Testing Heterogeneous Incomplete Pass-through: Evidence from Firm-Level Cotton Yarn Export Price Data*

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Abstract

Using firm-level monthly export price data for a highly homogenous product, i.e., cotton yarn in a specific count, set by multiple Japanese firms over the periods from 1897 to 1914 and detailed firm-level attributes, we empirically examines how the pass-through of currency exchange rate depends on firm heterogeneity. The estimate results show, first, that exporter firms' import intensity and firm size were the sources of heterogeneous pass-through as pointed out in Amiti et al. (2014). Second, we also find that the factors related to firms' funding, which are proxied for by the average funding rates and inventory turnover, were closely related to the heterogeneity in pass-through. Third, different levels of wages for female workers, which can be interpreted as a proxy for productivity and/or product quality, also led to heterogeneous pass-through. These results imply that multiple firm-level factors simultaneously affect the degree of heterogeneity in pass-through.

Keywords: Exchange rate pass-through; Firm heterogeneity
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1. Introduction

Many extant studies have pointed out the weak relation between export price measured in local (i.e., destination) currency and the currency exchange rate between the local and home currencies. Such a sticky dynamics of local currency-measured price is called as “incomplete pass-through” and has been one of the important research topics in international economics and macroeconomics. Such sluggish price movement in local currency-measured export price is referred to explain the low elasticities of export and import quantities to the change in exchange rate.

One major explanation for the incomplete pass-through is firms’ pricing-to-market behavior. It takes the form, for example, that export firms raise its export price measured in home currency when the home currency depreciates against the local currency in destination country. Under the pricing-to-market behavior, when home currency for exporter firms depreciates 10% against destination currency, the export firms on average raise its home currency-measured export price by x% so that the firms decrease its destination currency-measured export price by (10-x)%. As far as the production cost is kept constant, this leads to the increase in firms’ mark-up by x%. While the incomplete pass-through comes from the adjustment of mark-up in this illustration, the change in marginal cost, which is assumed to kept constant, also affect the level of incomplete pass-through. For example, if firms import intermediate goods from the country to which they export final goods, depreciation of home currency against the destination currency leads to the increase in its marginal cost measured in home currency. In the case that firms import intensity is higher, the firms need to increase the home currency-measured export price more.

As implied by these discussions, such incomplete pass-through and pricing-to-market could be heterogeneous among firms. Extant theoretical studies have provided various illustrations that incomplete pass-through is observed under the specific firm attributes. Using custom information and based on the claim that firms’ productivity is the sufficient statistics for various theoretical illustration, for example, Berman et al. (2012) empirically confirm that firms with higher productivity actually exhibit incomplete pass-through. Based on a slightly different model, Amiti et al. (2014) claims that firms' import intensity and market share are the sufficient statistics for incomplete pass-through and confirm that their conjecture is supported by data. Overall, the extant studies have confirmed the implication of firm heterogeneity in the context of incomplete pass-through.

While the question is well defined and studied extensively, there are still two controversial issues in the literature. First, the export price information used in the extant studies are unfortunately less than ideal. For example, it is common to use the unit value computed from export value and quantity data obtained from custom data. However, it is obvious that such data can mix up variety of products belonging to different categories. As one exception, Fitzgerald & Haler (2014) use monthly observation on prices of products classified in SIC 8-digit level detailed classification. However, there is still the same problem. To illustrate, in the SIC 8-digit classification, the code 22810302 accounts for "COTTON YARN, SPUN". Although this looks a finely measured category, there are in fact many type of cotton yarn belonging to different "counts", which represents the thickness of yarn. In modern clothing, dress shirt is made of 40-120 count cotton yarn while casual shirt is made of 20-80 counts. Mixing the products belonging to different categories in the analysis of incomplete pass-through definitely leads to the bias in the empirical results as, for example, such an analysis can be contaminated by firms' choice of export product.

Second, there are potentially many theoretical ways to generate incomplete pass-through as pointed out, for example, in Gopinath (2013). In her discussion commeting on Strasser (2013), which intends to establish the relation between incomplete pass-through and financial friction faced by firms, she wrote "*It is therefore important to control for other firm level factors before attributing causation to financial friction.*" Unfortunately, simply because it is not generally easy to obtain various firm attributes that can be appropriately used to study the sources of incomplete pass-through, therea re only a few studies successfully incorporating a comprehensive list of firm characteristics.

Against these backgrounds, we think the contributions of the present paper are three-fold. First, the hand collected information on firm-level export price of a highly homogenous product, i.e., cotton yarn in a specific count (i.e., 16 count and 20 count) in our analysis, allows us to implement much more precise empirical analysis that the extant studies using problematic export price information. Second, the data set, which is hand collected from a huge number of industry reports for cotton yarn industry in Japan, allows us to incorporate wide variety of firm attributes to our empirical analysis. The information in the dataset ranges from firms' production activities, financial statement, geographical location, and import status of intermediate goods. Third, we should also note that the empirical study using firm-level data and testing the abovementioned theoretical prediction is still scarce. In particular, there is almost no studies using precise export price measure comparable to Fitzgerald and Haler (2014) with a larger set of controls and its interaction with currency exchange rate than the extant studies such as Berman et al. (2012). We believe that our analysis of incomplete pass-through using fine price information and a comprehensive firm attributes could contribute to the better understanding of firms' export price choice.

As a major finding from our panel estimation for incomplete pass-through using firm-month level data, we find, first, that exporter firms' import intensity and firm size were the sources of heterogeneous pass-through as pointed out in Amiti et al. (2014). Second, more importantly, we also find that the factors related to firms' funding, which are proxied for by the average funding rates and inventory turnover, were also closely related to the heterogeneity in pass-through. Third, different levels of wages for female workers, which can be interpreted as a proxy for productivity and/or product quality, further led to heterogeneous pass-through. These results imply that multiple factors simultaneously generate the heterogeneous pass-through.

The organization of the remained parts of this paper is as follows. In section 2, we overview the related literature. Section 3 is used to provide theoretical framework as theoretical underpinnings of the hypotheses tested in the paper. In section 4, we detail the data used in our analysis and the empirical framework, followed by the presentation of empirical results and discussion in section 5. Section 6 concludes and provide potential avenue for future researches

2. Related Literature

From the theoretical viewpoint, extant studies have been providing various explanations for the mechanisms leading to heterogeneous exchange rate pass-through. First mechanism is based on heterogeneous markup set by individual firms. To illustrate, facing lower demand elasticity with respect to price, firms are induced to set higher markup. If such firms facing lower demand elasticity further experience the depreciation of home currency, which leads to the lower relative cost of production, such firms are induced to increase their mark-up largely. Thus, it is a key for constructing theoretical models generating heterogeneous pass-through to have the heterogeneity in demand elasticity faced by exporter firms. In Melitz and Ottaviano (2008), for example, this is achieved by assuming a linear demand function with horizontal product differentiation while Atkeson and Burstein (2008) employ CES demand function and Cournot competition. In their model, firms with higher productivity face lower demand elasticity through either low price (Melitz and Ottaviano 2008) or higher market share (Atkeson and Burstein 2008). In the similar vein, heterogeneity in product quality can be used to model the firms facing various demand elasticity as in Baldwin and Harrigan (2011). Given these discussion, Berman et al. (2012) have empirically confirmed that the incomplete pass-through has its interaction with firms' productivity.

Second, the structure of production cost affects the way of export price to react to the fluctuation in currency exchange rate. For example, Amiti et al. (2014) take into account the endogenous determination of import intensity of intermediate goods and show that firms with higher import intensity tends to increase home currency-measured export price more largely as home currency depreciates against the currency in the source country of imported intermediate goods. This reflects the mechanism that production cost increases as home-currency depreciates, which induce firms to increase the home currency-measured export price. Using the similar model environment to Melitz and Ottaviano (2008) and further assuming multiple products, each of which differ in terms of the distance to the "central" product, Chatterjee et al. (2013) show that firms increase the home currency-measured price less as the home currency depreciates if firms treat the product as "non-central” product. This result is based on the assumption that the marginal cost of non-central (e.g., outdated or niche product) is higher than central products due to the difference in delivery cost in destination market. Such difference in the share of distribution cost in the destination country is directly used to generate heterogeneous pass-through (Corsetti and Dedola 2005). In the similar vein. Strasser (2013) points out that financial friction faced by exporter firms also affect the degree of incomplete pass-through.

While these papers focus on a specific theoretical underpinning behind heterogeneous pass-through, there is a strong criticism (e.g., Gopinath 2013) for the analyses naively assigning the sources of incomplete pass-through to specific factors. A number of papers have been trying to decompose the determinants of incomplete pass-through to several key factors. For example, Nakamura and Zerom (2010) find that local (i.e., destination country) costs reduce long-run pass-through by 59% relative to a Constant Elasticity of Substitution benchmark while markup adjustment reduces pass-through by an additional 33%. They also show that the estimated menu costs have a negligible effect on long-run pass-through but are quantitatively successful in explaining the delayed response of prices to costs. Goldberg and Hellerstein (2013) also find that 60% of the incomplete exchange rate pass-through is due to local non-traded costs, while 8% is due to markup adjustment and 30% is due to the existence of own brand price adjustment costs. They also assign only 1% to the indirect/strategic effect of such costs. These discussions necessitate the simultaneous utilization of multiple factors affecting incomplete pass-through in empirical analysis.

Apart from the theoretical mechanism leading to heterogeneous pass-through, the extant studies have been also putting great effort to set up appropriate data to study exchange pass-through. Most of the papers cited above have employed custom information. As one important exception, Fitzgerald and Haller (2014) employs the export prices of the products classified by SIC 8 digit-level from the plants located in Ireland to U.K. and confirm that the pass-through rate is extremely low in their sample. In other words, they found that producers allow the markup in the foreign market to increase one-for-one with depreciations of the home currency. As illustrated in the introduction, however, there is still some room for mixing up various products in one category even in the 8-digit SIC classification.

As one important studies featuring Japanese firms' export price determination, Marston (1990) employs BOJ's price information for 17 final products from 1979 to 1987 and find the evidence of pricing to market and the degree of pricing-to-market was higher in periods when the yen appreciated. He claims that the estimated degree of pricing-to-market represents variations in the margin planned by Japanese firms to keep their products competitive abroad. In the context of Japanese firms' export price setting, another important example, Sazanami et al. (1997) analyze the movements of tradable goods prices in Japan and find that, for a number of commodities, the import prices do not decline as far as the exchange rate appreciates. In the export-side analysis, they find that the export path-through rates tend to be low when the value added ratios of foreign production of Japanese firms are high. They argue that while low export pass-through under currency appreciation is often interpreted as a result of firms' attempts to keep their foreign market share, the globalization of firms' activities may be another important factor in lowering the pass-through.

3. Theoretical underpinnings

In this section, we illustrate the theoretical framework leading to our testable hypothesis. We specifically aim at providing a sketch of a parsimonious theoretical model where a broad set of firm attributes affect incomplete pass-through. Note that we do not intend to provide a model featuring any specific determinants of incomplete pass-through. Instead, we will show that multiple firm-level factors can simultaneously generate the heterogeneous pass-through, which motivates our empirical study incorporating many firm attributes.

3.1. Demand

Following the theoretical environment demonstrated in Atkeson and Burstein (2008) and further extended in Amiti et al. (2014), first, we assume that an exporter firm-*i* is facing the following demand in destination market.

$$Q(i) = k(i)P^*(i)^{-r}P^{*r-f}D$$

The left hand-side of the equation denotes the residual demand faced by firm-*i* while *k(i)* denotes the preference factor for firm-*i*'s products (e.g., quality), $P^*(i)$ and P^* denote the export price of firm-*i* and price index measured in destination-currency, respectively, and *D* denotes the aggregate demand shifter in destination market. Among the variables in the right hand-side of the equation, *r* and *f* stand for the elasticity of substitution across the goods in the same category (i.e., a specific count cotton yarn in our analysis) provided by various exporter firms to the destination market and the elasticity of substitution across sectors (e.g., different count of cotton yarns).

Equating the marginal revenue and marginal cost faced by firm-*i*, which are heterogeneous in terms of a multiplicative markup *M(i)* and marginal cost $MC^*(i)$, we can obtain the following optimal price setting rule.

$$P^*(i) = M(i)MC^*(i) = s(i) / \{s(i) - 1\}\ MC^*(i)$$

where *s(i)* denotes the destination currency-measured price elasticity of demand faced by firm-*i*. Note that, using *S(i)*, which represents the share of firm-*i*'s export to the destination market (i.e., $S(i) = P^*(i)Q(i) / \sum_{i'} P^*(i')Q(i')$), *s(i)* can be rewritten as $s(i) = r\{1-S(i)\} + fS(i)$. Furthermore, the price elasticity of the markup factor can be written as the following:

$$G(i) = S(i) / [\{r/(r-f) - S(i)\}\{1 - (r-f)/(r-1)S(i)\}]$$

These expressions imply that firms with lower price obtain larger share, which also leads to higher markup and higher markup elasticity.

3.2. Technology

In order to illustrate the production technology owned by firm-*i*, we assume that the cost function *C(Q(i),O(i))* to produce *Q(i)* depends on the technology component *O(i)*, which incorporates productivity, access to better intermediate goods, better access to financial sources, higher managerial ability, and so on. As pointed out, for example in Gopinath (2013), it is definitely important to control for various firm level characteristics to attribute causation of incomplete pass-through to any specific factors simply because this technology component can account for potentially many issues.[5]

Under these environments, the profit maximization problem solved by firm-*i* can be written as follows.

$$\max \{eP^{*}(i)Q(i) - C(Q(i),O(i))\}$$

where *e* stands for the currency exchange rate measured as the ratio of home currency to destination currency. In other words, larger *e* denotes the depreciation of home currency. Using the home currency-measured export price *P(i)* and home currency-measured marginal cost *MC(i)*, we write down the optimal price setting rule as follows:

$$P(i) = M(i)\, MC(i)$$

Thus, we can rewrite this expression as in a log form and a full log differential:

$$\log P(i) = \log M(i) + \log MC(i)$$

[5] Amiti et al. (2014) also posit "*This theoretical framework has two sharp predictions about the markup. First, the variation in the market share fully characterizes the variation in the markup elasticity across firms. As we discuss in the introduction, this is less than general, and alternative demand structures emphasize other determinants of markup variability.*"

$\Delta log P(i) = \Delta log\, M(i) + \Delta log\, MC(i)$

This is the equation we employ in the following empirical analysis. We should note that the markup *M(i)* and marginal cost *MC(i)* could depend on various factors including the preference factor *k(i)*, the aggregate demand shifter *D*, the two elasticities of substitution *r* and *f*, the shape of cost function *C(Q(i),O(i))*, and the currency exchange rate *e*.

3.3. Tested hypothesis

As demonstrated in the optimal pricing rule, optimal price depends on both the level of markup and the level of marginal costs. First, the markup factor depends on the price elasticity of demand. This elasticity further depends on currency exchange rate, the level of home currency-measured export price, which is correlated with firm productivity, market share, the elasticity of substitution across the good provided by exporter firms to the destination market, the elasticity of substitution across sectors, and the preference factor for firm-*i*'s products. Given the change in exchange rate is the main driver of the change in export price, we focus on the direct effect of the exchange rate dynamics and its interaction with other factors in the context of the determination of export price measured by *P(i)* (i.e., home currency-measured export price). This leads to the following first and the second testable hypotheses:

Hypothesis 1: There is a systematic relationship between the change in currency exchange rate and home currency-measured export price.

Hypothesis 2: The systematic relationship between the change in currency exchange rate and home currency-measured export price has additional interaction effect with other firm attributes including firm productivity, firm size, and firm quality.

Second, regarding the marginal cost, it depends on productivity, import share of intermediate goods, management quality, and access to financial sources. Furthermore, the discussion in Chatterjee et al. (2013) predicts that the marginal cost also depends on how the product is close to the central product for firm-*i*. These lead to another testable hypothesis:

Hypothesis 3: The systematic relationship between the change in currency exchange rate and home currency-measured export price has additional interaction effect with other firm attributes including firm productivity, import intensity, financial cost, and the position of exported product in firms' production process.

4. Data and Methodology

4.1. Data overview

The dataset used in this paper consists of three data sources. First, firm-level export price measured in monthly frequency is obtained from the monthly industrial report in cotton yarn industry. Such report "*Dainipponn boseki rengokai geppo*" stores various information related to the cotton yarn industry and, most importantly, individual firms. Among the information recorded in the report, we hand collect the firm-level export price for cotton yarn to a specific market, i.e., Shanghai market, in China over the periods from May 1897 to December 1914 with multiple time gaps corresponding to, for example, Japan-Russo war. The original export price data are measured in *ryo*, which is the currency used in China in the periods. These data are reported by individual firms in each month and consist of multiple entries for each firm-month combination in many cases. In the case that the export prices associated with one individual firm in a specific month are recorded multiple times, we compute the monthly average price associated with one individual firm in a specific month and label as P^*. We should note that Japan introduced the gold-standard for its currency system in 1897 while China was using the silver-standard for its currency until 1935. This led to the exogenous fluctuation in the currency exchange rate between Japanese *yen* and Chinese *ryo* for individual firms. Multiplying this currency exchange rate *ER* measured as a unit of *yen* per one *ryo*, which we obtain from *Nihon Keizai Soran* (Japanese Economic Data Almanac), we convert the *ryo*-measured export price data stored in the monthly-report to *yen*-measured export price *P*. In the monthly industry report, the price information mainly account for two specific counts of cotton yarn, i.e., 16 counts and 20 counts, the former of which is thinner than the latter. We use *P* to denote the yen-measured export price of 16 counts cotton yarn while *P_20* to denote that of 20 counts.

The second data source is the production related information for each firms. This dataset contain the detailed information about firms' production process, which include the level of output measured in a physical unit (i.e., *kori*), the number of male and female workers, wages for male and female workers, the size of capital stock used for the production, and the operating level of workers and capitals. We use the information to compute the log of time-variant total output (*SIZE*), the time-variant capital utilization rate (*CAPUTIL*), and the time-variant total-factor-productivity (*TFP*) for each firm. In the computation of *TFP*, we assume a standard Cobb-Douglas production function and employ either firm-level fixed-effect estimation or Arellano-Bond type GMM estimation. Figure 1 plots these two TFP measures in vertical axis (fixed-effect) and horizontal axis (GMM). The production related information also contain the share of 16 counts cotton yarn in each firms' production (*SHARE*) and the import share of cotton from China out of all the other importing source countries (*IMPORT*). In order to proxy for the quality of product, we also compute the log of female wage (*WAGE*). We do not use *WAGE* as a proxy for productivity but that for quality in the following reason. First, from writings in the industry report we consult on to obtain the production and business environments at that period, we found that the female workers labor skill was a critical factor determining the product quality. As already detailed, we use a specific-count of cotton yarn (16 count) in our empirical analysis, thus the type of product is highly homogeneous. Nonetheless, there are variety of product quality in terms of whiteness of the cotton yarn, which could be damaged by oil stain caused by sloppy handling of the product by unskilled female workers in production process. As the level of wage for female workers is appropriate to proxy for the labor skill, we use *WAGE* to represent product quality. Obviously, this wage variable is also related to productivity. By simultaneously incorporating *TFP* in our estimation as well as *WAGE*, we study the marginal impact associated with *WAGE* conditional on the level of *TFP*, which explicitly controls for firm productivity.

The third data source is the financial statement for individual firms. We use this dataset to compute the ratio of the sum of inventory and account receivable to sales, which denotes the turnover of inventory (*INVENTORY*). This turnover measure accounts for the level working capital in each firms' business operation. We use this variable to proxy for firms' financial constraint. Namely, if firms exhibits higher *INVENTORY*, we assume that firms are facing larger working capital need, thus higher financial friction. We also use discount rate set by Bank of Japan (*RATE*) as a proxy variable for firms' funding condition.

The constructed firm-month level data accounts for the periods from May 1897 to June 1898, October 1901, April 1902 to December 1903, and June 1911 to December 1914. In this sense, the data periods do not contain the periods of Russo-Japan war but a part of the World War I. The data size is, at most, 32 firms and 517 observations. As we include a larger set of control variables, the sample size decreases up to 18 firms and 189 observations. Table 1 shows the summary statistics of the data used for each estimation detailed below. All the control variables (i.e., *TFP*, *WAGE*, *SIZE*, *INVENTORY*, *SHARE*, and *CAPUTIL*) except for *IMPORT* are demeaned by using the average levels of the largest dataset.

4.2. Empirical framework

The hypotheses constructed in the previous section can be tested through the estimation of the following firm-level equation (1):

(1) $$P_{it} = b_0 + b_1 ER_t + b_2 ER_t \times INTERACTION_{it} + b_3 INTERACTION_{it} + I_i + e_t$$

Following Berman et al. (2012), the left hand side variable (P_{it}) is the natural logarithm of export price measured in home currency *yen*. ER_t stands for the natural logarithm of exchange rate measured as the ratio of home currency *yen* to destination currency *ryo*. Thus, the large number of ER_t corresponds to the depreciation of *yen* against *ryo*. I_i and e_t denote the firm-level fixed-effect and disturbance term.

The important claim in Berman et al. (2012) is that by using the firm-level productivity (*TFP*) for $INTERACTION_{it}$, we can test the abovementioned empirical implication. To be more precis, Berman et al. (2012) hypothesize that both b_1 and b_2 take positive sign, which implies that firms with higher productivity raises home currency-measured export price more largely than that with lower productivity as facing the depreciation of home country currency.

Berman et al. (2012) employ a large dataset obtained from custom information and successfully confirm the connection between heterogeneous pricing-to-market and firm-level characteristics. As almost all the extant studies in this literature, Berman et al. (2012) employ custom information to compute the unit value as the ratio of export value divided by export volume. Although they use narrow product category to measure the unit value, it is always problematic to treat potentially heterogeneous products as one product. One exceptional study using fine category for products is Fitzgerald & Haler (2014) that use monthly observation on prices charged by the same plant for the same product to buyers in Ireland and the U.K. In their study, focusing on the cases where export price actually changed (i.e., conditional on price change), they estimate the following equation (2) for the euro-measured (i.e., home currency for Ireland) export price P_{it} of the products exported to UK on the exchange ratio of euro and sterling pound. ER_t accounts for the natural logarithm of “x euro per one sterling”, where larger number corresponds to depreciation of euro, with various controls.

$$(2) \qquad P_{it} = c_0 + c_1 ER_t + c_2 INTERACTION_{it} + I_i + e_t$$

What they found is that the estimate c_1 is very close to one. This implies that, facing 10% depreciation of euro against sterling, the Ireland export firms raise the euro-measured export price 10% without largely changing the sterling-measured export price. We should note that they are not using interaction term as in Berman et al. (2012).

To estimate the equation, we use (a) firm-level fixed-effect estimator as in the quation (1) as well as (b) Hybrid random-effect model proposed in Allison (2009) and (c) correlated random-effects model, the former and latter of which are formulated as in the equation (3) and (4), respectively.

$$(3)\quad P_{it} = d_0 + d_1(ER_t - ER\_AVR) + d_2(ER_t \times INTERACTION_{it} - ER \times INTERACTION\_AVR) + d_3(INTERACTION_{it} - INTERACTION\_AVR) + d_4 ER\_AVR + d_5 ER \times INTERACTION\_AVR + d_6\, INTERACTION\_AVR + R_i + e_t$$

$$(4)\quad P_{it} = f_0 + f_1 ER_t + f_2 ER_t \times INTERACTION_{it} + f_3 INTERACTION_{it} + f_4 ER\_AVR + f_5 ER \times INTERACTION\_AVR + f_6\, INTERACTION\_AVR + R_i + e_t$$

where the variables *x_AVR* denote the average level of the variable x computed over the sample periods and R_i denotes the random-effect. These two models incorporate such average levels of indenepdent variables and its interaction term as well as either the deviation of the variables from the average level or the variable itself to study the empirical implication associated with each independent variables with controlling for the time-invariant attributes associated with each firm (i.e., the averaged variables). We are mainly interested in (b_1 , b_2), (d_1 , d_2), and (f_1 , f_2). Note that, in order to extract the actual price change, we only use the sample where *ryo*-measured export price actually changed (Nakamura and Zerom 2010; Goldberg and Hellerstein 2013).

5. Empirical analysis

5.1. Estimate results

Table 2 summarizes the estimation based on the equation (1) using only *TFP* as the component of $INTERACTION_{it}$. First, the estimate results in the first column show that depreciation of *yen* led to higher export price measured in *yen*. More precisely, 10% depreciation of yen against *ryo* led to almost one-for-on (i.e., 10.67) increase in *yen*-measured export price. This result is confirmed in the model using *TFP* as the $INTERACTION_{it}$. In the second column, the estimated coefficients imply that, in the case of average *TFP* (i.e., *TFP*=0), facing 10% depreciation of *yen* against *ryo*, export firms did not largely change *ryo*-measured price. Interestingly, the size of pricing-to-market in the case of the average *TFP* level is comparable to that in Fitzgerald & Haler (2014) but much higher than Berman et al. (2012), i.e., 0.84% in home country currency-measured export price as 10% depreciation of home currency against destination currency. From the second and third columns, which correspond to the estimate results from the equation (3) and (4), we can also see that regardless of the estimation methods, the similar estimate results are obtained.

Second, the quantitative implication associated with interaction term is as follows. Qualitatively consistent with Berman et al. (2012), higher TFP led to larger increase in *yen*-measured export price in the case of *yen* depreciated. From Table 1 and 2, given one standard deviation of *TFP* is 0.13, if exporter firms exhibit higher *TFP* than the average (0.00) by one standard deviation, 10% depreciation of *yen* against *ryo* leads to almost one-for-one (12.512% = 1.024 + 1.748*0.13) increase in *yen*-measured export price. From the similar computation, on the other hand, if exporter firms exhibit lower *TFP* than the average (0.0) by one standard deviation, 10% depreciation of *yen* against *ryo* leads only to7.967% (= 1.024 – 1.748*0.13) increase in *yen*-measured export price. This also means that exporter firms with lower productivity decreases *ryo*-measured export price by 2.033% when they face 10% depreciation of *yen* against *ryo*. Figure 2 depicts the impacts of TFP difference onto the yen-measured export price by using one specific export firm (i.e., *Kanegafuchi boseki*) as one example. In the figure, based on the estimate result in the second column in Table 2, the solid bold line denotes the predicted export price (measured in *yen*) for *Kanegafuchi boseki.* We also plot the predicted values of *yen*-measured export price in the case of the firms with higher (fine solid line with "+") and lower

TFP (fine dashed line with) by one standard deviation to the actual TFP of *Kanegafuchi boseki*. The shaded area denotes the *yen*/*ryo* exchange rates measured in the right axis. We can easily see the difference in *TFP* generates a significant difference in the export price dynamics. Similar results are obtained from Table 3 where we estimate *TFP* through Arellano-Bond type system GMM estimation.

Third, from Table 4 where we add *WAGE* and *SIZE* to the list of $INTERACTION_{it}$, we can find that the interaction terms between *ER* and these variables show the similar pattern to *TFP*. To be more precise, controlling for *TFP* as an independent variable, we confirm that firms with higher female wage and/or output size exhibit higher sensitivity of *yen*-measured export price to the fluctuation in the currency exchange rate. This means that firms with higher *TFP*, *WAGE*, and *SIZE* show lower pass-through to *ryo*-measured export price. If we interpret the level of *WAGE* as the quality of products as discussed in the previous section, this finding can be interpreted as the result consistent with the theoretical prediction in Baldwin and Harrigan (2011). Similarly, if we interpret the level of *SIZE* as the market share, this finding is consistent with that in Atkeson and Burstein (2008). One important finding is that these three variables work as valid $INTERACTION_{it}$ simultaneously.

Fourth, in Table5, we show the estimate results based on the model including further $INTERACTION_{it}$, i.e., *IMPORT*, *INVENTORY*, and *RATE*. We should note that among these variables, only *IMPORT* is not time-variant so that it enters the equation only through the interaction term with *ER*. After incorporating such a comprehensive list of variables to our analysis, *WAGE* still works as an important determinant of the heterogeneous pass-through. As we interpret *WAGE* as a proxy for product quality, which is closely related to preference factor included in the margin factor, we can claim that the mark-up channel is confirmed in our empirical analysis. On the other hand, *TFP* and *SIZE* lose its significance.

Interestingly, we can see that firms with higher import intensity of cotton from China shows higher sensitivity of *yen*-measured export price to the fluctuation of currency exchange rate, which is consistent with the finding in Amiti et al. (2014). As the import intensity is not related to the margin factor in the optimal price setting rule, we can interpret this result as a supporting evidence for valid marginal cost channel.

About the two variables we intend to use as the proxies for firms' funding cost, we find that firms with higher inventory turnover, which could be associated with higher financial constraint, shows lower sensitivity of *yen*-measured export price to the fluctuation in the currency exchange rate. This means that firms with higher financial constraint shows higher pass-through on *ryo*-measured export price, which is consistent with the claim in Strasser (2013). We should note that the result is confirmed under a comprehensive list of controls. Somewhat inconsistent with this result, firms in the periods associated with higher BOJ discount rate, which is presumed to be periods with higher funding cost, shows the higher sensitivity of *yen*-measured export price to the fluctuation in the currency exchange rate. This means that firms facing higher financial constraint shows lower pass-through on *ryo*-measured export price. We should note that the periods with higher BOJ discount rate is also the periods with lower consumer price index. In recent studies such as Taylor (2000), it is pointed out the firms' price resetting tends to be less frequent during low inflation periods. Our result implies that during the periods with low inflation, firms respond to the fluctuation of currency exchange rate more when they set the *yen*-measured export price. This generically means that firms tended to be less frequent in their *ryo*-measured price setting during low inflation periods. We should need to scrutinize this result by taking look at, for example, the inflation rate in destination country.

5.2. Robustness

We have so far focused on the bilateral relationship between Japan and China with ignoring other countries such as India (i.e., a country where another major exporters to Shanghai market locate), U.S., Hong Kong, Vietnam, and Egypt (i.e., major import source of cotton). In particular, the pandemic episode of plague in Bombay 1986, which lasted for several years critically affected Japanese exporters' behavior. From a different point of view, we should take into account the channel through import intensity associated with other source countries than China. Given these backgrounds, we estimate the models with multiple currency exchange rates between yen and other currencies (i.e., rupee, US dollar, and shilling), the import intensity for cotton from multiple countries, and the interaction terms. Table 6 summarized the estimate results. We can see that the results obtained in the previous tables are basically intact. To be more precise, the interaction terms between *ER* and *WAGE*, *IMPORT*, *INVENTORY*, and *RATE* are still statistically significant and show the consistent signs with the previous results even after controlling for the additional factors. Regarding the additional factors, depreciation of yen to US dollar (larger *ER_D*) led to higher export price measured in yen. We also found that firms with higher import intensity with respect to U.S. (*IMPORT_D*) show higher sensitivity of yen-measured export price to the fluctuation of US dollar, which is similar feature to that with *IMPORT* and *ER*. Unlike our prediction, the yen to rupee exchange rate (*ER_R*) and its interaction with import intensity with respect to India do not show any significant coefficients. Somewhat surprisingly, the depreciation of yen to shilling (*ER_S*) led to lower export price.

In Table 7, we further show the results incorporating the raw number of the main count for each firm's production (*MAINCOUNT*) and a dummy variable taking the value of one when *MAINCOUNT* is higher than16 count (*HIGHCOUNT*). We predict that firms with focusing higher count cotton yarn than 16 count, which can be interpreted as firms treating 16 count as non-central product, show lower sensitivity of *yen*-measured export price of 16 count cotton yarn to the fluctuation of the currency exchange rate as claimed in Chatterjee et al. (2013). Also, if export firms face a plenty of domestic demand for its 16 count, they can export only when it is profitable to do so. In this sense, product cycle is one key determinant of pricing-to-market behavior. A simple prediction is that firms producing more outdated product are more likely to show lower pricing-to-market (i.e., cannot increase profit margin even when facing yen depreciation) since those firms anyway need to export. However, we could not find any statistically significant coefficient associated with these variables and its interaction with *ER*.

In Table 8, we run the same regression as in the previous analyses for the price of 20 count cotton yarn (*P_20*). Due to partly the limited number of observations for *P_20*, we could only see the effect of *WAGE* on the heterogeneous pass-through.

For the purpose of further robustness check, we incorporate the firm-prefecture-level control, which is measured as a share of the number of female workers held by each firm in each prefecture. We can see that the results obtained in the previous tables are intact. To be more precise, the interaction terms between *ER* and *WAGE*, *IMPORT*, *INVENTORY*, and *RATE* are still statistically significant and show the consistent signs with the previous results even after controlling for the additional factors.

5.3. Discussion

In the present paper, we emphasize the importance to incorporate multiple factors potentially related to incomplete pass-through simultaneously. While we are confident that most of the necessary variables are employed in the empirical analysis, we can still advocate other potentially important factors.

First, a proxy for management quality would be informative. Although we incorporate *INVENTORY* as a proxy for financial constraint, it still accounts partly for the management quality. From this perspective, we can predict that pass-through becomes lower if production of 16 count cotton yarn is more flexible thanks to higher management quality. In this sense, it would be informative to incorporate capacity utilization, inventor management, and labor management to see if this story is valid. Second, another important issue is dumping behavior of export firms to secure its market share. When firms intend to expand its market share through dumping, this could be an orthogonal factor to the abovementioned story. Third, human network could be one important factor. Mutual connection between the buyer in Shanghai market and export companies would affect the pricing-to-market behavior. Fourth, cost of production might be interesting. In this context, the estimated cost of production for each firm in 1898-first half of 1900 in the monthly industrial report might be useful. Saving on the cost of cotton by firms which have high cost of production, other things equal, may perhaps be interpreted as compromising on quality. Once we can compute the cost of raw cotton, e.g., by comparing the profit-loss information with the physical volume of cotton consumed, we can use the information on the share of production cost out of total cost, which could represent something orthogonal to the productivity. Fifth, one thing we have to be clear is the choice of invoice currency in our data periods, which is one actively discussed issue in the recent trade literature. Fitzgerald & Haller (2014) explain that for prices invoiced in destination currency (as in our case), exporter firms change home currency-measured export price and thus markups one-for-one with exchange rate changes.

6. Conclusion

In this paper, using unique firm-level monthly-frequency data accounting for the export prices set by Japanese firms over the periods from 1897 to 1914 and detailed firm-level attributes, we empirically examines how the pass-through of currency exchange rate depends on firm heterogeneity. The results of our estimations based on the export price information of a highly homogenous product, i.e., cotton yarn in a specific count, show, first that exporter firms' import intensity and firm size were the major sources of heterogeneous pass-through as pointed out in Amiti et al. (2014). Second, we also find that the factors related to firms' funding, which are proxied for by the average funding rates and inventory turnover, were also closely related to the heterogeneity in pass-through. Third, different levels of wages for female workers, which can be interpreted as a proxy for productivity and/or product quality, also led to heterogeneous pass-through. These results imply that multiple firm-level factors simultaneously affect the degree of heterogeneity in pass-through.

The research presented in this study could be expanded in a number of directions. One such direction would be to expand our analysis to the implication of mutual relationship between exporter firms and other players, e.g., banks or important "fixers". As we have the information associated with the company executives of exporter firms, we can see the economic role of these outside players once we construct network data among exporter firms, bank owners, and fixers. A further potentially interesting extension would be to use our data analysis for examining various other kinds of firm dynamics such as those with regard to productivity dynamics before and after the entry to export market. We believe all of these extensions would provide further insights to gain a better understanding of the determinants of incomplete exchange rate pass-through.

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Figures and Tables

Figure 1

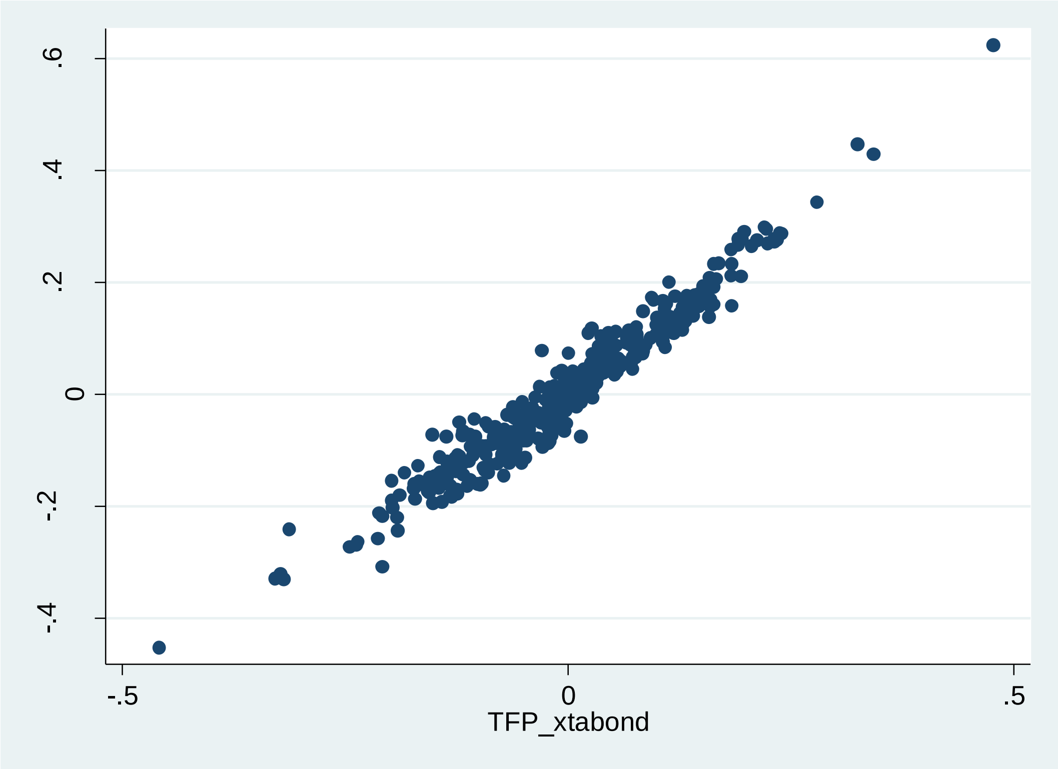
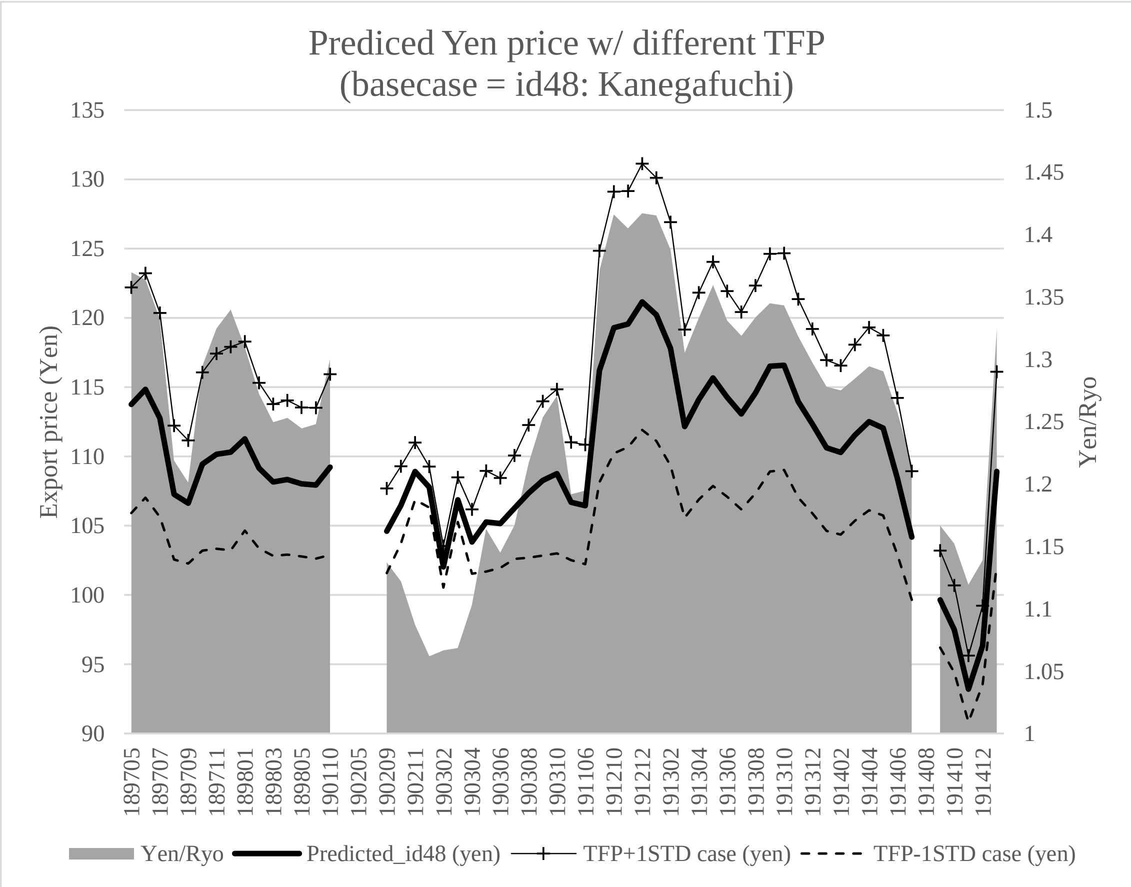


Figure 2



Prediced Yen price w/ different TFP
(basecase = id48: Kanegafuchi)
Export price (Yen)
Yen/Ryo
135
130
125
120
115
110
105
100
95
90
1.5
1.45
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
189705
189707
189709
189711
189801
189803
189805
190110
190205
190209
190211
190302
190304
190306
190308
190310
191106
191210
191212
191302
191304
191306
191308
191310
191312
191402
191404
191406
191408
191410
191412
Yen/Ryo
Predicted_id48 (yen)
TFP+1STD case (yen)
TFP-1STD case (yen)

Table 1

Variable	Definition	Obs	Mean	Std. Dev	Min	Max
	Sample (a): Sample for Table 2					
P	Natural logarithm of Yen(i.e., home currency)-measured 16-bante cotton exported	436	4.67	0.16	4.05	5.08
ER	Exchange rate measured as units of yen per one ryo	436	0.21	0.08	0.06	0.35
TFP	Firm-level total factor productivity obtained from fixed-effect panel estimation	436	0.00	0.13	-0.36	0.45
	Sample(b): Sample for Table 3					
P	Natural logarithm of Yen(i.e., home currency)-measured 16-bante cotton exported	353	4.67	0.16	4.46	5.08
ER	Exchange rate measured as units of yen per one ryo	353	0.22	0.07	0.06	0.35
TFP	Firm-level total factor productivity obtained from system GMM estimation	353	0.00	0.12	-0.33	0.34
	Sample(c): Sample for Table 4					
P	Natural logarithm of Yen(i.e., home currency)-measured 16-bante cotton exported	353	4.67	0.16	4.46	5.08
ER	Exchange rate measured as units of yen per one ryo	353	0.22	0.07	0.06	0.35
TFP	Firm-level total factor productivity obtained from fixed-effect panel estimation	353	0.01	0.13	-0.33	0.45
WAGE	Natural logarithm of female worker wage	353	0.00	0.29	-0.49	0.58
SIZE	Natural logarithm of output	353	0.06	1.14	-2.48	2.68

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Sample(d): Sample for Table 5						
P	Natural logarithm of Yen(i.e., home currency)-measured 16-bante cotton exported	189	4.68	0.17	4.51	5.08
ER	Exchange rate measured as units of yen per one ryo	189	0.21	0.07	0.06	0.35
TFP	Firm-level total factor productivity obtained from fixed-effect panel estimation	189	0.02	0.13	-0.31	0.43
WAGE	Natural logarithm of female worker wage	189	0.06	0.28	-0.43	0.53
SIZE	Natural logarithm of output	189	0.26	1.23	-2.48	2.68
IMPORT	Import from Ryo export source countries / Import from all the souces (Note: this variable is time-invariant and measured as of the initial appearance in the data)	189	4.46	20.60	-39.67	39.23
INVENTORY	(Inventory + Account receivable) / Sales	189	-0.01	0.08	-0.09	0.26
RATE	BOJ's discount rate	189	-0.15	0.64	-1.05	1.14
SHARE	Output share of 16 count cotton yarn	189	0.02	0.24	-0.42	0.55
CAPUTIL	Capituil utilization rate	189	-0.01	0.14	-0.41	0.51

Table 2

Dependent variable: *P*								
	Fixed-effect model		Fixed-effect model		Allison (2009) Hybrid random-effect model		Correlated random-effects model	
Independent Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
ER	1.067	0.070 ***	1.024	0.068 ***			1.019	0.068 ***
TFP			-0.400	0.150 ***			-0.407	0.149 ***
ER×TFP			1.748	0.629 ***			1.786	0.628 ***
ER - ER_AVR					1.019	0.068 ***		
TFP - TFP_AVR					-0.407	0.149 ***		
ER×TFP - ER×TFP_AVR					1.786	0.628 ***		
ER_AVR					-0.118	0.346	-1.137	0.352 ***
TFP_AVR					-0.131	0.628	0.276	0.640
ER×TFP_AVR					0.486	2.788	-1.300	2.831
constant	4.462	0.016 ***	4.451	0.015 ***	4.643	0.072 ***	4.643	0.072 ***
No. of Obs.	517		436		436		436	
No. of Groups	32		30		30		30	
Observation per group								
min	1		1		1		1	
avr	16.2		14.5		14.5		14.5	
max	57		57		57		57	
F or Wald chi2	231.55		76.79		227.30		227.30	
Prob > F or chi2	0.0000		0.0000		0.0000		0.0000	
R-sq								
within	0.3236		0.3637		0.3637		0.3637	
between	0.0047		0.0044		0.0136		0.0136	
overall	0.2074		0.1767		0.1791		0.1791	
corr(u_i, xb)	-0.0870		-0.1267		0 (assumed)		0 (assumed)	
F test that all u_i=0								
F	12.93		18.61		n.a.		n.a.	
Prob>F	0.0000		0.0000		n.a.		n.a.	

Note: TFP is computed through fixed-effect panel estimation. The data used for the estimation are conditional on the change in export price.

Table 3

Dependent variable: *P*									
	Fixed-effect model			Allison (2009) Hybrid random-effect model			Correlated random-effects model		
Independent Variables	Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.	
ER	1.016	0.076	***				1.012	0.076	***
TFP	-0.469	0.187	**				-0.480	0.187	***
ER×TFP	2.529	0.789	***				2.573	0.791	***
ER - ER_AVR				1.012	0.076	***			
TFP - TFP_AVR				-0.480	0.187	***			
ER×TFP - ER×TFP_AVR				2.573	0.791	***			
ER_AVR				-0.321	0.495		-1.333	0.501	***
TFP_AVR				-0.280	1.103		0.200	1.116	
ER×TFP_AVR				1.690	4.827		-0.883	4.881	
constant	4.449	0.017	***	4.686	0.106	***	4.686	0.106	***
No. of Obs.	353			353			353		
No. of Groups	24			24			24		
Observation per group									
min	2			2			2		
avr	14.7			14.7			14.7		
max	50			50			50		
F or Wald chi2	64.07			191.61			191.61		
Prob > F or chi2	0.0000			0.0000			0.0000		
R-sq									
within	0.3709			0.3709			0.3709		
between	0.0099			0.0332			0.0332		
overall	0.1925			0.1995			0.1995		
corr(u_i, xb)	-0.0789			0 (assumed)			0 (assumed)		
F test that all u_i=0									
F	21.40			n.a.			n.a.		
Prob>F	0.0000			n.a.			n.a.		

Note: TFP is computed through Arellano-Bond GMM estimation. The data used for the estimation are conditional on the change in export price.

Table 4

Dependent variable: *P*									
	Fixed-effect model								
Independent Variables	Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.	
ER	0.749	0.053	***	0.752	0.052	***	0.739	0.047	***
TFP							-0.331	0.096	***
ER×TFP							0.691	0.416	*
WAGE	-0.145	0.050	***				-0.195	0.058	***
ER×WAGE	2.129	0.196	***				1.668	0.258	***
SIZE				0.036	0.013	***	0.063	0.015	***
ER×SIZE				0.413	0.044	***	0.097	0.059	*
constant	4.508	0.012	***	4.494	0.011	***	4.505	0.011	***
No. of Obs.	353			353			353		
No. of Groups	24			24			24		
Observation per group									
min	2			2			2		
avr	14.7			14.7			14.7		
max	50			50			50		
F	321.31			308.83			195.99		
Prob > F	0.0000			0.0000			0.0000		
R-sq									
within	0.7473			0.7397			0.8099		
between	0.7139			0.3234			0.5648		
overall	0.8033			0.5979			0.7286		
corr(u_i, xb)	0.1507			-0.5224			-0.5099		
F test that all u_i=0									
F	7.18			23.45			11.90		
Prob>F	0.0000			0.0000			0.0000		

Note: TFP is computed through fixed-effect panel estimation. The data used for the estimation are conditional on the change in export price.

Table 5

Dependent variable: *P*									
	Fixed-effect model								
Independent Variables	Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.	
ER	0.272	0.090	***	0.691	0.065	***	1.078	0.127	***
TFP	-0.166	0.142		-0.079	0.108		-0.035	0.122	
ER×TFP	0.200	0.686		-0.482	0.480		-0.144	0.585	
WAGE	-0.219	0.079	***	-0.315	0.068	***	-0.045	0.072	
ER×WAGE	1.511	0.384	***	2.149	0.328	***	1.067	0.339	***
SIZE	0.037	0.019	*	0.058	0.017	***	0.071	0.017	***
ER×SIZE	0.174	0.081	**	0.108	0.073		0.033	0.071	
ER×IMPORT	0.018	0.003	***	0.015	0.003	***	0.010	0.003	***
INVENTORY	0.985	0.376	***				0.728	0.322	**
ER×INVENTORY	-7.053	1.682	***				-4.604	1.467	***
RATE				-0.072	0.015	***	-0.191	0.024	***
ER×RATE				0.324	0.073	***	0.777	0.109	***
constant	4.575	0.018	***	4.497	0.014	***	4.392	0.028	***
No. of Obs.	189			290			189		
No. of Groups	18			19			18		
Observation per group									
min	2			2			2		
avr	10.5			15.3			10.5		
max	43			50			43		
F	128.40			108.40			153.67		
Prob > F	0.0000			0.0000			0.0000		
R-sq									
within	0.8886			0.8210			0.9206		
between	0.5997			0.5931			0.7107		
overall	0.8519			0.7708			0.8845		
corr(u_i, xb)	-0.5951			-0.4363			-0.5352		
F test that all u_i=0									
F	6.61			6.94			7.09		
Prob>F	0.0000			0.0000			0.0000		

Note: TFP is computed through fixed-effect panel estimation. The data used for the estimation are conditional on the change in export price.

Table 6

Dependent variable: *P*									
Independent Variables	Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.	
ER	1.033	0.134	***	0.724	0.144	***	0.720	0.156	***
TFP	-0.078	0.131		-0.022	0.121		-0.068	0.128	
ER×TFP	0.171	0.615		-0.412	0.575		-0.136	0.601	
WAGE	-0.010	0.079		-0.042	0.070		-0.025	0.078	
ER×WAGE	0.818	0.372	**	1.061	0.340	***	0.883	0.378	**
SIZE	0.058	0.030	*	0.073	0.017	***	0.086	0.032	***
ER×SIZE	0.061	0.078		0.071	0.072		0.070	0.079	
ER×IMPORT	0.012	0.003	***	0.014	0.003	***	0.014	0.004	***
INVENTORY	0.669	0.328	**	0.882	0.322	***	0.891	0.336	***
ER×INVENTORY	-4.350	1.502	***	-5.796	1.524	***	-5.397	1.593	***
RATE	-0.186	0.026	***	-0.186	0.024	***	-0.182	0.026	***
ER×RATE	0.752	0.112	***	0.647	0.111	***	0.652	0.115	***
ER_R				0.211	0.616		0.078	0.648	
ER_R×IMPORT_R				-0.025	0.030		-0.035	0.037	
ER_D				7.407	1.630	***	6.965	1.687	***
ER_D×IMPORT_D				0.131	0.071	*	0.150	0.081	*
ER_S				-5.082	1.383	***	-5.043	1.432	***
ER_S×IMPORT_S				-0.705	0.694		-0.610	0.704	
constant	0.273	2.282		-3.808	1.991	*	-6.384	2.883	**
Prefecture control	yes			no			yes		
Other currency exchange rates	no			yes			yes		
No. of Obs.	189			189			189		
No. of Groups	18			18			18		
Observation per group									
min	2			2			2		
avr	10.5			10.5			10.5		
max	43			43			43		
F	102.55			114.79			84.82		
Prob > F	0.0000			0.0000			0.0000		
R-sq									
within	0.9235			0.9311			0.9327		
between	0.0000			0.0646			0.0439		
overall	0.0259			0.0152			0.0648		
corr(u_i, xb)	-0.9940			-0.9920			-0.9958		
F test that all u_i=0									
F	5.53			6.78			5.32		
Prob>F	0.0000			0.0000			0.0000		

Note: TFP is computed through fixed-effect panel estimation. The data used for the estimation are conditional on the change in export price.

Table 7

Dependent variable: *P*								
	Fixed-effect model							
Independent Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
ER	0.534	1.005	1.028	0.146 ***	-0.093	1.121	0.720	0.166 ***
TFP	-0.045	0.128	-0.013	0.129	-0.055	0.134	-0.070	0.136
ER×TFP	-0.165	0.611	-0.250	0.616	-0.139	0.626	-0.094	0.635
WAGE	-0.048	0.073	-0.050	0.076	-0.047	0.077	-0.017	0.080
ER×WAGE	1.060	0.342 ***	1.101	0.351 ***	0.946	0.376 **	0.881	0.392 **
SIZE	0.082	0.019 ***	0.077	0.019 ***	0.055	0.034	0.082	0.033 **
ER×SIZE	0.014	0.073	0.014	0.075	0.059	0.079	0.058	0.084
ER×IMPORT	0.007	0.004 *	0.008	0.004 **	0.012	0.004 ***	0.013	0.005 ***
INVENTORY	0.770	0.333 **	0.730	0.334 **	1.032	0.347 ***	0.963	0.355 ***
ER×INVENTORY	-4.656	1.485 ***	-4.666	1.498 ***	-5.529	1.594 ***	-5.587	1.633 ***
RATE	-0.193	0.028 ***	-0.185	0.029 ***	-0.186	0.029 ***	-0.190	0.031 ***
ER×RATE	0.763	0.123 ***	0.735	0.127 ***	0.596	0.127 ***	0.660	0.129 ***
MAINCOUNT	-0.001	0.012			0.009	0.013		
ER×MAINCOUNT	0.033	0.059			0.047	0.066		
HIGHCOUNT			-0.026	0.043			0.018	0.049
ER×HIGHCOUNT			0.157	0.195			-0.009	0.220
ER_R					-0.106	0.656	0.014	0.701
ER_R×IMPORT_R					-0.058	0.039	-0.042	0.039
ER_D					6.143	1.725 ***	6.809	1.761 ***
ER_D×IMPORT_D					0.153	0.080 *	0.165	0.085 *
ER_S					-4.194	1.476 ***	-4.922	1.509 ***
ER_S×IMPORT_S					-0.594	0.696	-0.654	0.712
constant	4.407	0.204 ***	4.400	0.033 ***	-5.147	2.900 *	-5.987	2.975 **
Prefecture control	no		no		yes		yes	
Other currency exchange rates	no		no		yes		yes	
No. of Obs.	189		189		189		189	
No. of Groups	18		18		18		18	
Observation per group								
min	2		2		2		2	
avr	10.5		10.5		10.5		10.5	
max	43		43		43		43	
F	131.58		130.80		80.52		77.50	
Prob > F	0.0000		0.0000		0.0000		0.0000	
R-sq								
within	0.9215		0.9210		0.9352		0.9329	
between	0.6564		0.7046		0.0468		0.0483	
overall	0.8638		0.8763		0.0622		0.0637	
corr(u_i, xb)	-0.5579		-0.5431		-0.9954		-0.9960	
F test that all u_i=0								
F	7.14		6.92		5.60		4.95	
Prob>F	0.0000		0.0000		0.0000		0.0000	

Note: TFP is computed through fixed-effect panel estimation. The data used for the estimation are conditional on the change in export price.

Table 8

Dependent variable: *P_20*									
	Fixed-effect model								
Independent Variables	Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.	
ER	0.846	0.139	***	1.217	0.266	***	0.690	0.283	**
TFP	0.047	0.181		-0.228	0.200		-0.075	0.176	
ER×TFP	-1.074	0.750		0.862	0.885		0.112	0.757	
WAGE	-0.276	0.129	**	-0.058	0.114		-0.023	0.098	
ER×WAGE	1.106	0.584	*	1.023	0.551	*	0.913	0.484	*
SIZE	0.116	0.032	***	0.094	0.049	*	0.111	0.045	**
ER×SIZE	0.109	0.149		-0.193	0.200		-0.074	0.182	
ER×IMPORT				0.002	0.015		0.006	0.013	
INVENTORY				-1.757	0.793	**	-0.965	0.816	
ER×INVENTORY				-1.721	2.319		-1.976	2.061	
RATE				-0.053	0.044		-0.059	0.040	
ER×RATE				-0.009	0.217		-0.135	0.191	
ER_R							1.167	1.093	
ER_R×IMPORT_R							0.009	0.054	
ER_D							9.914	2.029	***
ER_D×IMPORT_D							0.044	0.069	
ER_S							-6.576	2.390	***
ER_S×IMPORT_S							-0.490	0.578	
constant	4.448	0.032	***	4.412	0.057	***	-6.658	2.756	**
Other currency exchange rates	yes			yes			yes		
No. of Obs.	190			101			101		
No. of Groups	19			16			16		
Observation per group									
min	1			1			1		
avr	10.0			6.3			6.3		
max	38			31			31		
F	59.04			103.68			102.91		
Prob > F	0.0000			0.0000			0.0000		
R-sq									
within	0.7159			0.9446			0.9651		
between	0.3288			0.2855			0.0109		
overall	0.6149			0.6316			0.0000		
corr(u_i, xb)	-0.7048			-0.8544			-0.9862		
F test that all u_i=0									
F	5.90			9.85			9.64		
Prob>F	0.0000			0.0000			0.0000		

Note: TFP is computed through fixed-effect panel estimation. The data used for the estimation are conditional on the change in export price.

Table 9

Independent Variables	Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.	
	Dependent variable: *P*								
ER	1.055	0.153	***	0.670	0.158	***	0.669	0.177	***
TFP	-0.061	0.138		-0.018	0.127		-0.053	0.134	
ER×TFP	0.221	0.645		-0.341	0.593		-0.059	0.625	
WAGE	-0.009	0.088		-0.031	0.079		-0.024	0.089	
ER×WAGE	0.789	0.440	*	1.034	0.381	***	0.898	0.448	**
SIZE	0.052	0.032		0.070	0.017	***	0.072	0.032	**
ER×SIZE	0.075	0.080		0.084	0.071		0.090	0.078	
ER×IMPORT	0.013	0.004	***	0.014	0.003	***	0.015	0.004	***
INVENTORY	0.701	0.347	**	0.920	0.342	***	0.972	0.369	***
ER×INVENTORY	-4.307	1.540	***	-5.831	1.525	***	-5.564	1.597	***
RATE	-0.196	0.036	***	-0.185	0.034	***	-0.188	0.038	***
ER×RATE	0.776	0.161	***	0.595	0.167	***	0.625	0.186	***
ER_R				0.222	0.626		0.057	0.662	
ER_R×IMPORT_R				-0.035	0.031		-0.046	0.039	
ER_D				8.552	1.674	***	7.951	1.724	***
ER_D×IMPORT_D				0.109	0.071		0.115	0.082	
ER_S				-5.605	1.403	***	-5.568	1.443	***
ER_S×IMPORT_S				-0.806	0.688		-0.678	0.697	
constant	-0.001	2.413		-5.058	2.017	**	-7.519	2.921	**
Prefecture control	yes			no			yes		
Other currency exchange rates	no			yes			yes		
No. of Obs.	179			179			179		
No. of Groups	18			18			18		
Observation per group									
min	2			2			2		
avr	9.9			9.9			9.9		
max	38			1			38		
F	91.97			106.42			78.67		
Prob > F	0.0000			0.0000			0.0000		
R-sq									
within	0.9205			0.9305			0.9323		
between	0.0000			0.0554			0.0353		
overall	0.0288			0.0137			0.0609		
corr(u_i, xb)	-0.9945			-0.9920			-0.9951		
F test that all u_i=0									
F	4.77			6.04			4.53		
Prob>F	0.0000			0.0000			0.0000		

Note: TFP is computed through fixed-effect panel estimation. The data used for the estimation are conditional on the change in export price.