# 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 narrowly defined product, i.e., cotton yarn of a specific count, set by multiple Japanese firms over the periods from 1897 to 1914 and detailed firm-level attributes, we empirically examine how the exchange rate pass-through depends on firm heterogeneity. The estimate results show that the factor related to firms' financial cost, which is proxied for by inventory turnover, was closely related to the heterogeneity in pass-through. This result is obtained under the estimation properly controlling for a comprehensive list of firm attributes such as exporter firms' wages, import intensity, and firm size, all of which have been confirmed to be the important determinants of heterogeneous exchange rate pass-through. These results imply that multiple firm-level factors including financial cost simultaneously affect the degree of heterogeneity in pass-through.



Keywords: Exchange rate pass-through; Firm heterogeneity; financial cost
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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. Such a sticky dynamics of local currency-measured price is called “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 also 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 such 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)%. Inasmuch as the production cost is 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 also affects the level of incomplete pass-through. For example, if firms are importing 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 examples, such incomplete pass-through and pricing-to-market could be heterogeneous among firms. Extant theoretical studies have already provided various illustrations that incomplete pass-through is observed under the specific firm characteristics. 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 more incomplete pass-through. From a slightly different angle, Amiti et al. (2014) claims that firms' import intensity and market share are the important statistics for incomplete pass-through and confirm that their conjecture is supported by data. Overall, the extant studies have suggested 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 example, Fitzgerald and Haler (2014) use monthly observation on prices of products classified in SIC 8-digit level detailed classification. However, there is still the same problem. Notably, 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 shirts are made of 40-120 count cotton yarn while casual shirts are made of 20-80 counts. Mixing the products belonging to different categories in the analysis of incomplete pass-through inevitably 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 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, there are only a few studies successfully incorporating a comprehensive list of firm characteristics.

Against these backgrounds, the contributions of the present paper are at least three-fold. First, the unique hand-collected information on firm-level export price of a narrowly defined 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 than the extant studies. 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 into our empirical analysis. The information in the dataset ranges from firms' production activities, financial statement, geographical location, and import status of intermediate goods. These data allow us to pin down a specific mechanism through which firms' pass-through varies, i.e., financial cost channel, with controlling for a comprehensive list of other firm attributes. 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 are 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, different levels of wages for female workers, which can be interpreted as a proxy for product quality, further led to heterogeneous pass-through. These results imply that multiple factors simultaneously generate the heterogeneous pass-through. Third, most importantly, we also find that the factor related to firms' financial cost, proxied for by the turnover rate of inventory, was also closely related to the heterogeneity in pass-through. As far as we concern, the present paper is the first analysis employing precise price data to pin down financial cost factor affecting pass-through with controlling for a list of comprehensive firm attributes

The rest of the paper is organized 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 research.

**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 mark-up set by individual firms. To illustrate, facing lower demand elasticity with respect to price, firms are induced to set higher mark-up.[5] 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 further. 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 marginal cost affects the way of export price to react to the fluctuation in currency exchange rate. 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 as home currency depreciates

[5] Mayer et al. (2016) describes demand conditions leading to different levels of demand elasticity faced by firms. They also point out that demand elasticity decreases with consumption, which means that levels of demand elasticity is not independent of size.

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 a similar vein and most closely related to the central theme of the present paper, Strasser (2013) points out that financial friction faced by exporter firms also affect the degree of incomplete pass-through. He uses the survey data of German firms on their responses against the change in currency exchange rate. Given the presumption that firms require financial strength to maintain their local currency-measured export price over exchange rate movements, he tests how financially constrained firms react against exchange rate change and find that such constrained firms pass-through more.

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 customs information. As one important exception, Fitzgerald and Haller (2014) employ 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.[6]

## 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 including financial cost 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.

[6] 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 .

*3.1. 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.

$$Q(i) = k(i){P_i^*}^{-r} {P^*}^{r-f} D \tag{1}$$

The left hand-side of the equation (1) 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 $(1 + \mu_i)$ and marginal cost $MC_i^*$, we can obtain the following optimal price setting rule (2).

$$P_i^* = (1 + \mu_i)MC_i^* = s(i)/\{s(i) - 1\}MC_i^* \tag{2}$$

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:

$$G(i) = S(i)/[\{\frac{r}{r-f} - S(i)\}\{1 - \frac{r-f}{(r-1)}S(i)\}] \tag{3}$$

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 $C(Q(i), z(i))$ to produce $Q(i)$ depends on the technology component $z(i)$, which incorporates productivity, access to better intermediate goods, better access to financial resources, 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.[7]

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

$$max\{ER \times P_i^* Q(i) - C(Q(i), z(i))\} \tag{4}$$

where $ER$ stands for the currency exchange rate measured as the ratio of home currency to destination currency. In other words, larger $ER$ 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:

$$P_i = \{1 + \mu_i(P_i/ER\,, w_i)\}MC_i(ER, z_i) \tag{5}$$

[7] 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.*"

Given the abovementioned discussion, we express the mark-up as a function of the local currency-measured price $P_i^* = P_i/ER$ and $w_i = (r, f)$ while the home currency-measured marginal cost as $MC_i(ER, z_i)$. We can rewrite this expression in a log form:

$$\ln P_i = \ln\{1 + \mu_i(P_i/ER\,, w_i)\} + \ln MC_i(ER, z_i) \tag{6}$$

From this expression, we can obtain the elasticity of $P_i$ to currency exchange rate $ER$ (i.e., yen/ryo) as follows:

$$\frac{\partial \ln P_i}{\partial \ln ER} = -\frac{\frac{\partial \mu_i(P_i/ER, w_i)}{\partial (P_i/ER)} P_i}{\{1+\mu_i(P_i/ER, w_i)\} ER} + \frac{\frac{\partial MC_i(ER, z_i)}{\partial ER} ER}{MC_i(ER, z_i)} \tag{7}$$

Here, larger (smaller) $\frac{\partial \ln P_i}{\partial \ln ER}$ means lower (higher) pass-through. It also implies that $\frac{\partial \ln P_i}{\partial \ln ER}$ depends on (i) mark-up elasticity, (ii) marginal cost elasticity, (iii) price level, and (iv) currency exchange rate level. In order to see how this elasticity depends on the technology component $z(i)$, we can compute the cross-derivative:

$$\frac{\partial^2 \ln P_i}{\partial \ln ER \partial z_i} = \frac{ER}{MC_i(ER, z_i)^2} \left\{ MC_i(ER, z_i) \frac{\partial^2 MC_i(ER, z_i)}{\partial ER \partial z_i} - \frac{\partial MC_i(ER, z_i)}{\partial ER} \frac{\partial MC_i(ER, z_i)}{\partial z_i} \right\} \tag{8}$$

The equation (8) means that even if $ER$ and $z_i$ enter $MC_i(ER, z_i)$ linearly, $z_i$ matters for the impact of the change in $z_i$ on the elasticity $\frac{\partial \ln P_i}{\partial \ln ER}$. Similarly, we can see the interaction of the elasticity in (7) with $w_i = (r, f)$ as follows:

$$\frac{\partial^2 \ln P_i}{\partial \ln ER \partial w_i} = \frac{P_i}{ER\{1+\mu_i(P_i/ER, w_i)\}^2} \left\{ \frac{\partial \mu_i(P_i/ER, w_i)}{\partial (P_i/ER)} \frac{\partial \mu_i(P_i/ER, w_i)}{\partial w_i} - \frac{\partial^2 \mu_i(P_i/ER, w_i)}{\partial (P_i/ER) \partial w_i} \right\} \tag{9}$$

This means that even if $ER$ and $w_i$ enter $\mu_i(P_i/ER\,, w_i)$ linearly, $w_i$ matters. From these discussions, we can obtain the following proposition:

**Proposition 1**: Assume $ER$ and $z_i$ enter $MC_i(ER, z_i)$ linearly. Then, lager financial cost leads to smaller domestic price dynamics with respect to the change in exchange rate if marginal cost positively react to the depreciation of home currency and larger financial cost leads to higher marginal cost.

**Proof**: The assumption of linearity means $\frac{\partial^2 MC_i(ER,z_i)}{\partial ER \partial z_i} = 0$ in (8). Then, we have $\frac{\partial^2 \ln P_i}{\partial \ln ER \partial z_i} < 0$ if $\frac{\partial MC_i(ER,z_i)}{\partial ER} > 0$ and $\frac{\partial MC_i(ER,z_i)}{\partial z_i} > 0$.■

This is the case where firms are importing cotton from China and higher financial cost (e.g., larger working capital) is associated with higher marginal cost. Firms with higher turnover ratio of inventory exhibit higher financial cost associated with working capital. The proposition implies that even if there is no interaction between the financial cost and exchange rate in the functional form of marginal cost, firms facing such higher financial cost change their home currency-measured price largely corresponding to the fluctuation of exchange rate. We think it is natural to consider the case that the financial cost itself is not related to the level exchange rate. It is important to note that we still have the response of "the elasticity of $P_i$ to currency exchange rate $ER$" to $z_i$. Proposition 1 is the testale prediction we employ in the following empirical analysis.

From the same computation, we can also obtain the prediction about the elasticity of mark-up:

**Proposition 2**: The impact of the change in $w_i$ depends on $\frac{\partial \mu_i(P_i/ER,w_i)}{\partial (P_i/ER)}$, $\frac{\partial \mu_i(P_i/ER,w_i)}{\partial w_i}$, and $\frac{\partial^2 \mu_i(P_i/ER,w_i)}{\partial (P_i/ER) \partial w_i}$.

**Proof**: Immediate from (8).■

Unlike the functional form of marginal cost, it is natural to assume that $\frac{\partial^2 \mu_i(P_i/ER, w_i)}{\partial(P_i/ER)\partial w_i} \neq 0$. Thus, we keep the general expression in (8) as is.

*3.3. Tested hypotheses*

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. A Brief Historical Background (*Preliminary and incomplete*)**

We test these theoretical hypotheses using the data from the cotton spinning industry in the late nineteenth and early twentieth century Japan. The modern cotton spinning industry in Japan started in the early 1880s, when Osaka Boseki Co. was founded. Braguinsky et al. (2015) describes its development identifying three stages (Figure***). After the steady increase of cotton yarn production in the 1880s (stage 1), the production increase accelerated in the 1890s (stage 2). In the context of this paper, it is notable that the sharp production increase in the 1890s involved increase in export. While the increased products were primarily absorbed in the domestic market substituting the import until the middle of 1890s, export went up sharply in the late 1890s, and net export became positive in 1896.

In the early 1890s, the Japanese cotton spinning industry faced with the limit of the domestic cotton yarn market, which was reflected in the panic in 1890. This situation urged the cotton spinning firms to conduct innovations including the switch to longer-stapled raw cotton imported from India and the United States, and the diffusion of a newer type of production equipment, ring spinning machine, which are stressed in Braguinsky et al. (2015). The switch to longer-stapled raw cotton enabled the Japanese firms to produce finer yarns, namely yarns of higher counts in particular 20 count yarns. Another innovation related to these two innovations was cultivation of the overseas market. Some cotton spinning firms including Osaka Boseki and Kanegafuchi Boseseki started to make efforts to export their products to the Chinese market in the early 1890s, by sending sample products and requesting the government to abolish the export tariff of cotton yarn and the import tariff of raw cotton through the Japan Cotton Spinners Association.

The two innovations above were the basic reasons for the increase of export, but some additional reasons also contributed. First, a long-term contract for shipping raw cotton from India was concluded between the Japan Cotton Spinners Association and a major marine shipping company (Nippon Yusen Co.) in 1893, which reduced the shipping cost of imported raw cotton from India. Second, the export tariff of cotton yarn and the import tariff of raw cotton were abolished in 1894 and 1896, respectively. And finally, the pest plague prevailed in India in 1896, which had a substantial damage to the Indian cotton spinning industry, the largest exporter of the cotton yarn to China (Takamura 1971, pp.226-227; Miyamoto 1985, p.150, The Home Affairs Department of the Osaka Prefecture Government, 1901, p.33).

From the late 1890s to the early 1910s, export accounted for 20-40% of the cotton yarn production in Japan (Figure***). This implies that fluctuation of export substantially influenced on the fortune of the cotton spinning industry. Indeed the Boxers Upraise in China in 1900 had a substantial negative impact on the Japanese cotton spinning industry through decline in the cotton yarn export to China, which triggered the large merger wave in the cotton spinning industry (Braguinsky et al. 2015). As indicated in Figure***, the number of firms began to decline sharply in 1901, while the number of plants declined slightly and then increased again. While there were 79 cotton spinning firms in Japan in 1900, the number of firms came to be 32 in 1914. Out of these firms, 20-30 firms exported cotton yarn, and the share of the exporting firms increased over time (Figure***).

## 5. Data and Methodology

### *5.1. Data overview*

The dataset used in this paper consists of three data sources. First, firm-level export prices measured at monthly frequency are obtained from the monthly industry association bulletins. These bulletins, "*Dainipponn boseki rengokai geppo*," have been widely utilized as a source of rich and detailed data on Japan's cotton spinning industry and its comprising firms (see, for example, Saxonhouse, 1974; Braguinsky et al., 2015, etc.). For the purpose of this paper, we hand-collected all the data on firm-level export prices available in the bulletins. The reported prices represent firm-level export prices of cotton yarn to the main exporting destination for the industry at the time, Shanghai market, in China. The reports cover several periods from May 1897 to December 1914, unfortunately with multiple time gaps. To the best of our knowledge, these data have never been systematically coded or utilized in research before.

The original export price data are measured in *ryo*, which is the currency used in China in those periods. The data are reported by individual firms in each month and consist of multiple entries for each firm-month combination in many cases. In cases where export prices associated with an individual firm in a specific month were recorded at multiple points during a single month, we computed the monthly average price associated with that firm in a specific month and label it as $P_i^*$. We should note that Japan introduced the gold-standard for its currency system in 1897 while China had been using the silver-standard for its currency until 1935. This led to fluctuations in the currency exchange rate between Japanese *yen* and Chinese *ryo* that were exogenous for any given 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 $P_i$. In the monthly industry reports, the price information is mainly for two specific counts of cotton yarn, i.e., 16 counts and 20 counts (the former representing a thicker yarn than the latter) which were also the two main counts produced for export in Japan at the time. We use $P_i$ to denote the yen-measured export price of 16-count cotton yarn and *P_20* to denote that of 20-count yarn.

The second data source is firm-level production-related information for each firms obtained from the same industry association monthly bulletins. This dataset contains detailed information about firms' production process, including output measured in physical units, the number and wages of male and female workers, and the levels of capital (spindles) and raw cotton inputs. By matching these data with annual-frequency data on the total number of spindles installed by a firm, we can also calculate the capital utilization rates. 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 contains the share of 16-count and 20-count cotton yarn in each firms' total yarn output (*SHARE*) and the import share of raw cotton from China and other importing source countries (*IMPORT*). (These latter data are only available at annual frequency and until 1902.) We use the log of female wage (*WAGE*) as a proxy for the quality of product. Industry history studies as well as primary sources we consulted make it clear that female workers' labor skill was a crucial factor determining the product quality. As mentioned, we use a specific-count of cotton yarn (16-count) in our empirical analysis, thus the product is narrowly defined. Nonetheless, there is still ample room for variation of product quality, for example, in terms of whiteness and other characteristics of the spun yarn, which could be damaged by sloppy handling of the product by unskilled female workers in the 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. Note that we subtract the average level of female wages in the specific local market the firm is operating at each data point from the raw number of female wage. 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 statements for individual firms. We use these data to compute the ratio of the sum of inventory and account receivable to sales, which denotes the level of inventory (*INVENTORY*). This measure accounts for the demand for 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 cost. We also use discount rate set by the Bank of Japan (*RATE*) as a proxy variable for firms' funding condition.

The firm-month level export price data cover periods from May 1897 to June 1898, October 1901, April 1902 to December 1903, and June 1911 to December 1914. The maximum total number of observations is 517 observations on 32 exporting firms (the number of observations is smaller when more controls are included). 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.

### *5.2. Empirical framework*

The hypotheses constructed in the previous section can be tested through the estimation of the following firm-level equation (10):

$$\ln P_{i,t} = \alpha + \beta_1 \ln ER_t + \beta_2 x_{i,t} + \beta_3 \ln ER_t \times x_{i,t} + FE_i + \varepsilon_t \tag{10}$$

Following Berman et al. (2012), the left hand side variable ($\ln P_{i,t}$) is the natural logarithm of export price measured in home currency *yen*. $\ln ER_t$ 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 $\ln ER_t$ corresponds to the depreciation of *yen* against *ryo*. $I_i$ and $\varepsilon_t$ 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 $x_{i,t}$, we can test the abovementioned empirical implication. To be more precis, Berman et al. (2012) hypothesize that both $\beta_1$ and $\beta_3$ take positive sign, which implies that firms with higher productivity raises home currency-measured export price more than those with lower productivity as facing the depreciation of home country currency.

To estimate the equation, we use (a) firm-level fixed-effect estimator as in the quation (10) 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 equations (11) and (12), respectively.

$$\ln P_{i,t} = \alpha + \beta \ln ER_t + \gamma_1 (x_{i,t} - \bar{x}_i) + \gamma_2 \bar{x}_i$$
$$+\delta_1 \left\{ \ln ER_t \times x_{i,t} - \overline{\ln ER \times x_i} \right\} + \delta_2 \overline{\ln ER \times x_i} + RE_i + \varepsilon_t \quad (11)$$

$$\ln P_{i,t} = \alpha + \beta \ln ER_t + \gamma_1 x_{i,t} + \gamma_2 \bar{x}_i$$
$$+\delta_1 \ln ER_t \times x_{i,t} + \delta_2 \overline{\ln ER \times x_i} + RE_i + \varepsilon_t \quad (12)$$

where the variables $\bar{x}_i$ denote the average level of the variable $x_{i,t}$ computed over the sample periods and $RE_i$ 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 $\beta_1$ and $\beta_3$ in (10) as well as $\beta$ and $\delta_1$ in (11) and (12). 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).

## 6. Empirical analysis

### *6.1. Estimate results*

The first column of Table 2 summarizes the estimation based on the equation (10) using only *TFP* as the component of $x_{i,t}$. First, the estimation 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-one (i.e., 10.67) increase in *yen*-measured export price. This result is confirmed in the model using *TFP* as the $\ln ER_t \times x_{i,t}$. 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). From the second and third columns, which correspond to the estimate results from the equation (11) and (12), we can also see that regardless of the estimation methods, similar estimation 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 $x_{i,t}$, we can find that the interaction terms between $\ln ER_t$ 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 $x_{i,t}$ simultaneously.

Fourth, in Table 5 (a), we show the estimate results based on the model including further $x_{i,t}$, 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 $\ln ER_t$. 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 levels, which could be associated with higher financial cost, shows lower sensitivity of *yen*-measured export price to the fluctuation in the currency exchange rate. This means that firms with higher financial cost 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.

In Table 5 (b), we repeat the same estimation for the subsample constructed by the change in $\ln ER_t$. The second and third columns in the table account for the estimate results in the case of *yen* depreciated and appreciated against *ryo* from the period *t-1* to *t*, respectively. First, we can confirm that the result associated with the former (i.e., depreciation of *yen*) is largely consistent with that in Table 5 (a). Second, nonetheless, the negative coefficient associated with the interaction term between $\ln ER_t$ and INVENTORY shows the consistent sign with that in Table 5 (a). This shows the robustness of our key finding to the subsample analysis.

*6.2. 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.

*6.3. 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.

## 7. 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, 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. Third, most importantly, we find that the factors related to firms' financial cost, which are proxied for by the inventory turnover, was also closely related to the heterogeneity in 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 in the context of financial cost 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 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

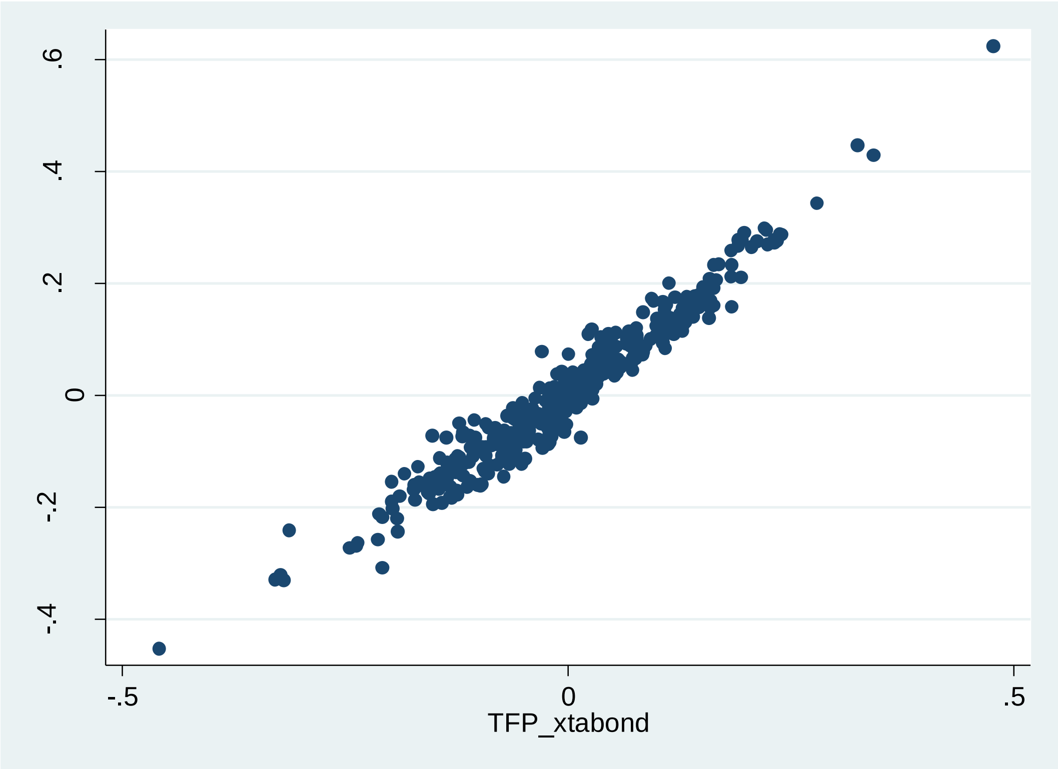
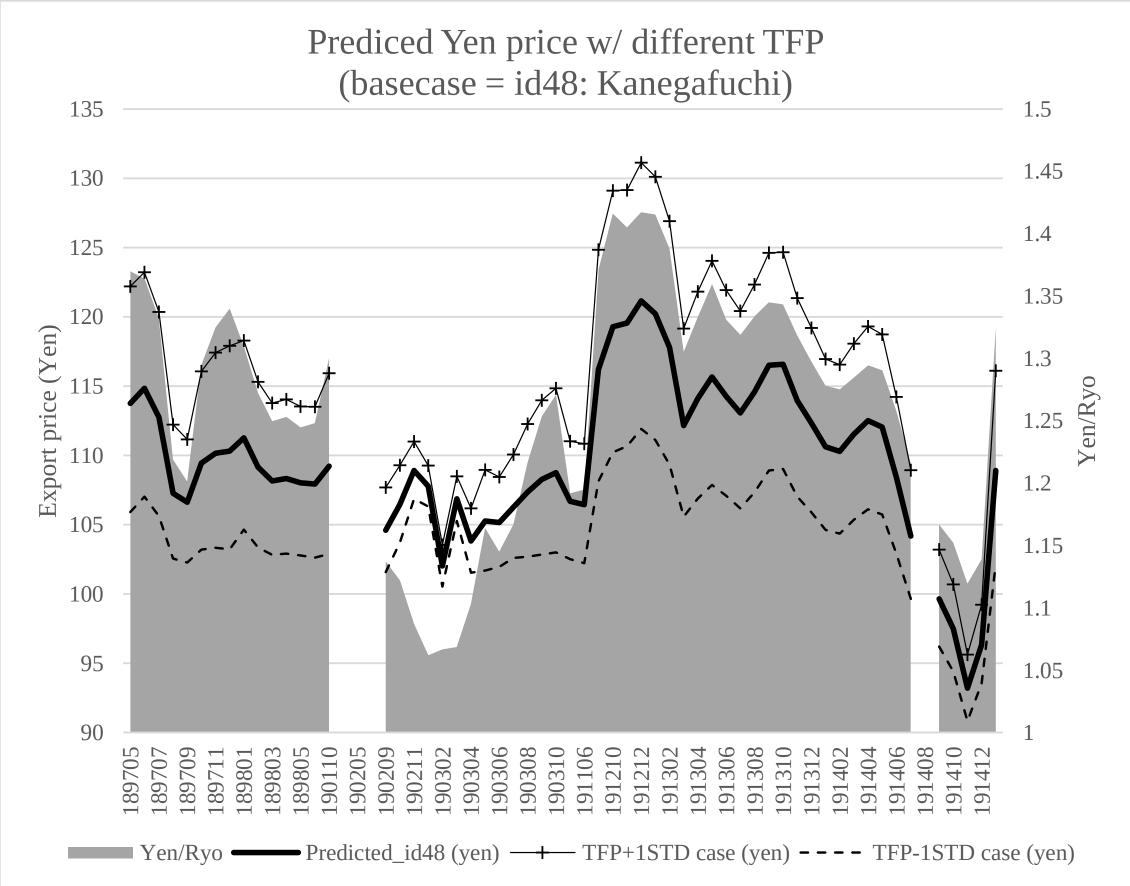


Figure 2



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 |

(continued to the next page)

(continued from the previous page)

| 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* | Capuital 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 (a)

| 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 5 (b)

| Dependent variable: *P* | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Fixed-effect model | | | | | | |
| | All | | ER ↑ (Yen dereciation) | | | ER ↓ (Yen appreciation) | |
| Independent Variables | Coef. | Std. Err. | Coef. | Std. Err. | p-value | Coef. | Std. Err. |
| *ER* | 1.078 | 0.127 *** | 0.863 | 0.113 *** | 0 | -0.088 | 0.648 |
| *TFP* | -0.035 | 0.122 | -0.018 | 0.104 | 0.866 | 0.738 | 0.418 * |
| *ER×TFP* | -0.144 | 0.585 | 0.153 | 0.529 | 0.774 | -4.001 | 1.912 ** |
| *WAGE* | -0.045 | 0.072 | -0.108 | 0.063 * | 0.092 | -0.302 | 0.282 |
| *ER×WAGE* | 1.067 | 0.339 *** | 1.472 | 0.298 *** | 0 | 1.944 | 1.338 |
| *SIZE* | 0.071 | 0.017 *** | 0.075 | 0.015 *** | 0 | 0.123 | 0.059 ** |
| *ER×SIZE* | 0.033 | 0.071 | 0.024 | 0.058 | 0.683 | -0.181 | 0.272 |
| *ER×IMPORT* | 0.010 | 0.003 *** | 0.008 | 0.003 *** | 0.001 | 0.031 | 0.011 *** |
| *INVENTORY* | 0.728 | 0.322 ** | 0.708 | 0.277 ** | 0.013 | 3.308 | 1.081 *** |
| *ER×INVENTORY* | -4.604 | 1.467 *** | -4.300 | 1.213 *** | 0.001 | -17.42 | 5.303 *** |
| *RATE* | -0.191 | 0.024 *** | -0.125 | 0.025 *** | 0 | -0.055 | 0.089 |
| *ER×RATE* | 0.777 | 0.109 *** | 0.568 | 0.115 *** | 0 | 0.170 | 0.385 |
| *constant* | 4.392 | 0.028 *** | 4.468 | 0.026 *** | 0 | 4.616 | 0.137 *** |
| No. of Obs. | 189 | | 99 | | | 90 | |
| No. of Groups | 18 | | 16 | | | 17 | |
| Observation per group | | | | | | | |
| min | 2 | | 1 | | | 2 | |
| avr | 10.5 | | 6.2 | | | 5.3 | |
| max | 43 | | 19 | | | 24 | |
| F | 153.67 | | 186.21 | | | 61.95 | |
| Prob > F | 0.0000 | | 0.0000 | | | 0.0000 | |
| R-sq | | | | | | | |
| within | 0.9206 | | 0.9692 | | | 0.9242 | |
| between | 0.7107 | | 0.7516 | | | 0.5619 | |
| overall | 0.8845 | | 0.8955 | | | 0.7891 | |
| corr(u_i, xb) | -0.5352 | | -0.5392 | | | -0.6596 | |
| F test that all u_i=0 | | | | | | | |
| F | 7.09 | | 6.79 | | | 4.03 | |
| 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

| Dependent variable: *P* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Independent Variables | Coef. | Std. Err. | | Coef. | Std. Err. | | Coef. | Std. Err. | |
| *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.