaction-level data obtained from Japan Customs, previously unavailable for empirical research. Thus, our study presents the first empirical research regarding the determinants of invoice currency in intra-firm trade using disaggregated Japan Customs' transaction-level data.

Our empirical examination demonstrates that the euro is more likely to be chosen for intra-firm exports from Japan to France than for arm's-length exports, indicating that Japanese automobile firms tend to use the euro so that parent firms in Japan can assume the exchange rate risks arising from international transactions with overseas subsidiaries. In arm's-length exports to France, Japanese firms prefer invoicing in yen, passing on the exchange rate risk to French importers. We also find that other conventional firm- and product-level factors have similar impacts on the invoice currency choice in our dataset compared with existing studies. Another aspect of this study's novelty is that labor productivity and R&D investment, which can be considered sources of nonprice export competitiveness, reduce the likelihood of LCP. The impact of these firm characteristics on the invoice currency choice has rarely been investigated directly.

Our findings offer important insights into multinational companies' exchange rate risk management, showing that Japanese parent firms choose LCP to centrally manage the group-wide exchange rate risk arising from intra-firm trade. Therefore, as a natural consequence, firms increase LCP-based transactions as intra-firm trade expands with the widening and deepening of GVCs, making exchange rate risk management a more significant concern for Japanese parent firms. If firms are eager to reduce exchange rate risk by using the yen, one possible approach is by improving the nonprice competitiveness of export products against nongroup importers. This way, they can offer PCP to importers to reduce exchange rate risk, at least in arm's-length trade. Even in the case of exports from Japanese parent firms to overseas subsidiaries, strongly competitive products give overseas subsidiaries greater negotiation power with local buyers, resulting in better group-wide exchange risk management. Our empirical findings suggest improving firm productivity and expanding R&D investment are also effective.

Another intriguing question is which currency is chosen in intra-firm trade between Japan and Asian countries, since USD invoicing has been observed more strongly in Asian regional trade (Ito et al., 2018). This issue is also worth investigating in the context of DCP. This research question is left for future research.

References

Amiti, Mary, Oleg Itskhoki, and Jozef Konings (2014) "Importers, Exporters, and Exchange Rate Disconnect" *American Economic Review*, 104(7), 1942–1978.

Amiti, Mary, Oleg Itskhoki, and Jozef Konings (2022) "Dominant Currencies: How Firms Choose Currency Invoicing and Why It Matters" *Quarterly Journal of Economics*, 137(3), 1435–1493.

Antoniades, Alexis (2015) "Heterogeneous Firms, Quality, and Trade" *Journal of International Economics*, 95(2), 263–273.

Bacchetta, Philippe and Eric van Wincoop (2005) "A Theory of the Currency Denomination of International Trade," *Journal of International Economics*, 67(2), 295–319.

Berman, Nicolas, Philippe Martin, and Thierry Mayer (2012) "How Do Different Exporters React to Exchange Rate Changes?" *Quarterly Journal of Economics*, 127(1), 437–492.

Casas, Camila, Federico J. Díez, Gita Gopinath, and Pierre-Olivier Gourinchas (2017) "Dominant Currency Paradigm: A New Model for Small Open Economies" IMF Working Paper, WP/17/264.

Chen, Natalie, Wanyu Chung, and Dennis Novy (2022) "Vehicle Currency Pricing and Exchange Rate Pass-Through" *Journal of the European Economic Association*, 20(1), 312–351.

Chung, Wanyu (2016) "Imported Inputs and Invoicing Currency Choice: Theory and Evidence from UK Transaction Data" *Journal of International Economics*, 99, 237–250.

Corsetti, Giancarlo, Meredith Crowley, and Lu Han (2022) "Invoicing and the Dynamics of Pricing-to-Market: Evidence from UK Export Prices around the Brexit Referendum" *Journal of International Economics*, 135, 103570.

Devereux, Michael B., and Charles Engel (2003) "Monetary Policy in the Open Economy Revisited: Price Setting and Exchange-rate Flexibility" *Review of Economic Studies*, 70(4), 765–783.

Devereux, Michael B., Charles Engel, and Peter E. Storgaard (2004) "Endogenous Exchange Rate Pass-Through When Nominal Prices Are Set in Advance" *Journal of International Economics*, 63(2), 263–291.

Devereux, Michael B., Wei Dong, and Ben Tomlin (2017) "Importers and Exporters in Exchange Rate Pass-Through and Currency Invoicing" *Journal of International Economics*, 105, 187–204.

Friberg, Richard, and Fredrik Wilander (2008) "The Currency Denomination of Exports—A Questionnaire Study" *Journal of International Economics*, 75(1), 54–69.

Goldberg, Linda S., and Cédric Tille (2016) "Micro, Macro, and Strategic Forces in International Trade Invoicing: Synthesis and Novel Patterns" *Journal of International Economics*, 102, 173–187.

Gopinath, Gita, and Roberto Rigobon (2008) "Sticky Borders" *Quarterly Journal of Economics*, 123(2), 531–575.

Gopinath, Gita, and Oleg Itskhoki (2010) "Frequency of Price Adjustment and Pass-Through" *Quarterly Journal of Economics*, 125(2), 675–727.

Gopinath, Gita, Oleg Itskhoki, and Roberto Rigobon (2010) "Currency Choice and Exchange Rate Pass-through" *American Economic Review*, 100(1), 304–336.

Gopinath, Gita, Emine Boz, Camila Casas, Federico J. Díez, Pierre-Olivier Gourinchas, and Mikkel Plagborg-Møller (2020) "Dominant Currency Paradigm" *American Economic Review*, 110(3), 677–719.

Goto, Mizuki, Kazunobu Hayakawa, Satoshi Koibuchi, and Taiyo Yoshimi (2021) "Invoice Currency Choice under Financial Constraints and Bargaining: Evidence from Japanese SMEs" RIETI Discussion Paper Series 21-E-080.

Hayakawa, Kazunobu, Nuttawut Laksanapanyakul, and Taiyo Yoshimi (2019a) "How Does Import Processing Time Impact Export Patterns?" *World Economy*, 42(7), 2070–2088.

Hayakawa, Kazunobu, Toshiyuki Matsuura, Nuttawut Laksanapanyakul, and Taiyo Yoshimi (2019b) "Export

Dynamics and the Invoicing Currency" ERIA Discussion Paper, ERIA-DP-2018-14.

Ito, Takatoshi, Satoshi Koibuchi, Kiyotaka Sato, and Junko Shimizu (2012) "The Choice of an Invoicing Currency by Globally Operating Firms: A Firm-Level Analysis of Japanese Exporters" *International Journal of Finance & Economics*, 17(4), 305–320.

Ito, Takatoshi, Satoshi Koibuchi, Kiyotaka Sato, and Junko Shimizu (2013) "Choice of Invoicing Currency: New Evidence from a Questionnaire Survey of Japanese Export Firms" RIETI Discussion Paper Series 13-E-034.

Ito, Takatoshi, Satoshi Koibuchi, Kiyotaka Sato and Junko Shimizu (2018) *Managing Currency Risk: How Japanese Firms Choose Invoicing Currency*, Cheltenham, UK: Edward Elgar.

Montfaucon, Angella Faith, Kiyotaka Sato, Nagendra Shrestha, and Craig Parsons (2021) "Exchange Rate Pass-through and Invoicing Currency Choice between Fixed and Floating Exchange Rate Regimes: Evidence from Malawi's Transaction-level Data" *Economic Analysis and Policy*, 72, 562–577.

Neiman, Brent (2010) "Stickiness, Synchronization, and Passthrough in Intrafirm Trade Prices" *Journal of Monetary Economics*, 57(3), 295–308.

Obstfeld, Maurice, and Kenneth Rogoff (2000) "New Directions for Stochastic Open Economy Models" *Journal of International Economics*, 50(1), 117–153.

Rondeau, Fabien, and Yushi Yoshida (2023) "Global Value Chains and Exchange Rate Pass-through into the Import Prices of Japanese Industries" RIETI Discussion Paper Series 23-E-013.

Saygılı, Hülya (2023) "Invoicing Currency, Exchange Rate Pass-through, and Value-added Trade: The Case of Turkey" *International Journal of Finance & Economics*, 28(4), 4401–4419.

Timmer, Marcel P., Abdul Azeez Erumban, Bart Los, Robert Stehrer, and Gaaitzen J. de Vries (2014) "Slicing Up Global Value Chains" *Journal of Economic Perspectives*, 28(2), 99–118.

Table 1. Definitions of intra-firm exports

Definition	Scope of Intra-firm Importers	Intra-firm Ratio [2014–2020] [Transaction-based]
Intra-firm 1	Sub-1 and Sub-2 firms	73.4%
Intra-firm 2	Sub-1, Sub-2, and Sub-3 firms	81.0%
Intra-firm 3	Sub-1, Sub-2, Sub-Sub 1, and Sub-Sub 2 firms	73.7%
Intra-firm 4	Sub-1, Sub-2, Sub-3, Sub-Sub 1, and Sub-Sub 2 firms	81.2%

Source: Authors' calculation based on Japanese customs data

Table 2. Distribution of Invoice Currency in Sample Firms' Exports to France

All

Number of transactions

	Yen	Euro
2014	5,851	11,095
2015	6,169	10,303
2016	7,749	10,916
2017	8,172	9,601
2018	6,269	10,115
2019	5,926	8,870
2020	8,309	9,297

Share

	Yen	Euro
2014	0.345	0.655
2015	0.375	0.625
2016	0.415	0.585
2017	0.460	0.540
2018	0.383	0.617
2019	0.401	0.599
2020	0.472	0.528

By trade type

Intra1

Number of transactions

	Intra-firm trade		Arm's-length trade	
	Yen	Euro	Yen	Euro
2014	2,354	10,730	3,497	365
2015	2,029	9,956	4,140	347
2016	3,173	10,521	4,576	395
2017	2,351	9,015	5,821	586
2018	2,362	9,767	3,907	348
2019	2,883	8,608	3,043	262
2020	4,425	8,958	3,884	339

Share

	Intra-firm trade		Arm's-length trade	
	Yen	Euro	Yen	Euro
2014	0.180	0.820	0.905	0.095
2015	0.169	0.831	0.923	0.077
2016	0.232	0.768	0.921	0.079
2017	0.207	0.793	0.909	0.091
2018	0.195	0.805	0.918	0.082
2019	0.251	0.749	0.921	0.079
2020	0.331	0.669	0.920	0.080

Intra2

Number of transactions

	Intra-firm trade		Arm's-length trade	
	Yen	Euro	Yen	Euro
2014	2,558	10,731	3,293	364
2015	2,549	9,964	3,620	339
2016	3,902	10,522	3,847	394
2017	4,202	9,016	3,970	585
2018	3,762	9,769	2,507	346
2019	4,495	8,617	1,431	253
2020	7,011	9,015	1,298	282

Share

	Intra-firm trade		Arm's-length trade	
	Yen	Euro	Yen	Euro
2014	0.192	0.808	0.900	0.100
2015	0.204	0.796	0.914	0.086
2016	0.271	0.729	0.907	0.093
2017	0.318	0.682	0.872	0.128
2018	0.278	0.722	0.879	0.121
2019	0.343	0.657	0.850	0.150
2020	0.437	0.563	0.822	0.178

Intra3

Number of transactions

	Intra-firm trade		Arm's-length trade	
	Yen	Euro	Yen	Euro
2014	2,401	10,730	3,450	365
2015	2,095	9,956	4,074	347
2016	3,204	10,521	4,545	395
2017	2,383	9,015	5,789	586
2018	2,394	9,774	3,875	341
2019	2,907	8,611	3,019	259
2020	4,436	8,968	3,873	329

Share

	Intra-firm trade		Arm's-length trade	
	Yen	Euro	Yen	Euro
2014	0.183	0.817	0.904	0.096
2015	0.174	0.826	0.922	0.078
2016	0.233	0.767	0.920	0.080
2017	0.209	0.791	0.908	0.092
2018	0.197	0.803	0.919	0.081
2019	0.252	0.748	0.921	0.079
2020	0.331	0.669	0.922	0.078

Intra4

Number of transactions

	Intra-firm trade		Arm's-length trade	
	Yen	Euro	Yen	Euro
2014	2,605	10,731	3,246	364
2015	2,615	9,964	3,554	339
2016	3,933	10,522	3,816	394
2017	4,234	9,016	3,938	585
2018	3,794	9,776	2,475	339
2019	4,519	8,620	1,407	250
2020	7,022	9,025	1,287	272

Share

	Intra-firm trade		Arm's-length trade	
	Yen	Euro	Yen	Euro
2014	0.195	0.805	0.899	0.101
2015	0.208	0.792	0.913	0.087
2016	0.272	0.728	0.906	0.094
2017	0.320	0.680	0.871	0.129
2018	0.280	0.720	0.880	0.120
2019	0.344	0.656	0.849	0.151
2020	0.438	0.562	0.826	0.174

Source: Authors' calculations

Notes: Numbers and shares are calculated, focusing on transactions invoiced in yen or euro based on Japanese customs data.

Table 3. Descriptive Statistics

	All			Intra-firm trade			Arm's length trade		
	Obs	Mean	S.D.	Obs	Mean	S.D.	Obs	Mean	S.D.
y (euro dummy)	114,364	0.614	0.487	86,675	0.779	0.415	27,689	0.096	0.294
Intra1	114,364	0.762	0.426						
Intra2	114,364	0.840	0.366						
Intra3	114,364	0.764	0.425						
Intra4	114,364	0.843	0.364						
IIS	114,336	-1.741	0.496	86,647	-1.618	-0.464	27,689	-2.126	-0.382
IIS_value	114,336	-2.009	0.816	86,647	-1.961	-0.833	27,689	-2.158	0.739
FirmMS	114,364	-6.456	2.107	86,675	-6.181	-2.015	27,689	-7.319	-2.156
sq(FirmMS)	114,364	46.081	29.715	86,675	-3.575	-1.444	27,689	-3.749	-1.439
ProductMS	114,364	-3.617	1.445	86,675	42.260	27.198	27,689	58.209	33.569
sq(ProductMS)	114,364	15.169	11.141	86,675	14.864	10.919	27,689	16.125	11.759
ERVol	114,364	1.260	0.301	86,675	1.251	0.296	27,689	1.289	0.313
LaborProd	110,184	20.275	0.362	86,045	20.265	0.375	24,139	20.307	0.309
R&D/Sales	110,184	-19.282	-0.243	86,045	-19.290	-0.204	24,139	-19.255	-0.347
Ownership Ratio	114,364	0.705	0.429	86,675	0.911	0.252	27,689	0.061	0.116

Source: Authors' calculation based on Japanese customs data

Table 4. Baseline Results

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
Intra1	0.247 **				0.241 **	0.684 **	0.220 **
	(0.006)				(0.004)	(0.003)	(0.005)
Intra2		0.209 **					
		(0.009)					
Intra3			0.254 **				
			(0.006)				
Intra4				0.222 **			
				(0.009)			
Firm-Year FE	NO	NO	NO	NO	YES	NO	NO
Product-Year FE	NO	NO	NO	NO	NO	YES	NO
Firm-Product FE	NO	NO	NO	NO	NO	NO	YES
Firm-Product-Year FE	YES	YES	YES	YES	NO	NO	NO
Model	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Obs.	113,276	113,276	113,276	113,276	114,357	114,018	114,031
Adj R2	0.932	0.928	0.932	0.928	0.774	0.607	0.920

Notes: The dependent variable is a dummy variable that takes a value of one if the transaction is invoiced in euros and zero otherwise. The linear probability model (OLS) and robust standard errors were used in all estimations. **, *, and # indicate 1%, 5%, and 10% levels of significance, respectively. The type of fixed effects employed in the estimation is shown in the table and varies across columns.

Table 5. Logit Model

	(I)	(II)	(III)	(IV)
Intra1	0.099 **			
	(0.002)			
Intra2		0.090 **		
		(0.002)		
Intra3			0.100 **	
			(0.002)	
Intra4				0.091 *
				(0.002)
IIS	0.030 **	0.033 **	0.029 **	0.032 #
	(0.007)	(0.007)	(0.006)	(0.007)
FirmMS	0.009 **	0.008 **	0.009 **	0.008 #
	(0.001)	(0.001)	(0.001)	(0.001)
Firm FE	YES	YES	YES	YES
Product	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Model	Logit	Logit	Logit	Logit
Obs.	108,156	108,156	108,156	108,156
Pseudo R2	0.872	0.853	0.873	0.854

Notes: The dependent variable is a dummy variable that takes a value of one if the transaction is invoiced in euros and zero otherwise. The logit model and robust standard errors were used in all estimations. **, *, and # indicate 1%, 5%, and 10% levels of significance, respectively. We employ firm, HS six-digit product, and year fixed effects in all estimations.

Table 6. Market share and firm characteristics

	(I)	(II)	(III)	(IV)	(V)	(VI)
Intra1	0.099 **	0.101 **	0.100 **	0.100 **	0.240 **	0.260 **
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)
IIS	0.030 **	0.026 **	0.022 **		-0.001	0.073 **
	(0.007)	(0.007)	(0.007)		(0.002)	(0.003)
IIS_value				0.021 **		
				(0.002)		
FirmMS	0.009 **			0.009 **	0.015 **	0.008 **
	(0.002)			(0.001)	(0.000)	(0.001)
sq(FirmMS)	0.000					
	(0.000)					
ProductMS		-0.007 **	-0.030 **			
		(0.001)	(0.003)			
sq(ProductMS)			-0.003 **			
			(0.000)			
LaborProd					-0.661 **	
					(0.007)	
R&D/Sales						-0.074 **
						(0.005)
Firm FE	YES	YES	YES	YES	Quartile	Quartile
Product FE	YES	YES	YES	YES	HS2	HS2
Year FE	YES	YES	YES	YES	YES	YES
Model	Logit	Logit	Logit	Logit	Logit	Logit
Obs.	108,156	108,156	108,156	108,156	110,060	110,060
Pseudo R2	0.872	0.868	0.869	0.872	0.743	0.653

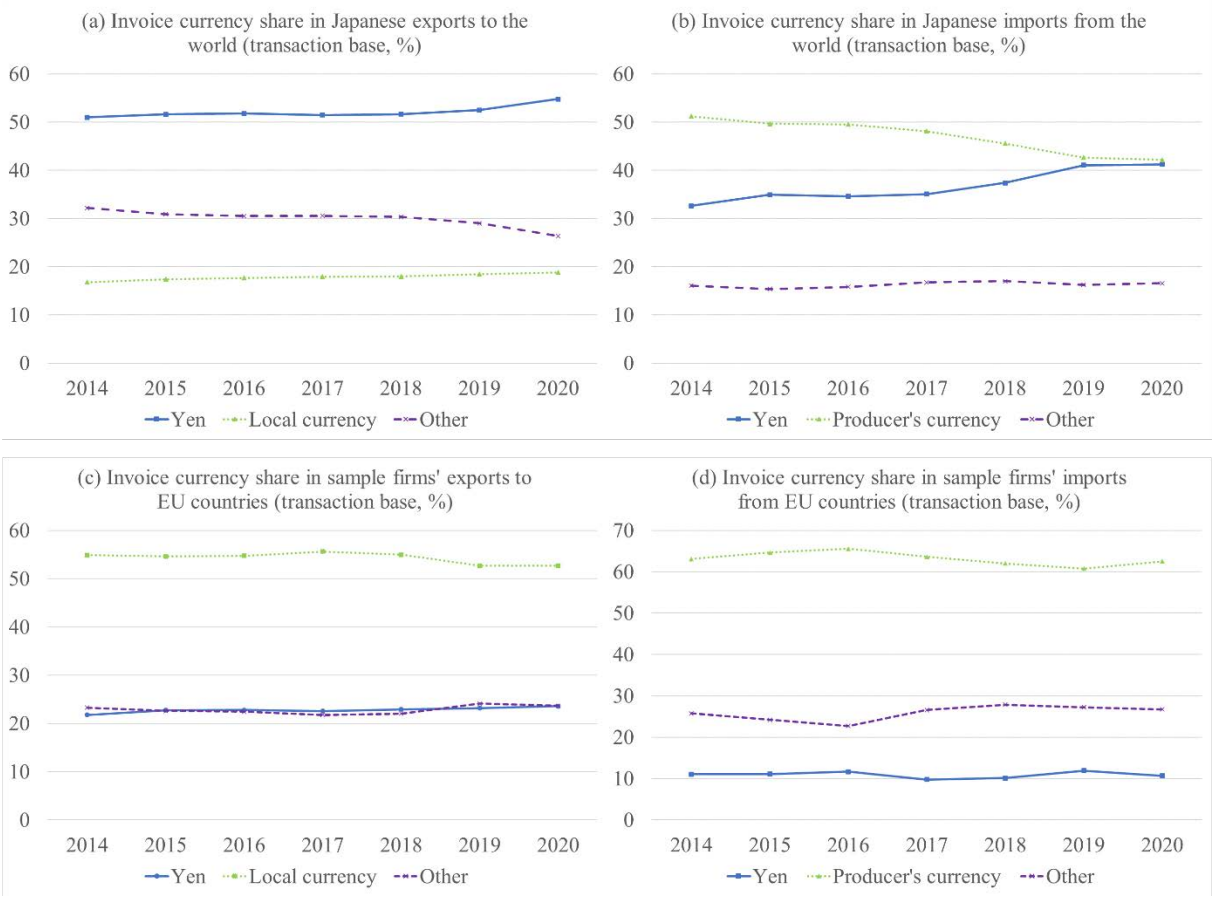
Notes: The dependent variable is a dummy variable that takes a value of one if the transaction is invoiced in euros and zero otherwise. The logit model and robust standard errors were used in all estimations. **, *, and # indicate 1%, 5%, and 10% levels of significance, respectively. Firm, HS six-digit product, and year fixed effects (FEs) are introduced in columns (I)–(V). In columns (V) and (VI), we use dummy variables that take a value of one for each quartile of firm sales and zero otherwise (i.e., quartile FEs) in addition to HS two-digit product and year FEs.

Table 7. Ownership ratio and exchange rate variables

	(I)	(II)	(III)	(IV)
Ownership Ratio	0.146 **			
	(0.003)			
Intra1		0.096 **	0.097 **	0.086 **
		(0.002)	(0.002)	(0.005)
IIS	0.020 **	0.032 **	0.005	0.007
	(0.007)	(0.006)	(0.005)	(0.005)
FirmMS	0.007 **	0.008 **	0.008 **	0.008 **
	(0.001)	(0.000)	(0.000)	(0.000)
ER		0.111 **		
		(0.009)		
ER Vol.			0.007 **	0.001
			(0.001)	(0.003)
*Intra * ER Vol*				0.008 *
				(0.004)
Firm FE	YES	YES	YES	YES
Product FE	YES	YES	YES	YES
Year FE	YES	NO	NO	NO
Model	Logit	Logit	Logit	Logit
Obs.	108,156	108,156	108,156	108,156
Pseudo R2	0.880	0.870	0.869	0.869

Notes: The dependent variable is a dummy variable that takes a value of one if the transaction is invoiced in euros and zero otherwise. The logit model and robust standard errors were used in all estimations. **, *, and # indicate 1%, 5%, and 10% levels of significance, respectively. The type of fixed effects employed in the estimation is shown in the table and varies across columns.

Figure 1. Invoice Currency Choice in Japanese Trade

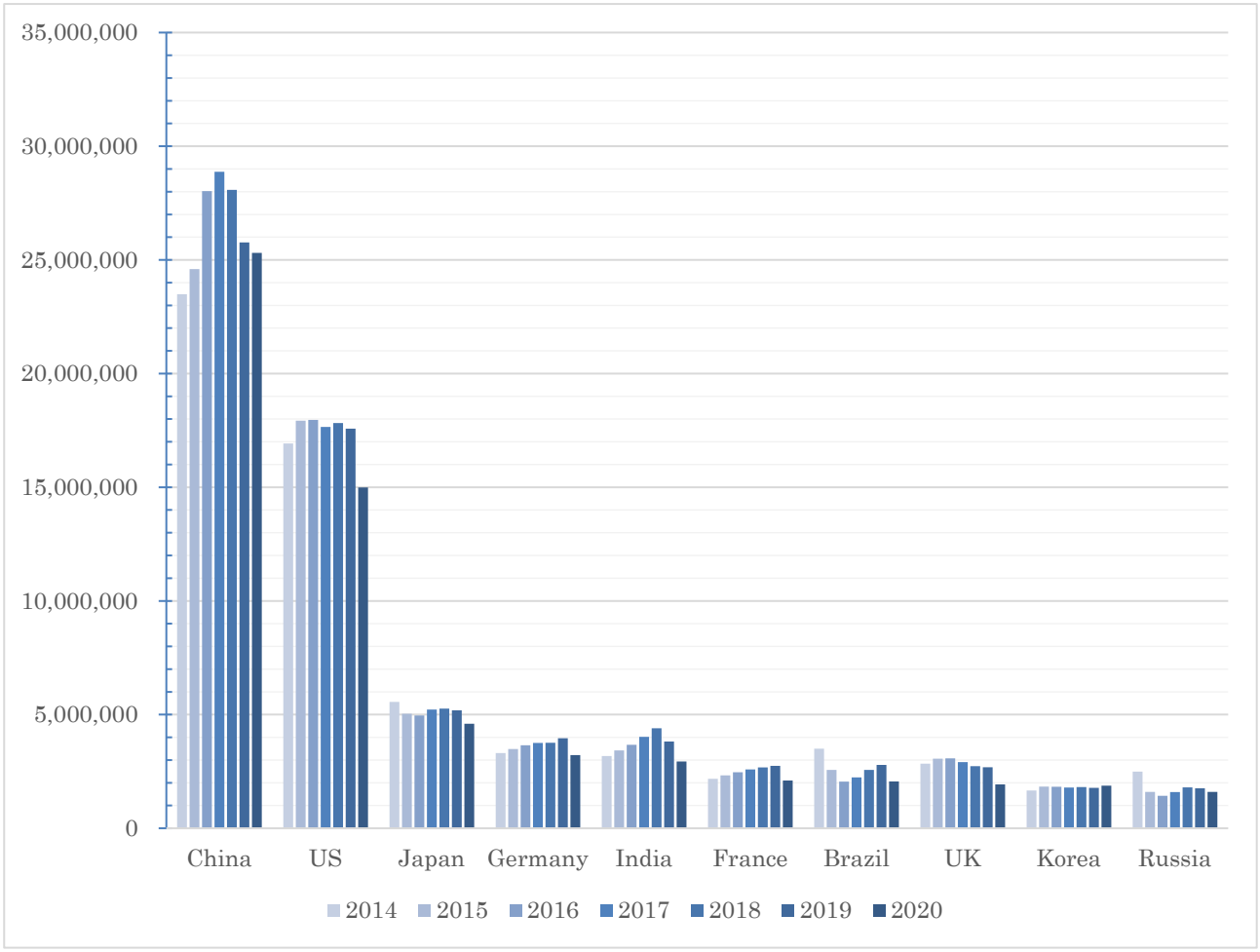


Sources: Japanese customs data

Notes: Invoice currency shares are calculated based on the number of transactions. Panels (a) and (b) show the invoice currency share in total Japanese (all industries') exports to the world and imports from the world, respectively. Panels (c) and (d) present the invoice currency share in sample automobile firms' exports to and imports from EU countries. "Local currency" in Panels (a) and (c) and "Producer's currency" in Panels (b) and (d) indicate the import country's and export country's currencies, respectively.

Figure 2. Japanese Automakers' Sales in 10 Major Countries, Including Japan

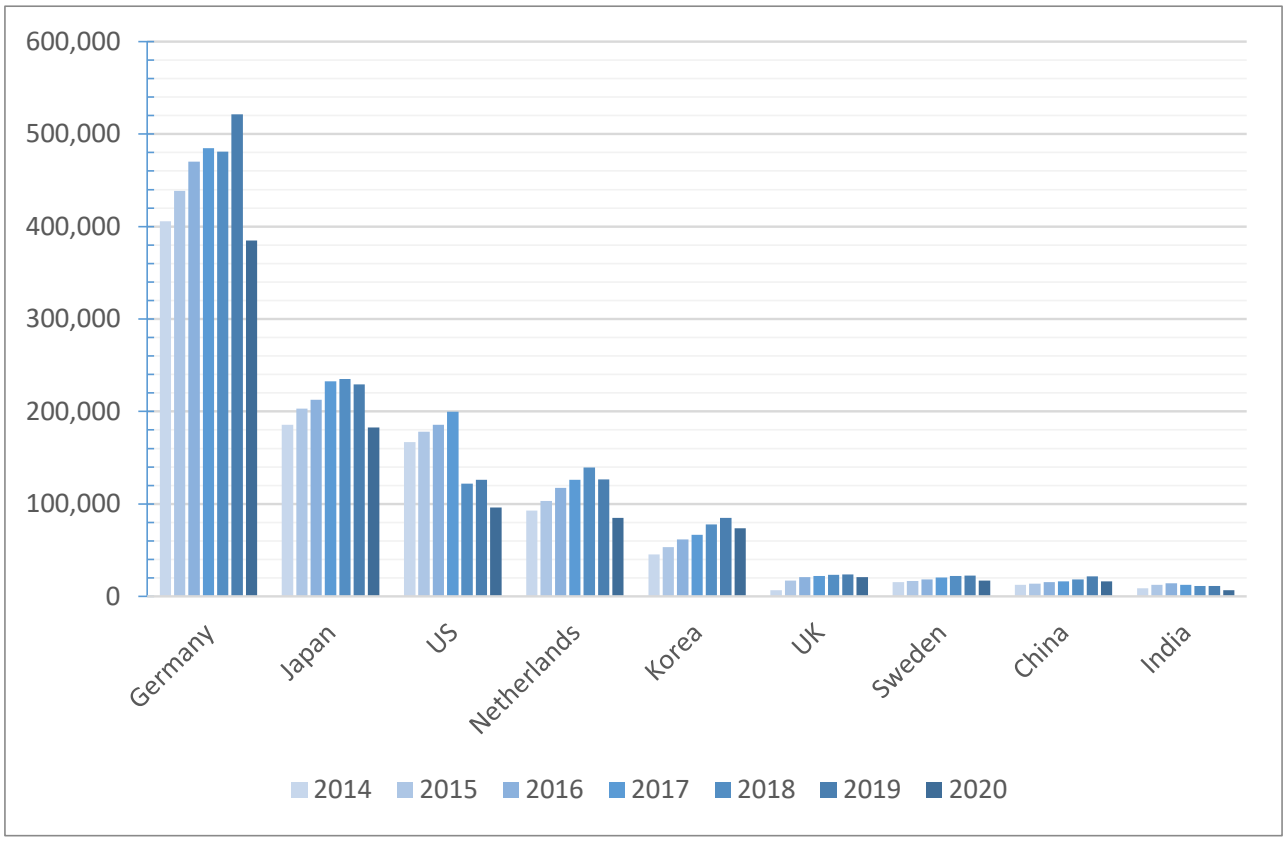
(Number of Unit)



Source: MarkLines Information Platform

Figure 3. Automobile Sales by Foreign Automakers in France

(Number of Unit)



Source: MarkLines Information Platform

Figure 4. Definitions of Foreign Subsidiaries

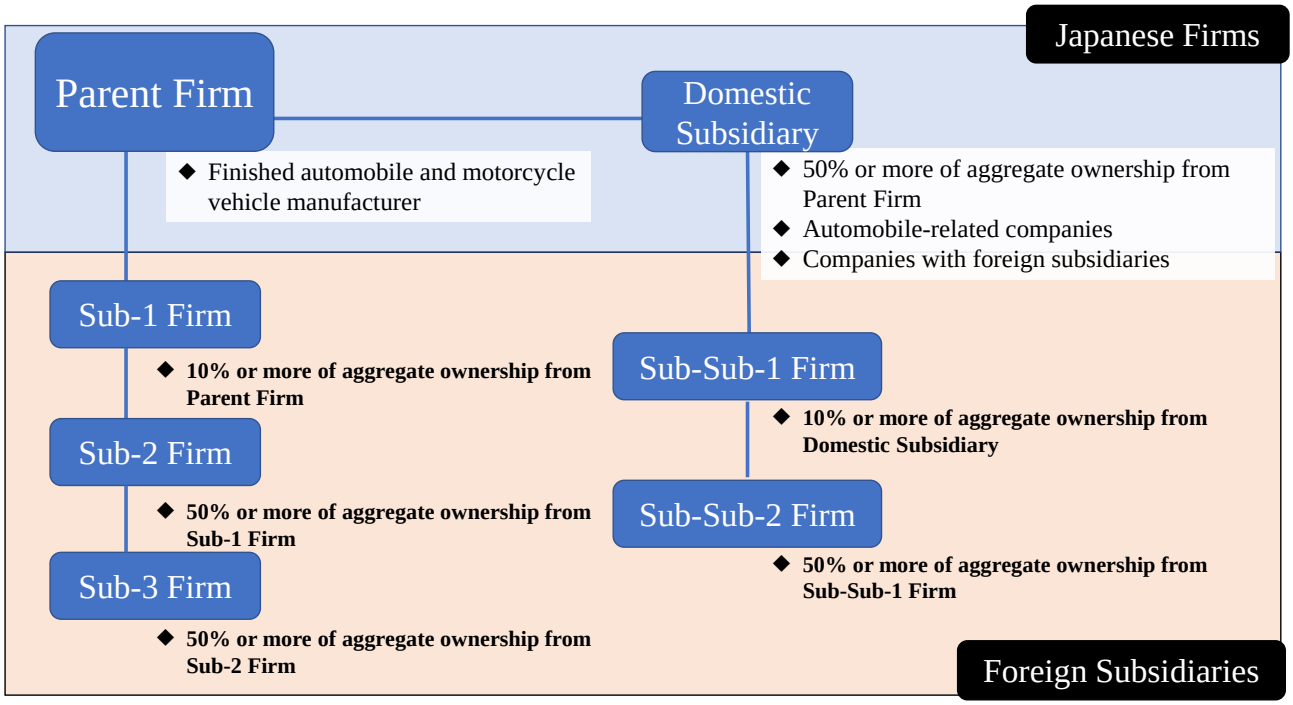
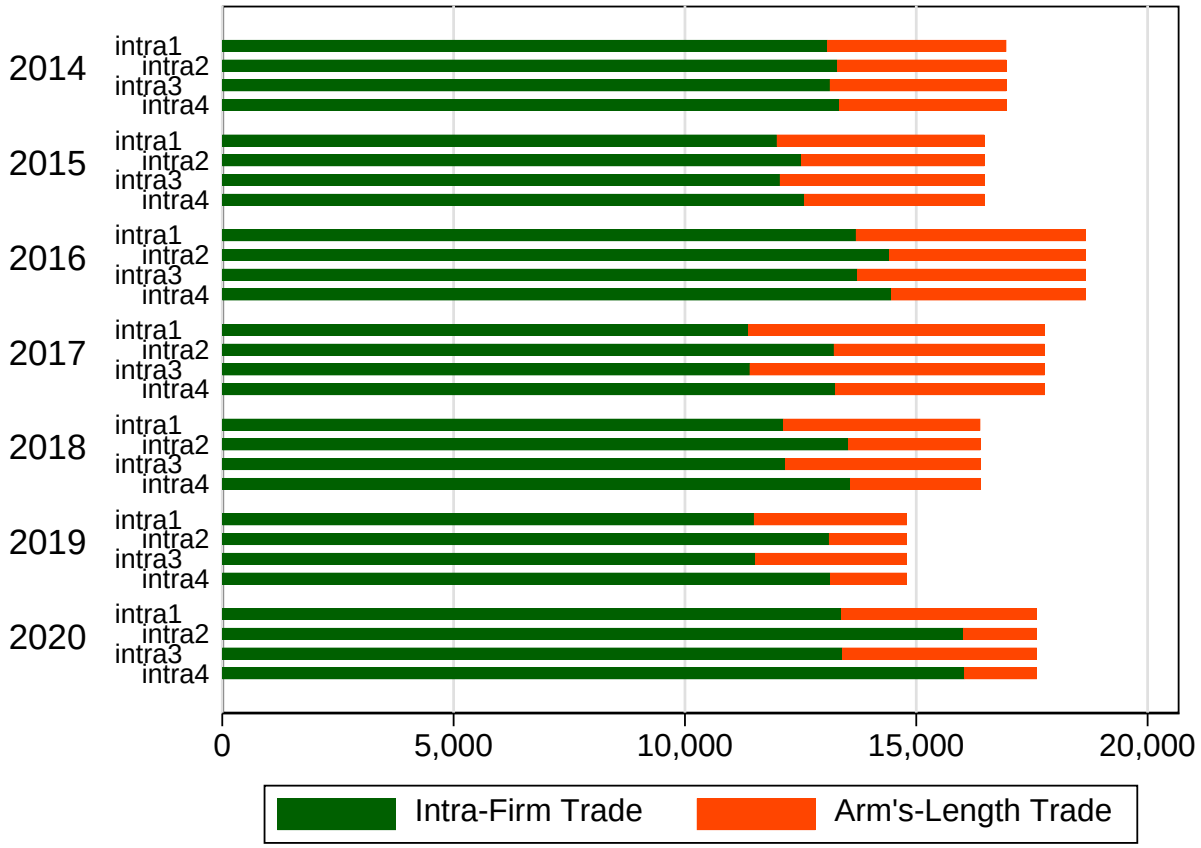


Figure 5. Share of Intra-firm and Arm's-length Exports in the Total Number of Export Transactions



Source: Authors' calculation based on Japanese customs data

Appendix Tables

Table A1. Estimations without 2020 Samples

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)
Intra1	0.233 **	0.097 **	0.097 **	0.098 **	0.244 **	0.268 **		0.094 **	0.074 **
	(0.006)	(0.018)	(0.002)	(0.002)	(0.004)	(0.005)		(0.002)	(0.005)
Ownership Ratio							0.145 **		
							(0.003)		
IIS		0.024 **	0.023 **	0.015 #	0.001	0.061 **	0.016 **	0.016 *	0.007
		(0.076)	(0.008)	(0.080)	(0.002)	(0.004)	(0.008)	(0.007)	(0.007)
FirmMS		0.010 **	0.010 **		0.015 **	0.007 **	0.008 **	0.009 **	0.009 **
		(0.001)	(0.002)		(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
sq(FirmMS)			0.000						
			(0.000)						
ProductMS				-0.034 **					
				(0.003)					
sq(ProductMS)				-0.003 **					
				(0.000)					
LaborProd					-0.680 **				
					(0.008)				
R&D/Sales						-0.124 **			
						(0.007)			
ER								0.145 **	
								(0.012)	
ER Vol.									-0.003
									(0.003)
*Intra * ER Vol.*									0.015 **
									(0.004)
Firm-Product-Year FE	YES	NO	NO	NO	NO	NO	NO	NO	NO
Firm FE	NO	YES	YES	YES	YES	YES	YES	YES	YES
Product FE	NO	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	NO	YES	YES	YES	YES	YES	YES	NO	NO
Model	OLS	Logit	Logit	Logit	Logit	Logit	Logit	Logit	Logit
Obs.	96,943	92,379	92,379	92,379	94,093	94,093	92,379	92,379	92,379
Adj R2 / Pseudo R2	0.928	0.870	0.870	0.867	0.732	0.642	0.878	0.869	0.868

Notes: The dependent variable is a dummy variable that takes a value of one if the transaction is invoiced in euros and zero otherwise. Robust standard errors clustered at the firm level are used in all estimations. **, *, and # indicate 1%, 5%, and 10% levels of significance, respectively. The model and type of fixed effects vary across columns and are shown in Table 1. Adjusted R-squared and pseudo R-squared are reported for OLS and logit regressions, respectively.

Table A2. Clustered Standard Errors

	(I)	(II)	(III)	(IV)
Intra1	0.300 **			
	(0.117)			
Intra2		0.236		
		(0.153)		
Intra3			0.303 *	
			(0.118)	
Intra4				0.236
				(0.155)
IIS	0.233 **	0.330 **	0.234 **	0.331 **
	(0.058)	(0.058)	(0.058)	(0.058)
FirmMS	0.015	0.019	0.016	0.019
	(0.012)	(0.013)	(0.012)	(0.013)
Firm FE	NO	NO	NO	NO
Product FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Model	Logit	Logit	Logit	Logit
S.E. clustering	Firm	Firm	Firm	Firm
Obs.	109,010	109,010	109,010	109,010
Pseudo R2	0.678	0.615	0.677	0.614

Notes: The dependent variable is a dummy variable that takes a value of one if the transaction is invoiced in euros and zero otherwise. The logit model and robust standard error clustered at the firm level are used in all estimations. **, *, and # indicate 1%, 5%, and 10% levels of significance, respectively. Product and year fixed effects are employed in all estimations.

Table A3. Clustered Standard Errors: Market Share and Firm Characteristics

	(I)	(II)	(III)	(IV)	(V)	(VI)
Intra1	0.302 **	0.300 *	0.300 *	0.446 **	0.270 *	0.322 **
	(0.113)	(0.118)	(0.118)	(0.089)	(0.004)	(0.008)
IIS	0.224 **	0.254 **	0.254 **		0.218 **	0.141 **
	(0.060)	(0.067)	(0.067)		(0.002)	(0.004)
IIS_value				0.081		
				(0.085)		
FirmMS	0.072			0.043 #	0.005 **	0.006 **
	(0.050)			(0.025)	(0.001)	(0.001)
sq(FirmMS)	0.004					
	(0.031)					
ProductMS		-0.004 **	-0.022 #			
		(0.006)	(0.012)			
sq(ProductMS)			-0.002 *			
			(0.001)			
LaborProd					0.089 **	
					(0.004)	
R&D/Sales						-0.281 **
						(0.010)
Firm FE	NO	NO	NO	NO	NO	NO
Year FE	YES	YES	YES	YES	YES	YES
Product FE	YES	YES	YES	YES	YES	YES
S.E. Clustering	Firm	Firm	Firm	Firm	Firm	Firm
Model	Logit	Logit	Logit	Logit	Logit	Logit
Obs.	109,010	109,010	109,010	109,010	103,814	103,814
Pseudo R2	0.682	0.673	0.673	0.605	0.730	0.744

Notes: The dependent variable is a dummy variable that takes a value of one if the transaction is invoiced in euros and zero otherwise. The logit model and robust standard error clustered at the firm level are used in all estimations. **, *, and # indicate 1%, 5%, and 10% levels of significance, respectively. Product and year fixed effects are employed in all estimations.

Table A4. Clustered standard errors: ownership ratio and exchange rate variables

	(I)	(II)	(III)	(IV)	(V)
Ownership Ratio	0.324 **				
	(0.005)				
Intra1		0.464 **	0.466 **	0.421 **	0.283 **
		(0.004)	(0.004)	(0.006)	(0.011)
IIS	0.127	0.382 **	0.379 **	0.381 **	0.238 **
	(0.003)	(0.008)	(0.008)	(0.008)	(0.002)
FirmMS	0.004	0.023 **	0.023 **	0.024 **	0.013 **
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ER		0.505 **		0.557 **	
		(0.017)		(0.018)	
ER Vol.			-0.020 **		-0.013 #
			(0.003)		(0.007)
*Intra * Level*				0.035 **	
				(0.004)	
*Intra * ER Vol.*					0.016 *
					(0.008)
Firm FE	NO	NO	NO	NO	NO
Product FE	YES	YES	YES	YES	YES
Year FE	YES	NO	NO	NO	NO
Obs.	109,010	114,246	114,246	114,246	109,010
S.E. clustering	Firm	Firm	Firm	Firm	Firm
Model	Logit	OLS	OLS	OLS	Logit
Adj R2 / Pseudo R2	0.725	0.669	0.666	0.670	0.671

Notes: The dependent variable is a dummy variable that takes a value of one if the transaction is invoiced in euros and zero otherwise. Robust standard errors clustered at the firm level are used in all estimations. **, *, and # indicate 1%, 5%, and 10% levels of significance, respectively. The model and type of fixed effects vary across columns and are shown in Table 1. Adjusted R-squared and pseudo R-squared are reported for OLS and logit regressions, respectively.

Table A5. Baseline Results for *Intra2*, *Intra3*, and *Intra4*

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VII)	(IX)
Intra2	0.293 **			0.619 **			0.199 **		
	(0.007)			(0.003)			(0.008)		
Intra3		0.241 **			0.683 **			0.226 **	
		(0.004)			(0.002)			(0.005)	
Intra4			0.302 **			0.618 **			0.210 **
			(0.007)			(0.003)			(0.008)
Firm-Year FE	YES	YES	YES	NO	NO	NO	NO	NO	NO
Product-Year FE	NO	NO	NO	YES	YES	YES	NO	NO	NO
Firm-Product FE	NO	NO	NO	NO	NO	NO	YES	YES	YES
Model	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Obs.	114,357	114,357	114,357	114,018	114,018	114,018	114,031	114,031	114,031
Adj R2	0.775	0.774	0.775	0.500	0.603	0.497	0.916	0.920	0.917

Notes: The dependent variable is a dummy variable that takes a value of one if the transaction is invoiced in euros and zero otherwise. The linear probability model (OLS) and robust standard errors were used in all estimations. **, *, and # indicate 1%, 5%, and 10% levels of significance, respectively. The type of fixed effects employed in the estimation is shown in the table and varies across columns.