Imports and RMB Exchange Rate Pass-Through: The Role of Quality Sorting*

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April 2021

Abstract

This paper examines how the use of imported intermediate inputs affects the exchange rate elasticity of export prices. We first construct a theoretical model to illustrate that a change in imported input cost followed by a change in the exchange rate affects export prices through two distinct channels: directly changing the marginal cost of export products(i.e., the *marginal cost* channel) and indirectly altering exporters' incentive to upgrade (or downgrade) the quality of products (i.e., the *quality change* channel). These two channels generate opposite effects on the exchange rate elasticity of export prices. Our empirical analyses find strong evidence of the existence of the *marginal cost* and *quality change* channels. Overall, the *marginal cost* effect dominates the *quality change* effect. The *marginal cost* channel is weaker for products with larger scope for quality differentiation and firms with a higher ability to upgrade quality, as predicted by the theoretical model.

JEL: F1, F3, F4

Key words: Exchange rate pass-through; Imported intermediate inputs; Quality sorting

*We are grateful to Mi Dai, Shengjie Hong, Jiandong Ju, Yao Amber Li, Zhiyuan Li, Larry Qiu, Xiaopeng Yin, Chaoqun Zhan, Hongsong Zhang, Linke Zhu, the anonymous referees, and the Editor for extremely useful comments and suggestions. We thank seminar and conference participants at Sun Yat-sen University, Zhongnan University of Economics and Law and the 2019 Annual Meeting of China Trade Research Group for comments. Wang thanks support from the National Natural Science Foundation of China (No. 71703078). Yu thanks China's Natural Science Foundation (No. 71625007) and China's Social Science Foundation (No. 20ZDA050, No. 16AZD003) for financial support.

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1 Introduction

How movements in exchange rates affect the prices of internationally traded goods has been an actively studied topic in international economics. In the existing literature, extensive efforts have been made to estimate the *exchange rate elasticity of export prices*, most of which are based on aggregate data, yielding widely varying results. Yet, the underlying mechanism of *exchange rate pass-through* (henceforth ERPT) remains understudied. Based on disaggregated transaction-level data, a recent line of work identifies certain firm-level characteristics as important factors affecting the exchange rate elasticity, including exporters' productivity (Berman et al., 2012; Li et al., 2015), export product quality (Auer et al., 2018; Chen and Juvenal, 2016), and so forth. These works provide helpful insights for understanding the ERPT mechanism.

In this paper, we study the potential impact of imports of *intermediate inputs* (henceforth inputs) on the exchange rate elasticity of export prices, which has received little attention to in the existing literature. We show theoretically and empirically that imported inputs' share, quality, and export quality affect ERPT deeply. Our study is empirically motivated by the following data patterns in China's General Administration of Customs data: (i) exporters who engage in input imports have better export performance than those who do not, and; (ii) exports and input imports overlap substantially. Our study is also motivated by a growing line of research that finds that exporters adjust their export product scope and upgrade export quality in response to input trade liberalization (Goldberg et al., 2010; Feng et al., 2016; Fan et al., 2015, 2018), which also echoes the data pattern (i) above.

As a first step, we construct a theoretical model to illustrate how input import activities affect export prices in response to exchange rate movements. We take the economic model of Amiti et al. (2014) as our starting point and depart from there by allowing for input and output qualities to be endogenously chosen by exporters. Another distinct feature in our model is that exporters source inputs from multiple countries and can freely choose import sourcing countries in response to exchange rate movements. Our theoretical model predicts that a firm's exchange rate elasticity of export prices depends on the change in the marginal cost of export products (i.e., through the *marginal cost* channel) and the exporters' ability to upgrade (or downgrade) their input and out qualities (i.e., through the *quality change* channel). When product quality cannot be chosen, or is treated as exogenous, the *marginal cost* channel plays a dominant role.

Guided by the theoretical model, we specify imported inputs share and product quality as the key explanatory variables, and export prices as the explained variable, in our baseline regression for the empirical analyses. We find strong evidence of the existence of the *marginal cost* and *quality change* channels. Particularly for exporters with a low degree of quality change, the exchange rate elasticity of export prices increases noticeably, from 3% to 22%, when moving the imported inputs share from the 5th percentile to the 95th percentile, indicating that the use of imported inputs has a substantial impact through *marginal cost* on ERPT. In comparison, for exporters with a high degree of quality change, the exchange rate elasticity of export prices decreases slightly, from 9% to 8%, when moving the imported inputs share by the same amount, which indicates the existence of the *quality change* channel and that the impact of the use of imported inputs through the *quality change* channel slightly surpasses that through the marginal cost channel for this particular type of exporters. Our empirical study yields the following additional findings: (i) the *marginal cost* channel is weaker for products with larger scope for quality differentiation or firms with a greater ability to upgrade quality, as expected by the theoretical model; and (ii) exporters upgrade their input and product quality facing home currency appreciation; and (iii) overall, the *marginal cost* channel dominates the *quality change* channel.

As RMB appreciation is an essential cause of competitive pressure on Chinese exports, we analyze the impacts of RMB exchange rate movements on Chinese export quantity and value. Briefly, we find that export quantity and value decrease by greater magnitudes for products with a low degree of quality upgrading compared with products with a high degree of quality upgrading. With the observation of significant variation in quality upgrading and imported inputs share among Chinese exporters, we show that these two channels are key in understanding the sensitivity of Chinese export prices to RMB exchange rate movements and variations in ERPT across firms and products.[1]

Our study contributes to the recent line of work that links the exchange rate elasticity to firm-level characteristics (Chatterjee et al., 2013; Amiti et al., 2014; Bernini and Tomasi, 2015; Li et al., 2015). Among these works, our study is most closely related to Li et al. (2015). We use the same data set, the Chinese Customs Data, as Li et al. (2015). And one of our main empirical findings, that RMB prices are insensitive to exchange rate movements, is consistent with theirs. Nevertheless, our study differs from Li et al. (2015) in two major aspects: (i) Li et al. (2015) mainly focus on firm productivity, showing its impact on ERPT, while we mainly focus on input imports and quality (of input and output), controlling for productivity as a robustness check; and (ii) we make a major effort to explain our empirical findings, based on the proposed theoretical model featuring endogenous quality choice. Therefore, our study complements Li et al. (2015).

Moreover, our study provides new insights into the underlying mechanism of ERPT. We extend the seminal work of Amiti et al. (2014) by taking into account the quality choice of firms, and examine how it affects the ERPT. We build on the theoretical framework of Amiti et al. (2014), and borrow the idea from Fan et al. (2018) to endogenize input and output qualities as exporters'

[1] Product-level evidence from China shows that ERPT into import prices is nearly complete. For example, Li et al. (2015) find that the average ERPT for Chinese exporters is around 95%. But they remain silent on explanations for the low exchange rate elasticity of export prices. Berman et al. (2012) also find very high ERPT using French firm-level data.

choices when facing bilateral exchange rate movements.[2] We show theoretically that exchange rate movements affect export prices through two offsetting channels – the *marginal cost* and *quality change* channels. This main theoretical prediction, together with our empirical validation and quantification of both channels, nicely explains the insensitivity of RMB prices to exchange rate movements. Overall, the impact through the *marginal cost* channel dominates that through the *quality change* channel among Chinese exporters, but not by much in magnitude. We note that Bernini and Tomasi (2015) adopt a framework similar to Amiti et al.'s (2014). Although allowing for heterogeneity in input qualities, Bernini and Tomasi (2015) still treat qualities as exogenously given. They also assume 100% imported input share. Our study differs from Bernini and Tomasi (2015) by treating both qualities and imported input share as endogenously chosen by exporters.

By endogenizing quality choice, we show how firm-product heterogeneity in quality change maps into firm-product heterogeneity in the exchange rate elasticity of export prices. Our theoretical model and empirical result show that the *quality change* channel is vital in understanding the exchange rate elasticity of export prices. We also show that *quality change* in exports generated by exchange rate movements is prevalent in our sample, especially in the differentiated goods sector. It is worth noting that existing estimates of the *exchange rate elasticity of export prices* vary across countries. Our framework is potentially applicable to (partially) explaining those varying estimates by considering the endogenous quality choice.[3] However, admittedly, the empirical validity of such an explanation needs to be carefully examined.

The remaining parts of the paper are organized as follows. Section 2 introduces the data used in the paper and provides some important data pattern on the link between a firm's imported inputs and export prices and the adjustments of export prices, quality, and imported inputs during the sample period. Section 3 develops a model to interpret how a firm's export prices are affected by exchange rate movements by endogenizing the input imports and exports quality decision. Section 3 also presents our empirical specification and baseline results, guided by the theoretical model. Section 4 provides a series of robustness checks and further discusses the potential channels. Section 5 concludes.

[2]In their theoretical model, Fan et al. (2015) show that input tariff reduction induces exporters to upgrade their output quality. Following similar logic, with nevertheless nontrivial modifications, we model quality changes as endogenous choices by exporters in response to exchange rate movements.

[3]For instance, based on Belgian data, Amiti et al. (2014) find the euro prices to be somewhat sensitive to exchange rate movements among Belgian exporters, as opposed to the finding of price insensitivity among Chinese exporters. A possible explanation for the high (estimated) elasticity, according to our theory, is that the *marginal cost* channel dominates the *quality change* channel by a large margin in this case.

2 Data Description and Patterns

2.1 Data Description and Variable Construction

Our main data source is China's General Administration of Customs. The trade data are compiled at the Harmonized System (HS) 8-digit product level. They include information on each product's quantity, value (in US dollars), type of trade (i.e., processing or non-processing), and export destinations (or import sources). Our sample period spans from 2000 to 2011. The raw data on transactions are recorded at monthly frequency before 2007 and yearly frequency since 2007. We collapse the data set at the yearly frequency level for the analysis. We use the concordance table from the United Nations (UN) Statistics Division to unify the commodity classification system.[4] Specifically, we use the HS 1996 classification code for defining products. We define products at the HS 6-digit level. And to be consistent with our theoretical analysis, we restrict our data sample to manufacturing firms by deleting all observations of trade intermediaries.[5] To alleviate the impacts of outliers, following Devereux et al. (2017) and Xu et al. (2019), we restrict the sample to price changes within the -300% to +300% range. Around 46% of the observations remain in our sample. Our variable of interest, the unit price, is calculated as export value divided by export quantity for each transaction.[6] As the export value is expressed in US dollars in Chinese Customs, we convert the unit price to an RMB-denominated price for the empirical analyses.

The main macro-level data, including the exchange rate and Consumer Price Index (CPI), are from the International Monetary Fund's International Financial Statistics. Observations on other macro-level variables, such as real gross domestic product (GDP) and real GDP per capita, are from the Penn World Table 8.0. The *bilateral real exchange rate index of the RMB* (henceforth RER) over destination country c's currency in year t is constructed as

$$RER_{ct} = \frac{NR_{ct} * P_{ct}}{P_{CH,t}}, \tag{1}$$

where NR_{ct} is the bilateral nominal exchange rate of the RMB over destination country c's currency (in direct quote), P_{ct} is country c's CPI, and $P_{CH,t}$ is China's CPI. We use year 2000 as the base period, thus $RER_{c,2000} = 1$. An increase in RER_{ct} denotes a real depreciation of the RMB

[4] The commodity classification system changes every five years. Before 2002, China's Customs used HS 1996 to define products. From 2002 to 2006, it used HS 2002, and from 2007 to 2011, HS 2007 to define products. The concordance table we use in this paper is from the UN Statistics Division: https://unstats.un.org/unsd/cr/registry/regdnld.asp?Lg=1.

[5] We follow the criteria in Tang and Zhang (2012b) for identifying the trade intermediaries. Specifically, we search for the keywords "waimao," "maoyi," "waijing," "jinchukou," "jingmao," "gongmao," "kemao," and so forth among Chinese firm names. If a firm's name includes such keywords, we identify the firm as a trade intermediary.

[6] There were a few inconsistencies in the units of transactions for each firm-product-country pair. We deleted those observations to exclude their impacts on the measure of the unit price.

against destination country c's currency. Figure 1 plots the RER indexes (defined above) over five of China's major trade partners – the United States, Japan, South Korea, Germany, and the United Kingdom – from 2000 to 2011.[7] According to Figure 1, the RMB has been appreciating in real terms against the currencies of all five partners roughly since 2006, with substantially more appreciation against the euro, British pound, and South Korean won than against the U.S. dollar and Japanese yen.[8]

[Insert Figure 1 Here]

2.2 Data Patterns

To extract useful information from the data, it is helpful to construct the *real effective exchange rate index of the RMB* (henceforth, REER) and proper export price indexes. The REER measures the strength of the RMB relative to an export-share-weighted basket of all other currencies. It is constructed as

$$REER_t = \prod_{c,t} RER_{ct}{}^{w_{c,t}} \tag{2}$$

for a given year t, where w_{ct} denotes the export share of China's total exports to destination c in year t, and RER_{ct} is the real exchange rate index of the RMB over and destination c in year t defined by Equation (1).

For the export price indexes, we categorize products into homogeneous products and differentiated ones according to Rauch (1999). Based on the Tornqvist index (Feenstra and Weinstein, 2017), we construct price indexes for the two categories as

$$Tindex\_homo_t = \prod_{c,k \in \mathscr{H}} \left(\frac{uv_{c,k,t}}{uv_{c,k,t-1}}\right)^{\overline{w}_{c,k,t}}, \quad \text{and} \quad Tindex\_diff_t = \prod_{c,k \in \mathscr{D}} \left(\frac{uv_{c,k,t}}{uv_{c,k,t-1}}\right)^{\overline{w}_{c,k,t}}, \tag{3}$$

respectively, where $w_{c,k,t}$ is the import share of product k in country c's total imports, $\overline{w}_{c,k,t}$ is the simple average value of the import share at times t and $t-1$,[9] $uv_{c,k,t}$ denotes the unit export price of China's product k to its trade partner c, and $\mathscr{H}$ and $\mathscr{D}$ are the sets of homogeneous products and differentiated ones, respectively. We use year 2000 as the base period for both price indexes.

Figure 2 plots the time series for the REER and the two export price indexes (for homogeneous and differentiated products, respectively), from the BACI database and International Financial

[7] In our data, excluding exports to Hong Kong, Macao, and Taiwan, five countries were China's top trade partners: the United States (ranking first for exports, third for imports), Japan (second for exports, first for imports), South Korea (third for exports, second for imports), Germany (fourth for exports, fourth for imports), and the United Kingdom (sixth for exports, 22nd for imports).

[8] Germany has adopted the use of the euro since 1999.

[9] Here we use the simple average share at times t and $t-1$, to smooth the effects of outliers.

Statistics.[10]

[Insert Figure 2 Here]

According to Figure 2, the RMB has experienced a continuous and quick appreciation since 2006. The REER index increased from 1.01 in 2005 to 0.39 in 2011 – an appreciation of $61.4\%(=1-\frac{0.39}{1.01})$. Both export price indexes increased, although by different magnitudes. The export price index of homogeneous goods more than tripled during the sample period, while that of differentiated goods increased by around 50%, which is noticeably less. In short, Figure 2 indicates a trend of RMB appreciation since 2006 and increasing export prices in RMB during the same period.

From a more micro perspective, we look into adjustments in export prices and export scale for given firm-product or firm-product-destination pairs. We summarize our findings in Table 1, where we distinguish between *importing exporters* and *non-importing exporters* according to whether they engaged in (intermediate) input imports in the same year.[11] According to panel A in Table 1, *importing exporters* exported at larger scales, in terms of total exports, number of export destinations, and number of HS 6-digit exporting products, compared with *non-importing exporters* did. In panel B in Table 1, we report changes in (log) export prices by *incumbent exporters*, that is, those exporting the same product to the same destination in consecutive periods. According to panel B, among *incumbent exporters*, the export prices of *importing exporters* were higher on average than those of *non-importing exporters*. Moreover, although the export prices of both groups increased over the sample period, the price increment was larger for *importing exporters*. Table 1 exhibits the following fact:

Fact 1. *Exporters who engage in input imports have better export performance than those who do not, in terms of larger scale of exports and higher export prices.*

[Insert Table 1 Here]

Next, we explore the use of imported inputs among *incumbent exporters*. Table 2 reveals the novel fact of the high overlapping pattern between export destination countries and import sourcing countries. We report the share of imported inputs involving imported inputs from the same export destination in terms of export transaction frequency and value for 2001, 2011, and the sample period average. Column (3) in Table 2 shows that on average, around $56.7\%(=1-43.3\%)$ of the export transactions involved imported inputs, among which around $47.6\%(=1-\frac{29.7\%}{56.7\%})$ of the

[10]The BACI database is provided by CEPII, covering all bilateral trade data for more than 200 countries since 1995. The classification code using in this data is HS 1996. Products are defined at the HS 6-digit level.

[11]We define the intermediate input by the Broad Economic Categories (BEC) classification. We convert the BEC classification to HS 1996 product classification using the World Integrated Trade Solution (WITS)'s concordance table: https://www.google.com/url?q=https://wits.worldbank.org/product_concordance.html.

export transactions involving input imports from the same export destination. As shown in column (6), export transactions involving input imports from the same export destination contributed more to export value than their share in total export transactions on average, at around $59.4\% (= 1 - 18.4\% - 22.2\%)$ of total exports. In sum, Table 2 exhibits the following fact:

Fact 2. *Exports and input imports overlap substantially.*

[Insert Table 2 Here]

3 Baseline Analyses

3.1 Theoretical Model

To save space, we sketch a theoretical model to illustrate the interactive roles of the shares of imported inputs and export product quality in determining firms' exchange rate pass-through.[12] To begin with, note that exchange rate movements directly affect the cost of imported inputs, which in turn affects export prices in two offsetting channels: the *marginal cost* and *quality change* channels.

Consider a case of home currency appreciation that directly reduces the cost of imported inputs. As illustrated by Figure 3, on the one hand, through the *marginal cost* channel, a decrease in the cost of imported inputs reduces the overall marginal cost of producing the final product (to be exported), and, in turn, drives down the export prices, given that both inputs and outputs qualities are fixed. On the other hand, through the *quality change* channel, a decrease in the cost of imported inputs potentially encourages firms to pursue higher quality for their final products by upgrading to better inputs, since better inputs are now more affordable now. This drives up the marginal cost of the final product. Since the *quality change* and *marginal cost* channels drive export prices towards opposite directions, they generate offsetting effects on the exchange rate elasticity of export prices. Our model also predicts the following contributing factors to export quality upgrading: a reduction in the cost of imported inputs, an increase in import intensity, and quality upgrading of imported input, all of which can be induced by home currency appreciation. We then discuss two different cases with and without allowing exporters to choose optimal quality.

[Insert Figure 3 Here]

Under a set of regularity conditions (specified in the Appendix), we derive the following testable implications: When there is a real appreciation of the home currency, exporters will lower the prices of exports when the *marginal cost* effect dominates the *quality change* effect in products

[12] A detailed and rigorous presentation of the model is provided in the Appendix.

with a low degree of quality differentiation. Exporters would increase the export prices when the *quality change* effect dominates the *marginal cost* effect in products with a high degree of quality differentiation. These theoretical results are formally stated as **Proposition A.1**, with detailed proofs, in the Appendix.

We also consider the impacts of exchange rate movements on a firm's input quality. In this case, exchange rate movements induce exporters to adjust input quality. In response to a real appreciation of the home currency, exporters would lower the quality for imported inputs when producing products with a low degree of quality differentiation. Exporters may increase the quality for imported inputs only when producing products with a high degree of quality differentiation. These results are formally stated as **Corollary A.1** in the Appendix.

In summary, our theoretical model predicts that adjustments in export prices depend on the imported inputs ratio (i.e., *marginal cost*) and the degree of quality differentiation of the firm's product (i.e., *quality change*). In addition, firms adjust input price and quality in response to exchange rate movements. We now set up a baseline econometric model to examine the empirical validity of the above-mentioned theoretical implications.

3.2 Input Imports and ERPT: Empirical Specification

In this subsection, we first formally introduce the baseline empirical specification. Then we report our empirical findings on the average ERPT among Chinese exporters and its variation across exports with heterogeneous input imports. These findings suggest the prevalence of the *marginal cost* channel. We test theoretical implications on the role of *quality sorting* in the next subsection. To link input imports to ERPT in empirically, we consider the following baseline specification:

$$\begin{aligned} \Delta lnExportprice_{fpct} &= \alpha + \beta_1 \Delta lnRER_{ct} + \beta_2 \Delta lnRER_{ct} \times IMshare_{fct} \\ &\quad + \beta_3 IMshare_{fct} + \gamma' W_{ct} + \nu_{fpc} + \lambda_t + \varepsilon_{fpct} \end{aligned} \tag{4}$$

with subscripts f, p, c, and t indicating exporter, product (at the HS 6-digit level), export destination, and year, respectively. The dependent variable $\Delta lnExportprice_{fpct}$ is the first-difference of the log export price, representing the export prices movement.[13] $IMshare_{fct}$ and $\Delta lnRER_{ct}$ are the key explanatory variables. $IMshare_{fct}$ is the share of exporter f's inputs sourced from destination c in its total imports, and is constructed as

$$IMshare_{fct} = \frac{Import_{fct}}{\sum_d Import_{fdt}}, \tag{5}$$

[13] $\Delta lnExportprice_{fpct} = lnExportprice_{fpct} - lnExportprice_{fpc(t-1)}$.

where $Import_{fct}$ is exporter f's input imports value from country c in year t.[14] $\Delta lnRER_{ct}$ is the first difference of the log RER (previously defined by Equation (1)), representing real exchange rate movements. W_{ct} is a vector of covariates that we include to control destination country characteristics, such as the real GDP and real GDP per capita. v_{fpc} is the firm-product-destination fixed effects, incorporating time-invariant factors that likely affect export pricing, such as the geometric and economic distances, culture, and consumer preferences. And λ_t is the time fixed effects, incorporating contributing factors that are common to all firm-country-product pairs, such as the price level and economic trend of the domestic country (i.e., China in the current study). ε_{fpct} is the idiosyncratic error.

An identification issue arises in Specification (4), due to heterogeneous impacts of input import activities on export performance across firms, as documented in the recent literature (see, Feng et al. 2016 and Fan et al. 2018, among others). That is, β_2 and β_3 vary across firms. More importantly, the decision to engage in input imports is endogenous to firms. Existing works, such as Fan et al. (2018) and Bastos et al. (2018), find that exporters are more likely to import higher quality intermediate inputs or source intermediate inputs from high-income countries for export quality upgrading. If so, a firm's extent of input imports engagement, measured by the imported inputs share, is also endogenous, as firms with a high share of imported inputs are more likely to charge higher export prices. Thus, our estimation equation contains random coefficients that are correlated with the endogenous imported inputs share. Therefore, it is a correlated random coefficients (CRC) model (Wooldridge, 2008).

Following Heckman and Vytlacil (1998), we handle the CRC model to identify average coefficients via a series of exogenous variables Z_{fct} (to be specified soon). Specifically, we have

$$IMshare_{fct} = E(IMshare_{fct}|Z_{fct}) + \epsilon_{fct}, \quad \text{with} \quad E\left(\epsilon_{fct}|Z_{fct}\right) = 0. \tag{6}$$

Substituting Equation (6) into Equation (4) yields

$$\begin{aligned} \Delta lnExportprice_{fpct} \quad = \quad & \alpha + \beta_1 \Delta lnRER_{ct} + \beta_2 \Delta lnRER_{ct} \times E(IMshare_{fct}|Z_{fct}) \\ & + \beta_3 E(IMshare_{fct}|Z_{fct}) + \gamma' W_{ct} + v_{fpc} + \lambda_t + u_{fpct}, \end{aligned} \tag{7}$$

where the error term $u_{fpct} = (\beta_2 \Delta lnRER_{ct} + \beta_3)\, \epsilon_{fct} + \varepsilon_{fpct}$.[15] The estimation is based on a feasible

[14] Our measure of import intensity is different from that of Amiti et al. (2014), who use firm-level imported inputs share (measured as the ratio of the firm's imported inputs overt total intermediate inputs). We would suffer a great loss of data if we replaced the current denominator with total intermediate inputs, as this information is only available before 2008 in the merged data sets. And we find that the two imported input shares are highly correlated. Therefore, we use the other measure in a robustness check.

[15] The conditional homoscedasticity of covariance assumption for the term $\epsilon_{fct}\varepsilon_{fpct}$ is needed to ensure that the estimates are unbiased.

version of Equation (7), in which $E(IMshare_{fct}|Z_{fct})$ is replaced by a predicted value $IMs\hat{h}are_{fct}$ obtained via a type-2 Tobit model, or, equivalently, a bivariate sample selection model (Cameron and Trivedi, 2005).[16] The type-2 Tobit specification is as follows:

(i) An intermediate input imports participation equation,

$$IMdummy_{fct} = \begin{cases} 1 & \text{if } V_{fct} \geq 0; \\ 0 & \text{if } V_{fct} < 0, \end{cases} \tag{8}$$

where V_{fct} is a vector of latent variables determining firm f's use of imported inputs.

(ii) An "outcome" equation, where Z_{fct} is a series of exogenous variables in the corresponding Heckman selection equation, including the firm-level input tariff, real GDP per capita, and real GDP in the importing country. Specifically, China's import tariff rate for product p at the HS 6-digit level (τ_{pt}), is recorded by and available from the Wrold Trade Organization (WTO).[17] We construct the firm-country-level input tariff as $FIT_{fct} = \sum_{p=1}^{N} w_{fpc} * \tau_{pt}$, a weighted average of the τ_{pt}'s over HS-6 products, with the weight w_{fpc} being product p's imported inputs share in firm f's total input imports from country c. Following Topalova and Khandelwal (2011) and Yu (2015), to avoid potential endogeneity, we use imported inputs shares from the initial sample period, rather than the current period, for computing the time-invariant weights (w_{fpc}).[18] Hence, the weights are time-invariant.

The type-2 Tobit model above is estimated by the Heckman two-step procedure, which requires a vector of excluded variables that affect the firm's import decision but does not appear in the extent of imports. We include the importer's importing age and importing cost of border compliance in the selection equation as the excluded variables. Importer's importing age ($Importerage_{fct}$) is defined as the current year minus the importer's initial year of importing from a given source country. We use it as a measure of the importer's experience. Previous literature points out that export probability is higher for more experienced firms (Amiti and Davis, 2012). The importing cost of border compliance ($Importcost_{ct}^{border}$) is measured as the monetary cost of compliance with the economy's customs regulations and with regulations relating to other inspections for exporter's shipment to cross the border in the country c.[19] The importing cost of border compliance is classified as a fixed cost; thus, we believe it only affects the decision whether to import or not, and it does not affect the value of imports.

[16] Feenstra et al. (2014) and Yu (2015) adopt the same method to estimate average effects in CRC models.

[17] China's import tariff data are from the WTO webpage: http://tariffdata.wto.org/ReportersAndProducts.aspx.

[18] Since a firm will lower its imported inputs share of the product with an increase in input tariff rates, using imported inputs shares from the current period (for computing the w_{fpc}'s) would introduce endogeneity and lead to an underestimation of the actual input tariff facing importers.

[19] The data are from the World Bank's Investment Climate Report, http://data.worldbank.org/indicator/IC.EXP.CSDC.CD?.

[Insert Table 3 Here]

In Table 3, we report the estimation results for the Heckman two-step selection model. According to columns (2) and (4), from the first-step probit estimates, importers are less likely to import intermediate inputs with a higher firm country-level input tariff. In addition, we find that a higher importing cost of border compliance would dampen the firm's intention to import intermediate inputs.[20]We obtain our fitted value of the firm's imported inputs share from a sourcing country ($IM\hat{share}_{fct}$) with controlling for the endogenous selection of imported inputs use in columns (1) and (3).

In Table 4, we report empirical results on the average ERPT and its variation across exports with heterogeneous input imports engagements. These results suggest the prevalence of the *marginal cost* channel. According to column (1), at the annual horizon, the average exchange rate elasticity of export prices is 0.08, which is equivalent to a $92\%(=1-0.08)$ ERPT (into import prices). In column (2), we control for product-destination fixed effects and year fixed effects, in addition to column (1)'s specification, and we obtain a similar estimate for ERPT. Our ERPT estimate (for China) is higher than the estimates for some other countries. For instance, Amiti et al.'s (2014) ERPT estimate for Belgian exporters is around 80%. And Berman et al.'s (2012) estimate for French exporters is around 87%. A possible explanation is centered around the offsetting effects from the *quality change* channel: Chinese exporters might be more actively engaged in *quality sorting* and, hence, experience stronger effects from the *quality change* channel. This would be because Chinese exporters are at an earlier stage of quality upgrading, compared with exporters in high-income countries (such as Belgium and France) do. Nevertheless, the empirical relevance of such an explanation needs to be carefully examined, which is beyond the scope of the current study.

In columns (3) and (4) in Table 4, we separately estimate the exchange rate elasticity of export prices for *importing exporters*, and for *non-importing exporters*. The exchange rate elasticity of export prices for *importing exporters* is noticeably higher than that for *non-importing exporters*. On average, following a 10% appreciation of the RMB real exchange rate, the export prices among *importing exporters* decrease by 1.1%, while prices among *non-importing exporters* decrease by only 0.4%. In column (5), we report estimation results based on regression Equation (7), where the imported inputs share (estimated) and its interaction with exchange rate movement are included. In column (6), we slightly modify the specification of Equation (7)'s specification as a robustness check, where the imported inputs share is replaced by the imported inputs dummy (defined by

[20]Further, the importing cost of border compliance cost and importer's age have weak explanatory power for the importer's use of imported inputs. Further, when we include the importing cost of border compliance and importer's age in the second-step Heckman estimate, we find that the joint contribution of the two variables in explaining the variation in input imports value is less than 1%. Hence, we have validated the appropriateness of our choice of excluded variables.

Equation (8)), $IMd\hat{u}mmy_{fct}$, as an alternative measure of the use of imported inputs. The results in both columns (5) and (6) show that the exchange rate elasticity of export prices increases with imported inputs use from the same export destination, which is consistent with the findings in columns (3) and (4).[21]

[Insert Table 4 Here]

3.3 Quality Change, Input Imports and ERPT

Our theoretical model predicts that compared with the *marginal cost* channel, the *quality change* channel has an opposite impact on export prices. It is through the *quality change* channel that a real appreciation of the home currency affects export prices positively (i.e., drives up the prices), rather than driving down the prices, as suggested by the *marginal cost* channel, because exporters are more motivated to pursue quality upgrading when facing home currency appreciation. The effect from the *quality change* channel is relatively strong for products with a large scope for quality differentiation, and for exporters that are capable of making quality adjustments. In this subsection, we test the empirical validity of this prediction to examine the existence of the *quality change* channel among Chinese exporters, and then we quantify the magnitudes of both channels.

To test the theoretical prediction above, we utilize quality differentiation at two different levels – the product level and firm-product-destination level. At the product level, we distinguish between homogeneous products and differentiated products according to Rauch (1999) and Kugler and Verhoogen (2012). If the *quality change* channel exists, we expect that the *marginal cost* channel's impact on the exchange rate elasticity of export prices is weaker, because for differentiated products the *quality change* channel has a stronger impact, it offsets a greater portion of the impact from the *marginal cost* channel. As we will show, our empirical findings ascertain this case. At the firm-product-destination level, we take a closer look to provide further evidence on the existence of the *quality change* channel by introducing a firm-product-country level measure for the quality change measure in baseline equation (7).

We report and compare the ERPTs for products with different quality differentiation at the product level in Table 5. We use Rauch's (1999) classification to define two subgroups of products, homogeneous products ($Diff_p = 0$) and differentiated products ($Diff_p = 1$). According to the estimation results in Table 5, columns (1) and (2) show that the *marginal cost* channel is much stronger in homogeneous goods than differentiated goods. We report the estimation results in column (1) with imported inputs use measured as imported inputs share. In column (2), we measure

[21] We also try an additional modified equation, where the lagged term for imported inputs share is used. We obtain very similar results, which we omit to save space.

the imported inputs use as a predicted dummy. We interpret the results in column (2) quantitatively: the ERPT for *importing exporters* is 85 percentage points lower than that for *non-importing exporters* for homogeneous products. For differentiated products, the ERPT for *importing exporters* is only 30 percentage points(=0.85-0.55) lower than that for *non-importing exporters*. In columns (3) to (6), following Kugler and Verhoogen (2012), we replace the product quality differentiation measure with research and development (R&D) intensity and the Gollop-Monahan (GM) index and the estimations yield similar results.[22] [23]

[Insert Table 5 Here]

Observing a notable variation in quality change across firms within the same product category shown in the data, we introduce a firm-product-destination level measure for quality change to facilitate further analysis. The firm-product-destination level measure, denoted by $\widetilde{Q}_{fpct}$, is defined as the first difference of log product quality: [24]

$$\widetilde{Q}_{fpct} \equiv \Delta ln Q_{fpct} \tag{9}$$

where Q_{fpct} is a quality measure a la Khandelwal et al. (2013) and Fan et al. (2015), for firm f's export product p to destination c.[25] Specifically, Q_{fpct} is constructed as the residual from ordinary least squares (OLS) estimation of the product and destination-year fixed effects (denoted by φ_p and φ_{ct}, respectively) based on the following regression:

$$lnx_{fpct} = \sigma lnp_{fpct} + \varphi_p + \varphi_{ct} + \varepsilon_{fpct} \tag{10}$$

where x_{fpct} is product quantity, p_{fpct} is product price, and σ represents the elasticity of substitution across different products.[26] That is, $Q_{fpct} \equiv \widehat{\varepsilon}_{fpct} = lnx_{fpct} - \sigma lnp_{fpct} - \hat{\varphi}_p - \hat{\varphi}_{ct}$, with $\hat{\varphi}_p$ and

[22] R&D intensity is defined as (r&d expenditure + advertisement cost)/sales. The GM index is constructed as: $GM_k = \sum_{j,t} w_{j,k,t} (\sum_i \frac{|s_{i,j,k,t} - s_{i,\bar{k},t}|}{2})^{1/2}$,where i, j, k and t denotes intermediate input, firm, industry and year, respectively. $s_{i,j,k,t}$ denotes the cost share of firm j in industry k for intermediate input i at time t. $s_{i,\bar{k},t}$ denotes the average cost share of firms in industry k for intermediate input i at time t. $w_{j,k,t}$ is firm j's market share in industry k at time t. This measure is constructed according to Bernard et al. (2007). The raw data are at the International Standard of Industrial Classification second version's 4-digit level. We use the concordance table from UN COMTRADE to match the data to the HS 1996 6-digit level.

[23] Bernini and Tomasi (2015) try a similar specification using the initial value of export product quality instead of export product quality change in the triple interaction. Different from their explanation, we propose the endogenous quality change generated by the exchange rate movements as the key channel. We also included the quality and all its interactions in the regression for a robustness check and found that our baseline results remain robust.

[24] We also tried one-period lag value, moving average value, and mean value of the quality change in the robustness checks to alleviate endogeneity. Our baseline conclusion did not change with different quality change measures.

[25] These papers assume a constant elasticity of substitution utility function incorporating product quality. Under this assumption, the individual demand function can be written as: $x_{fpct} = q_{fpct}^{\sigma-1} p_{fpct}^{-\sigma} P_{ct}^{\sigma-1} Y_{ct}$,where x_{fpct}, q_{fpct}, p_{fpct} are export quantity, quality, and price, respectively. P_{ct} and Y_{ct} are country c's price level and income level, respectively.

[26] Like in Fan et al. (2015), we plug in Broda and Weinstein's (2006) mean and median value estimates for σ.

$\hat{\varphi}_{ct}$ being the OLS estimators. The economic intuition is to use the unit price and export quantity to infer product quality from the demand side. Given the same product price, if a product's export volume is higher than that of another product within the same product category, it is considered a higher quality product. In Table A.5, we see that larger exporters are associated with much higher total input import growth rates. [27]

Adding the quality change measure $\widetilde{Q}_{fpct}$ and its interaction with the existing regressors to Equation (7), we obtain the following specification:

$$\begin{aligned}\Delta lnExportprice_{fpct} = \; & \alpha + \beta_1 \Delta lnRER_{ct} + \beta_2 (\Delta lnRER_{ct} \times E(IMshare_{fct}|Z_{fct})) \\ & + \beta_3 (\Delta lnRER_{ct} \times \widetilde{Q}_{fpct}) + \beta_4 (E(IMshare_{fct}|Z_{fct}) \times \widetilde{Q}_{fpct}) \\ & + \beta_5 (\Delta lnRER_{ct} \times E(IMshare_{fct}|Z_{fct}) \times \widetilde{Q}_{fpct}) + \beta_6 E(IMshare_{fct}|Z_{fct}) \\ & + \beta_7 \widetilde{Q}_{fpct} + \gamma' W_{ct} + v_{pc} + \lambda_t + u_{fpct} \end{aligned} \tag{11}$$

Table 6 reports the estimation results based on Equation (11). Based on Proposition A.1, we should expect a negative coefficient on the triple interaction term (β_5) in Equation (11): for firms with a high ability to adjust the exported product's quality, the *quality change* channel will weaken the *marginal cost* channel of imported inputs. The estimation results in Table 6 provide evidence to support our conjecture, with the coefficient on the triple interaction term being negative and significant.

We quantify the relative magnitudes of the *marginal cost* and *quality change* channels by comparing two particular types of exporters, referred to as types LC and HC. LC exporters have a very low degree of quality change (at the 5th percentile), and HC exporters have a very high degree of quality change (at the 95th percentile). Presumably, both two channels would appear in HC exporters' experience, while only the *marginal cost* channel would appear in LC exporters' experience. According to column (1) in Table 6, when moving the imported inputs share from the 5th percentile to the 95th percentile, the exchange rate elasticity of export prices for LC exporters

[27] Table A.5 summarizes the time series of quality change at the firm-product-destination-level measure $\widetilde{Q}_{fpct}$. To link quality change to imported input use, we also summarize the time series of firm-level imported inputs use in the same table. In panel A, we report the summary statistics of the full sample. Accordingly, the export qualities and imports of intermediate inputs grew rapidly in the sample, with annual growth rates of 2.6% and 0.2%, respectively. To exclude the impacts of the global financial crisis, we recalculated the annual growth rates of export product quality and imported inputs with a sample without observations during the global financial crisis. We find that the annual growth rates of the reduced sample were much higher than those of the full sample. A possible explanation is a large decline in the production capacity of the imported inputs providers. We find consistent evidence from the data on imports of intermediate inputs by Chinese exporters. During 2008–2009, there was a plummet in intermediate input imports by Chinese exporters, with an accumulated percentage decline of over 20%. Panel B in Table A.5 offers information on annual growth rates for various subsamples. Products exported to developed countries had higher growth rates in quality compared with products exported to developing countries did. Our summary statistics are consistent with the findings in Hallak and Schott (2011) and Feenstra and Romalis (2014). Both studies confirm a positive relationship between import quality and the importing country's income level.

increases noticeably, from 3% to 22%, indicating a substantial impact from the *marginal cost* channel. In comparison, the exchange rate elasticity of export prices for HC exporters decreases slightly, from 9% to 8%. The slight decrease in the elasticity for HC exporters, as a result of the collision between the two offsetting channels, indicates that the *quality change* channel slightly dominates the *marginal cost* channel for this particular type of exporters.

[Insert Table 6 Here]

4 Robustness Checks and Further Discussions

4.1 Exports and Input Imports Activity Engagement

We take an alternative approach to quantify the magnitudes of the two channels, namely, the *marginal cost* channel and the *quality change* channel by exploiting heterogeneous ERPT between firms with different sourcing and export destinations and those with identical (sourcing and export) destination. To explain the idea, consider the following thought experiment: Two firms, say, A and B, import the same amount of inputs, and export the same amount to the same destination country. Yet, firm A imports from its export destination, while firm B imports from countries other than its export destination. Heuristically, both channels would appear in firm A's experience, while only the *quality change* channel would appear in firm B's experience. Therefore, comparing the ERPT of these two types of firms would provide additional insights on the relative size of the two channels.

To implement this thought experiment, we divide the observations into four bins according to export value and imported inputs use. The four bins are as follows:

$$\begin{cases} \textbf{Bin 1}: & \text{If } Export_{fct} \geq median_f(Export_{fct}) \text{ and } Import_{ft} \geq median_f(Import_{ft}); \\ \textbf{Bin 2}: & \text{If } Export_{fct} \geq median_f(Export_{fct}) \text{ and } Import_{ft} < median_f(Import_{ft}); \\ \textbf{Bin 3}: & \text{If } Export_{fct} < median_f(Export_{fct}) \text{ and } Import_{ft} \geq median_f(Import_{ft}); \\ \textbf{Bin 4}: & \text{If } Export_{fct} < median_f(Export_{fct}) \text{ and } Import_{ft} < median_f(Import_{ft}), \end{cases} \tag{12}$$

where $Export_{fct}$ is firm f's export value to destination country c, $Import_{ft} = \sum_c Import_{fct}$ is firm f's total input imports value, and $median_f(\cdot)$ represents the mathematical operator of taking median over all firms. Therefore, for firms within each bin, although they import inputs from different countries, their total input imports (from all countries), as well as their exports (to a given destination), are roughly comparable or at similar levels.

For each bin, we estimate regression equation (11) and report the results in Table 7. According to Table 7, our baseline findings remain valid for all four bins of exporters. Based on these estimation results, we can predict the exchange rate elasticity of export prices for two firms whose only noticeable difference is in their inputs sourcing countries (as described in the thought experiment) for comparison. To illustrate, consider two hypothetical exporters within Bin 1, firms A and B, both with the average level of quality change (0.02 for Bin 1) such that they export to the same destination c. Yet, firm A's imported inputs share is fixed at $IMshare_{A,ct} = 1$ (firm A sources all its imported inputs from the export destination c), while firm B's share is fixed at $IMshare_{B,ct} = 0$ (firm B sources all its imported inputs from countries other than c). As expected from our model, the exchange rate elasticity of export prices for firm A is higher than that for firm B, predicted at 0.210 and 0.049, respectively.[28]

[Insert Table 7 Here]

In addition, we provide more robustness checks by using alternative measures and alternative samples, by taking currency area and vehicle currency into account, and by exploring exporter size and destination heterogeneity. All such checks yield similar results, which are provided in the Appendix to save space.

4.2 Further Analysis of the Channels

We further decompose the export prices into export quality and net-quality export price. In columns (1) and (2) in Table 8, we examine the impact of exchange rate movements on export quality. If exporters adjust export quality in response to exchange rate movements, as predicted by our theoretical model, we expect exporters to upgrade their product quality when facing a reduction in imported inputs costs as a result of domestic currency appreciation. Moreover, we expect the impact to be magnified by increases in imported inputs share and degree of product quality differentiation. According to columns (1) and (2), these results are indeed the case, as indicated by the coefficients. In columns (3) and (4), we examine the impact of exchange rate movements on net-quality export price. In this way, we separate the *quality change* effect from the *marginal cost* effect. Consequently, the impact of input imports on the exchange rate elasticity of net-quality export prices is solely from the *marginal cost* channel. Following Fan et al. (2015), the net-quality export prices ($lnprice\,adjusted_{fpct}$) are defined as the log of export prices ($lnExportprice_{fpct}$) subtracting log of export quality ($lnQuality_{fpct}$). As shown in columns (3) and (4), the coefficients are consistent with our theoretical predictions of the *marginal cost* effect. Qualitatively similar results are obtained when the estimations are restricted to the subsample of ordinary exports, which we report in Table A.7 in the Appendix.

[28] We have $0.21 = 0.049 - 0.031 \times 1 \times 0.02 + 0.01 \times 0.02 + 0.165 \times 1$ and $0.049 = 0.049 - 0.031 \times 0 \times 0.02 + 0.01 \times 0.02 + 0.165 \times 0$.

[Insert Table 8 Here]

The imported inputs share, input quality, and export quality, as endogenous choices by exporters, should be affected by exchange rate movements. In Table 9, we empirically evaluate the impact of exchange rate movements on the imported inputs share and input and export qualities. According to column (1), Chinese exporters tend to increase their imported inputs share from a given country, say c, when the RMB appreciates against c's currency. In column (2), we analyze the impact of exchange rate movements on imported inputs quality, for which we use the unit price of inputs as a proxy, following Fan et al. (2018). $\widetilde{Q}_{ft}$ measures export quality at the firm level, and is constructed as the average value of $\widetilde{Q}_{fpct}$ over products and destinations.[29] As shown in column (2), the empirical result is consistent with Corollary A.1's prediction that exporters with a high ability to differentiate quality tend to increase input quality when facing home currency appreciation. [30] In column (3), we examine the impact of imported input quality change on the exchange rate elasticity of export quality. Again, we use the imported input's unit price ($IMprice_{fqct}$) as the proxy for imported inputs quality. $\Delta lnIMprice_{ft}$ is constructed as the average value of $\Delta IMprice_{fqct}$ over all imported inputs.[31] As shown in column (3), the coefficient on the interaction term suggesting that, in response to an appreciation of the home currency, exporters who upgrade imported input quality are usually associated with export quality upgrading. Together with our finding from column (2), this further suggests that exporters adjust imported input quality as a common way to adjust exported product quality when facing exchange rate movements, which is expected from our model.

[Insert Table 9 Here]

In the first two columns in Table 10, we extend our baseline empirical analysis (based on Equation (11)) to allow explicitly for the imported inputs share and quality to be affected by exchange rate movements. In column (1), we include an additional explanatory variable, denoted by $\Delta IMshare^{RER}_{fct}$, which is the predicted change in the imported inputs share based on the regression in column (1) in Table 9. $\Delta IMshare^{RER}_{fct}$ can be interpreted as the (estimated) adjustment of imported inputs share induced by exchange rate movements. Consequently, the coefficient on

[29] For a given imported input q, there is no specification information in the data on the variety of corresponding export products, that is, export products whose production involves using input q. Therefore, it is only feasible to measure the change in the quality of input q as responding to a change in $\widetilde{Q}_{ft}$, i.e., export quality at the firm level. From an alternative view, $\widetilde{Q}_{ft}$ can be interpreted as a measure of the firm's ability to differentiate export quality.

[30] The results in columns (1) and (2) are qualitatively similar when we restrict the sample to ordinary imports and rerun the regression, as shown in columns (1) and (2) in Table A.8 in the Appendix.

[31] Since for a given export product p, there is no specific information in the data on the amount or variety of the use of inputs for producing the product p, we measure output p's quality change as responding to imported input quality change at the firm level, denoted by $\Delta lnIMprice_{ft}$.

$\Delta IMshare_{fct}^{RER}$ measures the impact of exchange rate movements (on export prices) through affecting the imported inputs share. According to column (1), our baseline results are robust to the inclusion of $\Delta IMshare_{fct}^{RER}$. We also find that the coefficient on $\Delta IMshare_{fct}^{RER}$ is positive and significant, suggesting that exchange rate movements influence the export prices through affecting the imported inputs share. Nevertheless, quantitatively, the adjustment in imported inputs share induced by exchange rate movements has little explanatory power on the variation in the exchange rate elasticity of export prices.[32] In column (2), we add a new explanatory variable to the baseline equation (11), denoted by $\Delta lnIMprice_{ft}^{RER}$. $\Delta lnIMprice_{ft}^{RER}$ is constructed as the predicted $\Delta lnIMprice_{fqct}$ (averaging over products and countries) based on the regression in column (2) in Table 9, as a proxy for the (estimated) adjustment of imported input quality induced by exchange rate movements. Compared with the baseline results (in column (1) in Table 6), for the interaction term between export quality change and exchange rate movement and the triple interaction term, their coefficients become insignificant and much smaller (in absolute value) in column (2) in Table 10. These changes in the corresponding coefficients suggest that the input quality adjustment is a primary sub-channel through which the *quality change* channel operates to affect export prices.

In column (3) in Table 10, we replace the export quality change $\widetilde{Q}_{fpct}$ by the (estimated) export quality change due to imported input quality change, denoted by $\widetilde{Q}_{fpct}^{Input}$. $\widetilde{Q}_{fpct}^{Input}$ is constructed as the predicted $\widetilde{Q}_{fpct}$ based on the regression in column (3) in Table 9. According to column (3), our baseline results are robust to the alternative specification on export quality change, which are consistent with our findings in column (2) in Table 10. In the baseline regression, we include the product-destination country fixed effects to account for all product-destination characteristics that are time-invariant and potentially affect the product quality change and export prices. In column (4) in Table 10, we include in addition the product-year fixed effects to capture the impacts of time-varying product characteristics that are homogeneous across firm-destinations, such as the product-level technology frontier. According to column (4), our baseline results still hold after including the additional fixed effects.

[Insert Table 10 Here]

4.3 Alternative Explanations

In this subsection, we consider three alternative explanations, which might help to understand the variation in ERPT across firms and products.

[32] As shown in column (1) in Table 9, on average, the impact of exchange rate movements on imported inputs share is quantitatively small although significant. A 10% appreciation of the RMB against a destination country only increases the imported inputs share by around 0.03 percentage points. In other words, the imported inputs share is quantitatively insensitive to exchange rate movements. Combining the first columns in Tables 9 and 10, we have that a 10% home currency appreciation, on average, will induce export prices to rise by $0.007\% (= 0.03 * 0.245\%)$, which is quite small compared with the average exchange rate elasticity of export prices (around 0.07).

(i) Market competition. According to the model of Berman et al.'s (2012) model, the ERPT depends on the elasticity of substitution between goods, which is closely related to the degree of competition in the sector. Our analysis focuses on estimating the effect of changes in quality on ERPT. Hence, our estimates might be biased if high-competition industries were systematically associated with a low degree of quality upgrading. To ensure that this does not drive our results, we provide two robustness checks in Table 10, columns (5) and (6). In column (5), we control the industry competition effect by including the Herfindahl index (HHI)(Fan et al., 2015). We construct the HHI (HHI_{sct}) as the sum of the squared terms of all firms' market shares within a market at the sector (HS 4-digit)-destination level. In column (6), we include industry dummies interacted with the exchange rate. The results are robust after controlling the market competition effects.

(ii) Quality differentiation in imported inputs. Bernini and Tomasi (2015) shows that the *marginal cost* channel has a weak negative impact on the ERPT for high-quality exported varieties, due to the high exchange rate elasticity of the prices of high-quality imported inputs. To exclude the impacts of quality differentiation in imported inputs, we control the export product quality and all its interaction terms with exchange rate movements and imported inputs share in Table 10, column (7). We find that our baseline results still hold.

(iii) Markup channel. The exchange rate elasticity of a firm's markup is correlated with adjustments in export price and quality in response to exchange rate movements. To control the possible impacts of change in markups, we include the firm-level markup by adding firm-year fixed effects to our empirical specification in Table 10, column (8). Further, by including firm-year fixed effects, we also control the impacts of a firm's engaging exporting and/or importing inputs. The results indicate that our baseline results remain qualitatively unchanged after we include firm-year fixed effects.

4.4 Export Value and Quantity

In Table A.6, we report the exchange rate elasticities of export quantity and value. From the theoretical analysis (demonstrated in the Appendix), we expect that this impact would vary with different firm-product quality changes. Based on the estimates in columns (1) and (2), we find that, on average, the elasticities of export quantity and export value to RMB exchange rate movements are 0.18 and 0.25, respectively. The estimates are consistent with the literature (Tang and Zhang, 2012a; Li et al., 2015). Further, we find great variation in exchange rate elasticities across firm-products with different quality change levels. When the RMB appreciates by 10%, export quantity and value for products with a high degree of quality upgrading (at the 95th percentile of the quality change distribution) decrease by 0.6% and 1.3%, respectively, for exporters with average imported inputs share. We find that products with a low degree of quality upgrading (at the 5th percentile of the quality change distribution) decrease by greater magnitudes, 3.0% for export quantity and 3.6% for export value. In columns (3) and (4), we include firm-year fixed effects to control for unobserved time-varying firm characteristics and find that our estimates are robust.

5 Conclusion

We show theoretically that exchange rate movements can affect export prices through two offsetting channels – the *marginal cost* and *quality change* channels, both of which are related to imports of intermediate inputs. Based on Chinese Customs transaction data from 2000 to 2011, we find strong empirical evidence for the existence of both channels. We have two main empirical findings are as follows: (i) There is a *marginal cost* channel. The exchange rate elasticity of export prices is higher for exporters with higher shares of imported inputs. We also confirm the existence of the *marginal cost* channel by analyzing quality-adjusted prices. (ii) There is also a *quality change* channel. Overall, the *marginal cost* channel dominates the *quality change* channel. The offsetting impacts of the two channels, as we show theoretically and empirically, explain the variation in the exchange rate elasticity of export prices across firms and products, which is low on average among Chinese exports.

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Table 1: Comparison between Importing Exporters and Non-Importing Exporters

A. Export scale	Importing exporters	Non-importing exporters
Total exports (US dollars)	8,038,492	1,977,618
Export destinations (#)	10	7
HS 6-digit products exported (#)	35	27

B. Export price	Importing exporters			Non-importing exporters		
Full sample	2001	2011	$\Delta ln(Export price)$	2001	2011	$\Delta ln(Export price)$
$ln(Export price_{fpt})$	3.00	3.79	2.49%	2.47	3.26	1.51%
$ln(Export price_{fpct})$	2.20	7.66	6.24%	1.25	3.89	6.05%
Homogeneous goods sample	2001	2011	$\Delta ln(Export price)$	2001	2011	$\Delta ln(Export price)$
$ln(Export price_{fpt})$	3.10	3.89	2.49%	2.64	3.42	1.61%
$ln(Export price_{fpct})$	2.37	8.72	7.27%	1.49	4.51	6.30%
Differentiated goods sample	2001	2011	$\Delta ln(Export price)$	2001	2011	$\Delta ln(Export price)$
$ln(Export price_{fpt})$	3.02	4.09	5.92%	2.35	3.92	3.40%
$ln(Export price_{fpct})$	2.47	9.60	18.60%	1.19	6.80	10.02%

Note: The data sample is restricted to manufacturing firms by excluding trade intermediaries. The sample contains only incumbent exporters with observations for consecutive periods in panel B. $ln(Export price_{fpt})$ is firm f's export price of product p in year t in log value. $ln(Export price_{fpct})$ is firm f's export price of product p to destination c in year t in log value. $\Delta ln(Export price)$ denotes change in export price, measured as the first-difference log value of the export price. Products are defined at HS 6-digit level. Importing-exporter refers to an exporter that imports intermediate inputs; otherwise, an exporter is tagged as a non-importing exporter. Total exports, number of export destinations, export scope, export, export price, and price changes are reported in median values. Product differentiation (homogeneous goods or differentiated goods) is classified according to Rauch (1999).

Table 2: Intermediate Input Imports Incidence in Exports (%)

	(1)	(2)	(3)	(4)	(5)	(6)
	Fraction of export transactions			Fraction of export value		
	2001	2011	Average	2001	2011	Average
$Import_{ft} = 0$	34.84	50.45	43.32	15.46	23.83	18.42
$IMshare_{fct} = 0$ and $Import_{ft} > 0$	27.11	30.06	29.70	18.84	25.60	22.23
$0 < IMshare_{fct} \leq 0.1$	19.61	10.44	13.91	36.39	34.78	38.51
$0.1 < IMshare_{fct} \leq 0.2$	3.32	1.42	2.22	5.05	2.44	3.97
$0.2 < IMshare_{fct} \leq 0.3$	2.12	0.84	1.28	3.68	1.71	2.37
$0.3 < IMshare_{fct} \leq 0.4$	1.44	0.62	0.90	2.14	1.45	1.75
$IMshare_{fct} > 0.4$	11.57	6.19	8.66	18.44	10.19	12.74

Note: The data sample is restricted to manufacturing firms by excluding trade intermediaries and only keeping incumbent exporters with observations for consecutive periods. Firms with $Import_{ft} = 0$ refer to those exporters without imported intermediate inputs in year t. Imported inputs share, $IMshare_{fct}$, is firm f's share of imported inputs from the export destination c in the total imported inputs cost of the exporter. The values in columns (1) to (3) denote the fraction of export transactions (recorded at the firm-product-destination-year level) in terms of the number of observations number for each corresponding bin of imported inputs share. The values in columns (4) to (6) denote the fraction of export transaction in terms of export value for each corresponding bin of imported inputs share.

Table 3: Heckman Two-Step Estimates of Import Selection

	(1)	(2)	(3)	(4)
Dep.var.	$IMshare_{fct}$	$IMdummy_{fct}$	$IMshare_{fct}$	$IMdummy_{fct}$
FIT_{fct}	-0.071***	-0.009***	-0.127***	-0.030***
	(-184.26)	(-93.94)	(-342.82)	(-347.64)
$lnImportcost^{border}_{c(t-1)}$		-0.064***		-0.056***
		(-15.14)		(-13.33)
$Importerage_{fc(t-1)}$		-0.096***		-0.098***
		(-510.83)		(-519.98)
$Inv.\ Mill's\ Ratio$	1.238***		1.160***	
	(120.15)		(116.43)	
Fixed effects				
Country	Y	Y	Y	Y
Year	Y	Y	Y	Y
Observations	3,191,538	9,691,834	3,191,708	9,690,941

Note: We use the two-step variance Heckman estimator to estimate the covariance matrix. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. $IMshare_{fct}$ denotes firm $f's$ value of imported inputs from source country c in year t divided by the total imported value of inputs by firm f in year t. $IMdummy_{fct}$ denotes whether firm f imports inputs from source country c in year t. In the first two columns, we use the initial imported inputs share($IMshare_{fc,initial\ year} = \frac{Import_{fc,initial\ year}}{\sum_d Import_{fd,initial\ year}}$) to construct input tariffs (FIT_{fct}). In columns (3) and (4), we use the average imported inputs share ($\overline{IMshare_{fc}}$) to construct input tariffs. We use the one-period lagged term for importing cost of border compliance ($Importcost^{border}_{ct}$, in log value) and importer's importing age in the regression. We include country and year fixed effects in the regression. All regressions include the source country's GDP (gross domestic product) and GDP per capita controls.

Table 4: Imported Intermediate Inputs and Exchange Rate Pass-Through

Dep.var.	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta lnExport\,price_{fpct}$	Full	Full	Non-importing	Importing	Full	Full
$\Delta lnRER_{ct}$	0.081***	0.075***	0.039***	0.114***	0.076***	0.020
	(4.36)	(5.59)	(3.31)	(5.90)	(4.53)	(0.66)
$\Delta lnRER_{ct} \times Im\hat{p}ort_{fct}$					0.188***	0.281***
					(4.48)	(3.27)
$Im\hat{p}ort_{fct}$					0.038	0.057**
					(1.59)	(2.34)
$lnGDPPC_{ct}$	0.013	0.006	0.029	0.106*	0.090	0.086
	(0.65)	(0.46)	(1.26)	(1.69)	(1.44)	(1.34)
$lnGDP_{ct}$	-0.008	-0.011	-0.021	-0.110*	-0.095*	-0.098*
	(-0.47)	(-1.01)	(-1.03)	(-1.96)	(-1.68)	(-1.73)
Fixed effects						
Firm-product-country	Y		Y	Y	Y	Y
Product-country		Y				
Year	Y	Y	Y	Y	Y	Y
Observations	8,796,313	8,796,313	5,101,911	3,694,402	3,551,533	3,551,533
R-squared	0.446	0.028	0.486	0.394	0.394	0.394

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The data sample is restricted to manufacturing firms by excluding trade intermediaries and only keeping incumbent exporters with observations for consecutive periods. The sample for the regressions in columns (1), (2), (5), and (6) includes export transactions with and without imports of intermediate input. We use export transactions without and with imports of inputs from the same export destination in columns (3) and (4). We use the predicted imported inputs share ($IMs\hat{h}are_{fct}$) and dummy ($IMd\hat{u}mmy_{fct}$) from Heckman selection estimates (from columns (1) and (2) in Table 3) in columns (5) and (6).

Table 5: Product Differentiation and Exchange Rate Pass-Through

	(1)	(2)	(3)	(4)	(5)	(6)
Dep.var.	Rauch (1999)		R&D intensity		GM index	
$\Delta lnExportprice_{fpct}$	$IM\hat{share}_{fct}$	$IMd\hat{u}mmy_{fct}$	$IM\hat{share}_{fct}$	$IMd\hat{u}mmy_{fct}$	$IM\hat{share}_{fct}$	$IMd\hat{u}mmy_{fct}$
$\Delta lnRER_{ct}$	0.054***	0.007	0.082***	0.024	0.082***	0.025
	(3.79)	(0.32)	(5.42)	(1.06)	(7.04)	(0.47)
$\Delta lnRER_{ct} \times Im\hat{p}ort_{fct} \times Diff_p$	-0.444*	-0.551**	-1.408*	-1.723	-0.099	-0.148*
	(-1.66)	(-2.35)	(-1.82)	(-1.64)	(-1.41)	(-1.83)
$\Delta lnRER_{ct} \times Im\hat{p}ort_{fct}$	0.808***	0.852***	0.214***	0.331***	0.221***	0.348**
	(2.93)	(3.50)	(3.12)	(4.80)	(4.36)	(2.50)
$Im\hat{p}ort_{fct}$	0.048**	0.075*	0.045***	0.056	0.045**	0.056**
	(2.48)	(1.78)	(3.99)	(1.35)	(2.31)	(2.55)
Fixed effects						
Firm-product-country	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
Observations	2,767,590	2,767,590	2,996,099	2,996,099	2,996,099	2,996,099
R-squared	0.388	0.387	0.392	0.392	0.392	0.392

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The data sample is restricted to manufacturing firms by excluding trade intermediaries and only keeping incumbent exporters with observations for consecutive periods. We use the imported inputs share ($IM\hat{share}_{fct}$) predicted from Heckman selection (column (1) in Table 3) second-step estimates in columns (1), (3) and (5). The input imports dummy we use in columns (2), (4) and (6) is the imported inputs use dummy ($IMd\hat{u}mmy_{fct}$) predicted from Heckman selection first-step estimates (column (2) in Table 3). Product differentiation (homogeneous goods or differentiated goods) is classified according to Rauch (1999). The R&D intensity and GM index were obtained from Kugler and Verhoogen (2012). All regressions include GDP and GDP per capita controls. GDP=gross domestic product; GM=Gollop Monahan; R&D=Research and Development.

Table 6: Imported Intermediate Inputs, Quality Change, and Exchange Rate Pass-Through

	(1)	(2)	(3)	(4)
Dep.var.	$IM\hat{share}_{fct}$		$IMd\hat{u}mmy_{fct}$	
$\Delta lnExport\,price_{fpct}$	$\widetilde{Q}^1_{fpct}$	$\widetilde{Q}^2_{fpct}$	$\widetilde{Q}^1_{fpct}$	$\widetilde{Q}^2_{fpct}$
$\Delta lnRER_{ct}$	0.059***	0.077**	-0.096***	-0.074
	(16.94)	(2.32)	(-6.73)	(-1.20)
$\Delta lnRER_{ct} \times Im\hat{port}_{fct} \times \widetilde{Q}_{fpct}$	-0.033***	-0.075***	-0.088***	-0.095***
	(-3.29)	(-2.93)	(-5.28)	(-2.82)
$\Delta lnRER_{ct} \times \widetilde{Q}_{fpct}$	0.008***	0.009	0.035***	0.032
	(5.69)	(0.74)	(4.96)	(1.45)
$\Delta lnRER_{ct} \times Im\hat{port}_{fct}$	0.104***	0.077	0.508***	0.487**
	(11.73)	(1.58)	(13.50)	(2.25)
$Im\hat{port}_{fct} \times \widetilde{Q}_{fpct}$	0.012***	0.015***	-0.000	0.005
	(39.51)	(3.50)	(-0.17)	(0.46)
$Im\hat{port}_{fct}$	0.005***	0.005**	-0.075***	-0.058***
	(6.07)	(2.04)	(-20.83)	(-6.24)
$\widetilde{Q}_{fpct}$	0.090***	0.071***	0.096***	0.075***
	(29.63)	(68.41)	(26.53)	(30.54)
Quantification: change in the effect of $\Delta lnRER_{ct}$ (%), from 5th to 95th percentile of $IM\hat{share}_{fct}$				
5th of $\widetilde{Q}_{fpct}$	$3.3 \longrightarrow 22$	$4 \longrightarrow 37.9$		
95th of $\widetilde{Q}_{fpct}$	$8.6 \longrightarrow 7.9$	$11.5 \longrightarrow 9.5$		
Fixed effects				
Product-country	Y	Y	Y	Y
Year	Y	Y	Y	Y
Observations	3,530,367	3,530,367	3,530,367	3,530,367
R-squared	0.342	0.408	0.343	0.406

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5% and 10% level. The data sample is restricted to manufacturing firms by excluding trade intermediaries and only keeping incumbent exporters with observations for consecutive periods. The imported inputs share measure we use in columns (1) and (2) is the imported inputs share ($IM\hat{share}_{fct}$) predicted from Heckman selection (column (1) in Table 3) second-step estimates. We use the input imports dummy ($IMd\hat{u}mmy_{fct}$) predicted from Heckman selection first-step estimates (column (2) in Table 3) in columns (3) and (4). We use the median and mean values of substitution elasticities among goods from Broda and Weinstein (2006) to construct quality change measure 1 ($\widetilde{Q}^1_{fpct}$) and quality change measure 2 ($\widetilde{Q}^2_{fpct}$), respectively. All regressions include gross domestic product (GDP) and GDP per capita controls.

Table 7: Exports and Input Imports Activity Engagement

Dep.var.	(1)	(2)	(3)	(4)
$\Delta lnExport price_{fpct}$	Bin 1	Bin 2	Bin 3	Bin 4
$\Delta lnRER_{ct}$	0.049***	0.046	0.041***	0.037**
	(10.49)	(1.25)	(3.98)	(2.14)
$\Delta lnRER_{ct} \times IMs\hat{h}are_{fct} \times \widetilde{Q}_{fpct}$	-0.031**	-0.197***	-0.031	-0.107***
	(-2.19)	(-3.57)	(-0.82)	(-3.11)
$\Delta lnRER_{ct} \times \widetilde{Q}_{fpct}$	0.010***	0.043**	0.007	0.023***
	(4.99)	(2.42)	(1.34)	(3.54)
$\Delta lnRER_{ct} \times IMs\hat{h}are_{fct}$	0.165***	0.126*	0.117***	0.148***
	(12.24)	(1.92)	(3.68)	(5.29)
$IMsh\hat{a}re_{fct} \times \widetilde{Q}_{fpct}$	0.019***	0.009***	0.022***	0.014***
	(40.10)	(7.70)	(15.09)	(12.95)
$IMsh\hat{a}re_{fct}$	-0.013***	0.002	0.003	0.011***
	(-10.60)	(0.52)	(1.12)	(4.62)
$\widetilde{Q}_{fpct}$	0.092***	0.087***	0.090***	0.084***
	(17.69)	(48.13)	(181.32)	(151.80)
Fixed effects				
Product-country	Y	Y	Y	Y
Year	Y	Y	Y	Y
Observations	2,098,221	467,513	640,153	324,480
R-squared	0.352	0.372	0.389	0.399

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The data sample is restricted to manufacturing firms by excluding trade intermediaries and only keeping incumbent exporters with observations for consecutive periods. We classify observations into four bins according to the exporter's exports and use of imported inputs. For classification of exports and input imports activity engagement, please see Equation (12). We use the imported inputs share ($IMs\hat{h}are_{fct}$) predicted from Heckman selection (column (1) in Table 3) second-step estimates in all columns. We use quality change measure 1 ($\widetilde{Q}^1_{fpct}$) in all columns. All regressions include gross domestic product (GDP) and GDP per capita controls.

Table 8: Exchange Rate Movements on Export Quality and Net-Quality Export Prices

Dep. Var.	(1)	(2)	(3)	(4)
	$\Delta lnQuality_{fpct}$		$\Delta lnprice\ adjusted_{fpct}$	
	Differentiated	Homogeneous	Differentiated	Homogeneous
$\Delta lnRER_{ct}$	-0.149***	0.899**	0.223***	0.707**
	(-6.08)	(2.52)	(8.27)	(2.16)
$\Delta lnRER_{ct} \times IM\hat{share}_{fct}$	-0.212***	-1.151	0.369***	1.125
	(-3.36)	(-1.16)	(5.29)	(1.23)
$IM\hat{share}_{fct}$	0.027***	0.152*	0.035***	0.149*
	(5.10)	(1.75)	(5.81)	(1.87)
Fixed effects				
Product-country	Y	Y	Y	Y
Year	Y	Y	Y	Y
Observations	2,725,954	21,523	2,725,954	21,523
R-squared	0.036	0.181	0.038	0.178

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The data sample is restricted to manufacturing firms by excluding trade intermediaries. We use the median values of substitution elasticities among goods from Broda and Weinstein (2006) to construct the quality measure. $lnprice\ adjusted_{fpct}$ is measured as log value of export price ($lnExportprice_{fpct}$) less log value of export quality($lnQuality_{fpct}$). We use the imported inputs share ($IM\hat{share}_{fct}$) predicted from Heckman selection (column (1) in Table 3) second-step estimates in all columns. Product quality differentiation (differentiated or homogeneous) is classified according to Rauch (1999). All regressions include gross domestic product (GDP) and GDP per capita controls.

Table 9: Exchange Rate Movements, Imported Intermediate Inputs and Quality Change

	(1)	(2)	(3)
Dep.var.	$\Delta IMshare_{fct}$	$\Delta lnIMprice_{fqct}$	$\Delta lnQuality_{fpct}$
$\Delta lnRER_{ct}$	-0.003***	0.475***	0.220***
	(-2.76)	(11.38)	(8.85)
$\Delta lnRER_{ct} \times \widetilde{Q}_{ft}$		-0.008**	
		(-2.38)	
$\widetilde{Q}_{ft}$		0.015***	
		(43.72)	
$\Delta lnRER_{ct} \times \Delta lnIMprice_{ft}$			-0.195***
			(-3.55)
$\Delta lnIMprice_{ft}$			0.091***
			(14.87)
Fixed effects			
Country	Y		
Product-country		Y	Y
Year	Y	Y	Y
Observations	2,772,432	4,229,999	3,969,484
R-squared	0.001	0.011	0.044

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The data sample is restricted to manufacturing firms by excluding trade intermediaries. We use the firm average quality change ($\widetilde{Q}_{ft}$) in column (2). We construct the imported inputs price change ($\Delta lnIMprice_{ft}$) as the firm f's average value of change in log imported inputs prices ($\Delta lnIMprice_{fqct}$) in column (3). Regressions include the source country's gross domestic product (GDP) and GDP per capita controls in columns (1) and (2). Regression includes the destination country's GDP and GDP per capita controls in column (3).

Table 10: More Discussion on Channels

Dep.var.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta lnExportprice_{fpct}$	$\Delta IMshare^{RER}_{fct}$	$\Delta lnIMprice^{RER}_{ft}$	$\widetilde{Q}^{Input}_{fpct}$	Product-year	HHI	Industry-year	Quality	Markup
$\Delta lnRER_{ct}$	0.021***	0.052***	0.006	0.055***	0.106**	0.022*	0.065***	0.033***
	(2.97)	(8.92)	(0.83)	(15.52)	(2.10)	(1.94)	(11.46)	(6.71)
$\Delta lnRER_{ct} \times IM\hat{s}hare_{fct} \times \widetilde{Q}_{fpct}$	-0.033***	-0.010	-0.037***	-0.032***	-0.048*	-0.034**	-0.076***	-0.143***
	(-3.29)	(-0.54)	(-4.95)	(-3.22)	(-1.92)	(-2.08)	(-3.75)	(-4.34)
$\Delta lnRER_{ct} \times \widetilde{Q}_{fpct}$	0.008***	0.002	0.265***	0.006***	0.008	0.008*	0.011**	0.010**
	(5.64)	(0.36)	(5.45)	(4.21)	(0.43)	(1.73)	(2.37)	(2.29)
$\Delta lnRER_{ct} \times IM\hat{s}hare_{fct}$	0.097***	0.149***	0.152***	0.089***	0.087*	0.110***	0.080***	0.097***
	(11.02)	(8.19)	(5.79)	(9.80)	(1.70)	(8.31)	(5.70)	(3.58)
$IM\hat{s}hare_{fct} \times \widetilde{Q}_{fpct}$	0.012***	0.017***	-0.004	0.012***	0.009	0.012***	0.004***	0.014***
	(39.51)	(14.05)	(-1.28)	(39.48)	(0.84)	(13.22)	(16.12)	(15.23)
$IM\hat{s}hare_{fct}$	0.005***	-0.003	0.300***	0.004***	0.006**	0.005***	0.001	0.015***
	(6.05)	(-1.51)	(26.35)	(5.54)	(2.09)	(3.42)	(0.54)	(5.54)
$\widetilde{Q}_{fpct}$	0.090***	0.094***	0.008***	0.090***	0.064***	0.094***	0.040***	0.083***
	(91.70)	(68.02)	(4.44)	(35.75)	(22.82)	(22.96)	(11.76)	(18.47)
$\Delta IMshare^{RER}_{fct}$	0.245***							
	(13.08)							
$\Delta lnIMprice^{RER}_{ft}$		0.022***						
		(18.04)						
Fixed effects								
Product-country	Y	Y	Y	Y	Y	Y	Y	Y
Product-year				Y				
Firm-year								Y
Year	Y	Y	Y		Y	Y	Y	
Observations	3,530,367	2,795,791	3,026,068	3,506,696	2,651,962	3,530,367	3,530,367	3,378,144
R-squared	0.342	0.347	0.034	0.349	0.281	0.342	0.343	0.437

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The data sample is restricted to manufacturing firms by excluding trade intermediaries. We use the imported inputs share ($IM\hat{s}hare_{fct}$) predicted from Heckman selection (column (1) in Table 3) second-step estimates in all columns except column (1). We use the predicted imported inputs share ($\Delta IMshare^{RER}_{fct}$) from column (1) in Table 9 for the regression in column (1). We use quality change measure 1 ($\widetilde{Q}^{1}_{fpct}$) in all columns except column (3). We use the predicted quality change measure ($\widetilde{Q}^{Input}_{fpct}$) from column (3) in Table 9 for regression in column (3). We construct the imported inputs price change ($\Delta lnIMprice^{RER}_{ft}$) as the predicted value of firm f's average value of change in log imported inputs prices ($\Delta lnIMprice^{RER}_{fqct}$, from column (2) in Table 9). For column (5), we include HHI's interaction with the exchange rate movement and the triple interaction term for HHI, exchange rate movement, and imported inputs share. For column (6), we include sector dummies times exchange rate and the triple interaction term for sector dummy, exchange rate movement, and imported inputs share. For column (7), we include the quality and all its interaction terms with the exchange rate movement and imported inputs share (including the triple interaction term). To save space, we do not report the coefficients of these terms. All regressions include GDP and GDP per capita controls. GDP= gross domestic product; HHI=Herfindahl index.

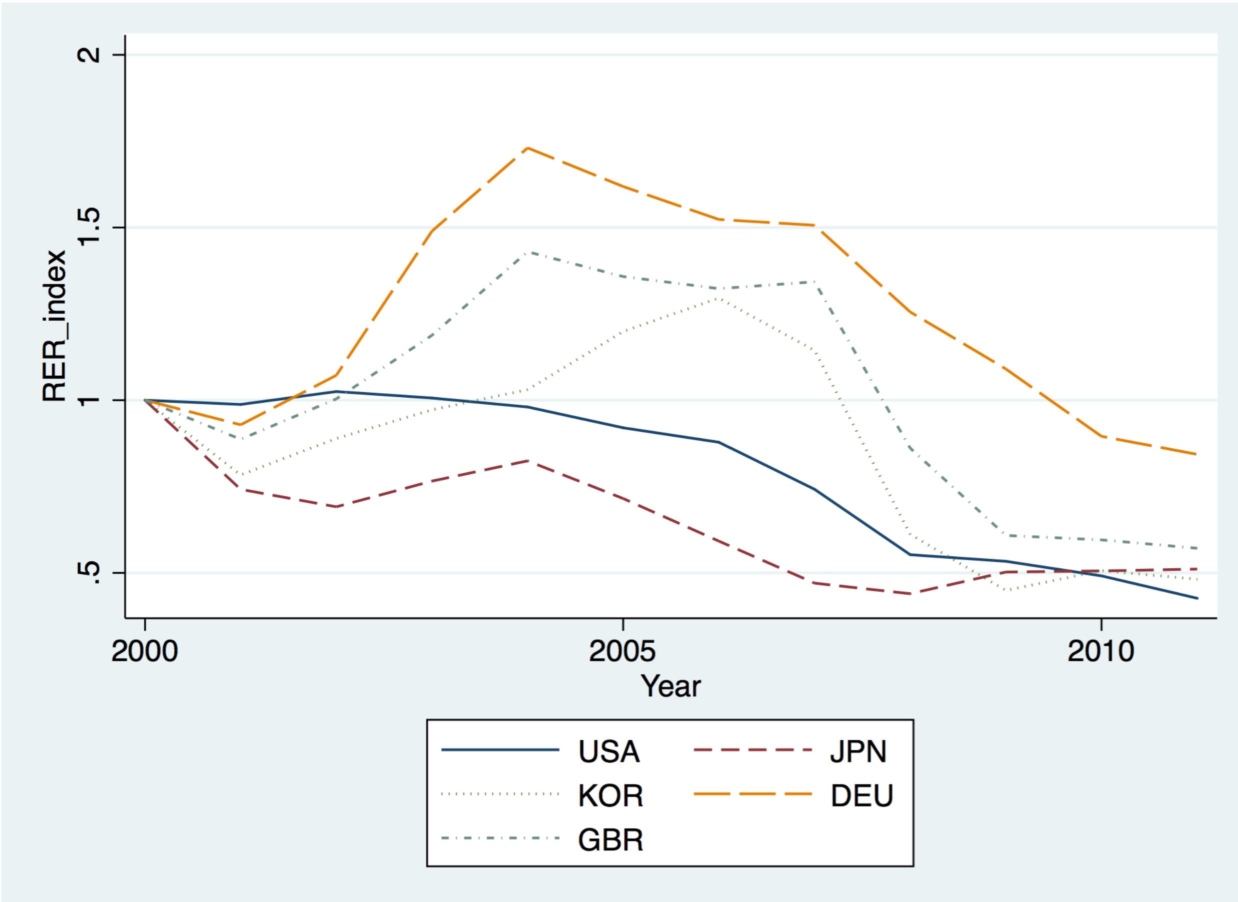

Figure 1: RMB Bilateral Exchange Rate against Major Trade Partners

Note: *RER_index* denotes the bilateral real exchange rate between China and its trade partners, constructed based on Equation (1). An increase in *RER_index* denotes a real depreciation of the RMB. We set the base period for all exchange rate indexes as 2000 (index = 1 in 2000).

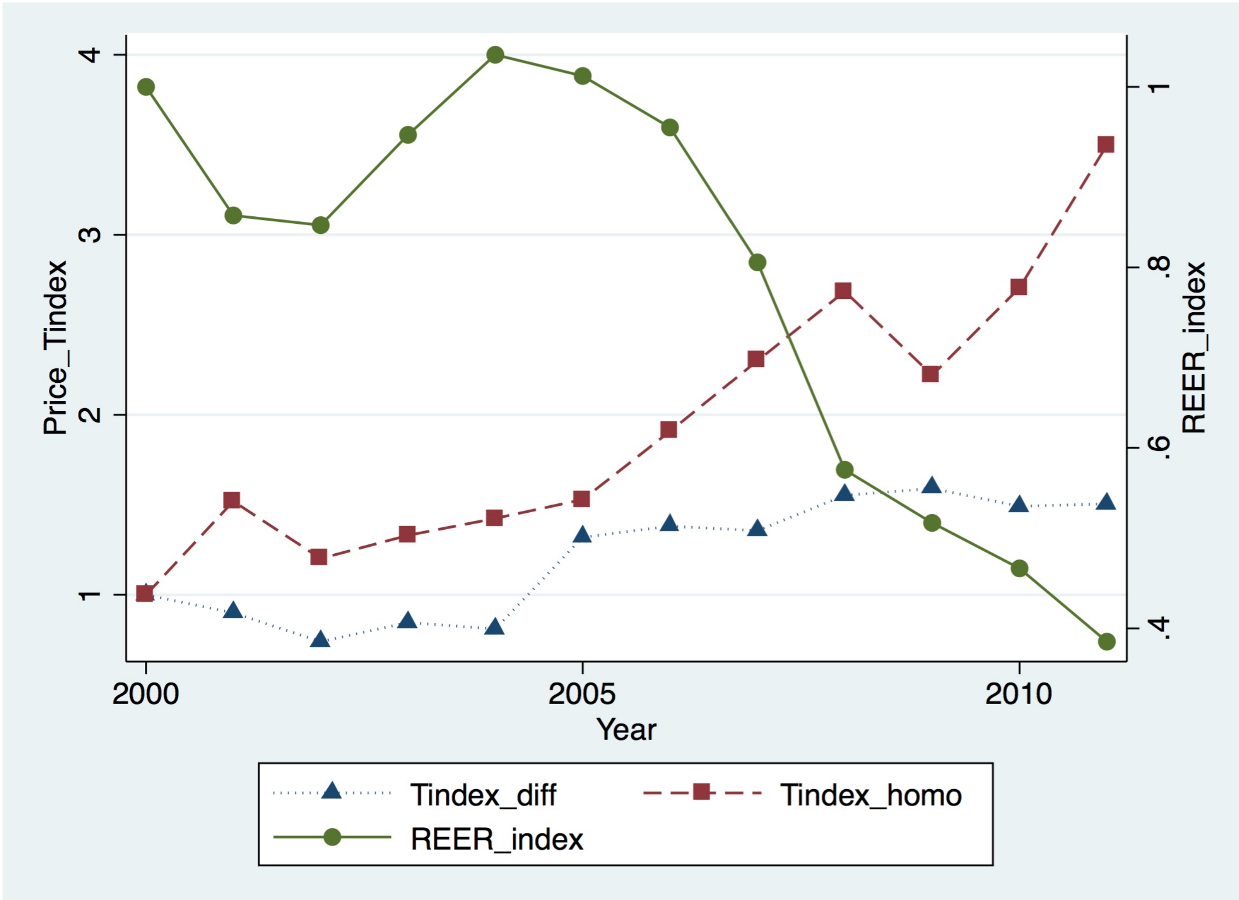

Figure 2: Homogeneous/Differentiated Product Export Price Index and RMB Real Effective Exchange Rate Index

Note: *REER_index* denotes the RMB real effective exchange rate, defined by Equation (2). An increase in *REER_index* denotes a real depreciation of the RMB. *Tindex_diff* and *Tindex_homo* denote the export price indexes of differentiated goods and homogeneous goods, respectively, defined by Equation (3). The export price indexes are constructed according to the Tornqvist index. Export price is converted to RMB-denominated price. Product differentiation is classified according to Rauch (1999). We set the base period of all three indexes as 2000 (index=1 in 2000).

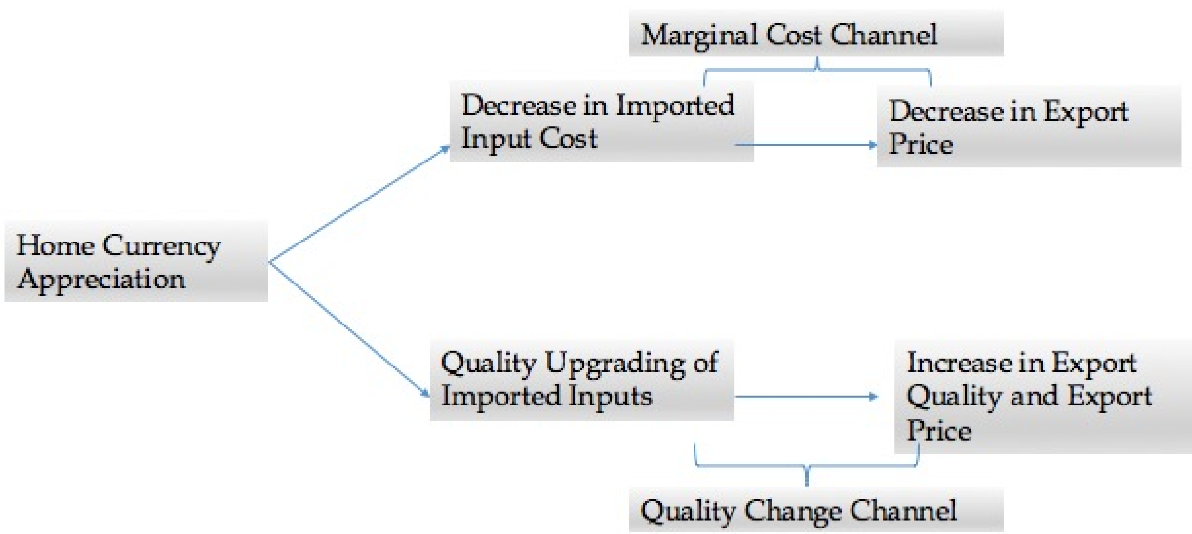

Figure 3: *Marginal Cost* Channel and *Quality Change* Channel for the Effect of Changes in the Exchange Rate on Export Prices

Appendix

A. Theoretical Model

In this section, we develop a theoretical model to link a firm's exchange rate elasticity of export prices to imported inputs share and export quality. We extend the model of Amiti et al. (2014) by introducing the endogenous choice of input and output quality.

Utility

We assume a constant elasticity of substitution (CES) utility function of a representative consumer in a foreign country c:

$$U = [\int_{w \in \Omega_c} q(w)^{\frac{\sigma-1}{\sigma}} x(w)^{\frac{\sigma-1}{\sigma}} dw]^{\frac{\sigma}{\sigma-1}} \tag{A.1}$$

where w is variety; $q(w)$ and $x(w)$ are the quality and quantity consumed, respectively, of variety w. σ is the substitution elasticity across goods, $\sigma > 1$. We assume constant markup in the model. In this way, we abstract the impact of exchange rate movements on a firm's markup adjustment. Ω_c is the set of consumption varieties. Following the consumer's utility maximization decision, we have:

$$x(w) = EP^{\sigma-1} p_f(w)^{-\sigma} q(w)^{\sigma-1} \tag{A.2}$$

where E is the consumer's aggregate expenditure on all varieties, and P is the aggregate price level. For each variety w, consumers in the foreign country face price $p_f(w)$. Denote ξ as the bilateral nominal exchange rate between the home country and its trade partner. Define:

$$p_f(w) = p_c(w)/\xi \tag{A.3}$$

where $p_c(w)$ is the price set by a home exporter producing variety w. An increase in ξ represents home currency depreciation. Following Equation (A.3), we have $P = \frac{1}{\xi}[\int_{w \in \Omega_c} p_c(w)^{1-\sigma} q(w)^{\sigma-1} dw]^{\frac{1}{1-\sigma}}$. Denote $P_c = [\int_{w \in \Omega_c} p_c(w)^{1-\sigma} q(w)^{\sigma-1} dw]^{\frac{1}{1-\sigma}}$. We have $P = P_c/\xi$.

Production

For an exporter with productivity ϕ producing output with quality q, we assume the production function takes a Cobb-Douglas form as:

$$Y(\phi, q, \epsilon) = \mu^{-\mu}(1-\mu)^{-(1-\mu)} \phi X(\phi, q, \epsilon)^{\mu} L(\phi, q, \epsilon)^{1-\mu} \tag{A.4}$$

where $Y(\phi, q, \epsilon)$ is the exporter's total exports of variety w. $1-\mu$ is the cost share of labor $L(\phi, q, \epsilon)$.[33] Denote the real exchange rate $\epsilon = \xi * w^*/w$. w^* is the wage rate in foreign country and w is the wage rate in home country. q is the firm's output quality. To produce output with quality q, the firm needs workers' effort level as q_l and composite intermediate inputs with quality q_m. We assume the quality production function takes the following form:

$$g(q) = (\frac{1}{\mu})^{\mu}(\frac{1}{1-\mu})^{1-\mu}\phi q_m^{\mu} q_l^{1-\mu} \tag{A.5}$$

where $g(q)$ is an increasing function in quality q. For simplicity, we assume $g(q) = q^{\alpha}$. We assume the quality of composite intermediate inputs is produced by a continuum of intermediate inputs indexed by z with quality $q(z)$ via Leontief technology. Thus we have:

$$q_m = \min\{q(z)|\forall z\} \tag{A.6}$$

To produce input quality q_m, we assume $\frac{q_m}{a_m}$ units of workers' effort in the production line of intermediate input are required. Similarly, we assume $\frac{q_l}{a_l}$ units of workers' effort in the production line of the final output is required to produce effort q_l. a_l and a_m are the production efficiency of workers in the final good and intermediate input production sector. Let w_f and w_m denote the wages of final good and intermediate good production workers, respectively. We assume linear forms of the effort-wage schedule as follows:

$$w_f = \frac{q_l}{a_l} \tag{A.7}$$

$$w_m = \frac{q_m}{a_m} \tag{A.8}$$

Minimizing the production cost of quality q, we have:

$$q_l = (1-\mu)(\frac{1}{a_l P_x(\phi, \epsilon)})^{-\mu}\frac{q^{\alpha}}{\phi} \tag{A.9}$$

$$q_m = \mu(\frac{1}{a_l P_x(\phi, \epsilon)})^{1-\mu}\frac{q^{\alpha}}{\phi} \tag{A.10}$$

where $P_x(\phi, \epsilon)$ is the quality-adjusted price index of all intermediate inputs. We normalize the wage rate of workers producing unit quality in the home country as one, i.e., $a_l = 1$. We assume $\alpha > 0$, implying that more inputs are required to produce higher quality varieties. According to

[33] Here we do not include the production decision for domestic production in the model. Implicitly, we assume that the domestic and foreign markets are separate markets, following the conventional approach in the literature (for example, Bai et al. (2017) and Fan et al. (2018)).

Equation (A.4), we get the following marginal cost function:

$$C(\phi,q,\epsilon)=P_x(\phi,\epsilon)^{\mu}q(\phi,\epsilon)^{\alpha}/\phi \tag{A.11}$$

Equilibrium

In addition to the marginal production cost, the firm also needs to pay the fixed export cost, which is $fq(\phi,\epsilon)^{\beta}$ in home currency. β is a measure of quality differentiation. A higher β means lower quality differentiation. The scope for quality differentiation depends on product quality differentiation (i.e., a homogeneous product or a differentiated product) and firm-specific ability to innovate. The firm's profit maximization problem is as follows:

$$Max_{p_c,q}\pi(\phi,q,\epsilon)=Max_{p_c,q}[(p_c(\phi,q,\epsilon)-C(\phi,q,\epsilon))x(\phi,q,\epsilon)-fq(\phi,\epsilon)^{\beta}] \tag{A.12}$$

Assuming the input bundle takes the following CES form:

$$X(\phi,\epsilon)=[Z(\phi,\epsilon)^{\rho}+M(\phi,\epsilon)^{\rho})]^{1/\rho} \tag{A.13}$$

and

$$Z(\phi,\epsilon)=[\int_{j\in[0,1]}z_j(\phi,\epsilon)^{\theta_z}dj]^{1/\theta_z},M(\phi,\epsilon)=[\int_{k\in\Omega_m}m_k(\phi,\epsilon)^{\theta_m(\phi,\epsilon)}dk]^{1/\theta_m}$$

where input bundle (Z) and input bundle (M) are also CES aggregates. $z_j(\phi,\epsilon)$ is the firm's use of produced inputs j from countries outside the export destination, including the domestic inputs. We normalize the set of produced inputs to be one. $m_k(\phi,\epsilon)$ is the firm's use of imported inputs k from the export destination. Ω_m is the set of firm's sourced intermediate inputs from the export destination. So we have the following:

$$\begin{cases} P_x(\phi,\epsilon)=(P_z^{\frac{\rho}{\rho-1}}+P_m^{\frac{\rho}{\rho-1}})^{\frac{\rho-1}{\rho}} \\ P_z(\phi,\epsilon)=(\int_{j\in[0,1]}p_j^{\frac{\theta_z}{\theta_z-1}}dj)^{\frac{\theta_z-1}{\theta_z}} \\ P_m(\phi,\epsilon)=(\int_{k\in\Omega_m}p_m^{\frac{\theta_m}{\theta_m-1}}dj)^{\frac{\theta_m-1}{\theta_m}}=|\Omega_m(\phi,\epsilon)|^{\frac{\theta_m-1}{\theta_m}}b_m\epsilon_m \end{cases} \tag{A.14}$$

where ϵ_m is the bilateral real exchange rate, between home currency and its source country.

In Proposition A.1, we summarize how the exchange rate elasticity of export prices depends on the interactive roles of *marginal cost* and *quality change*.

Lemma A.1: (Quality Change Effect) A real appreciation of the home currency will encourage exporters with imported inputs to pursue higher quality. And the impact of exchange rate movements on quality adjustment is magnified by the imported inputs ratio and the product's quality differentiation.

Proposition A.1: A real appreciation of the home currency will induce lower marginal cost and higher product quality. These two effects offset each other. Exporters will lower the export prices when the marginal cost change effect dominates the quality change effect in products with a low degree of quality differentiation. Exporters will increase the export prices when the quality change effect dominates the marginal cost change effect in products with a high degree of quality differentiation.

A1. Proof of Lemma A.1 and Proposition A.1

By first-order conditions of firm's profit maximization problem in Equation (A.12), we get:

$$p_c(\phi,q,\epsilon)=\frac{\sigma}{\sigma-1}\frac{q(\phi,\epsilon)^{\alpha}}{\phi}P_x(\phi,\epsilon)^{\mu}=\frac{\sigma}{\sigma-1}C(\phi,q,\epsilon) \tag{A.15}$$

$$q(\phi,\epsilon)=\{\frac{\beta f}{D(\phi,\epsilon)[\alpha(1-\sigma)+\sigma-1]}\}^{\frac{1}{(\alpha-1)(1-\sigma)-\beta}} \tag{A.16}$$

where $D(\phi,\epsilon)=\xi EP_c^{\sigma-1}\sigma^{-\sigma}(\sigma-1)^{\sigma-1}(\frac{P_x(\phi,\epsilon)^{\mu}}{\phi})^{1-\sigma}$
Based on Equations (A.15) and (A.16), we obtain:

$$\frac{\partial lnp_c(\phi,q,\epsilon)}{\partial ln\epsilon}=\underbrace{\mu\frac{\partial lnP_x(\phi,\epsilon)}{\partial ln\epsilon}}_{\text{marginal cost}}+\underbrace{\alpha\frac{\partial lnq(\phi,\epsilon)}{\partial ln\epsilon}}_{\text{quality change}} \tag{A.17}$$

$$\frac{\partial lnq(\phi,\epsilon)}{\partial ln\epsilon}=\frac{1}{\beta-(\alpha-1)(1-\sigma)}+\frac{\mu(\sigma-1)}{(\alpha-1)(1-\sigma)-\beta}\frac{\partial lnP_x(\phi,\epsilon)}{\partial ln\epsilon} \tag{A.18}$$

As we can tell from Equation (A.17), the exchange rate elasticity of export prices consists of two parts, the exchange rate elasticity of intermediate input price (*marginal cost*) and the exchange rate elasticity of quality (*quality change*).According to Equation (A.18), if β is very large, it would be difficult for the firm to adjust quality. We impose the parameter restriction that $(\alpha-1)(1-\sigma)-\beta<0$. With a real appreciation of the home currency against its export destination, the marginal cost and quality change move in opposite directions. Next, we try to solve the explicit algebra form of $\frac{\partial lnP_x}{\partial ln\epsilon}$.

With exporters sourcing the intermediate inputs from the same export destination, thus $\xi_m =$

$\xi, \epsilon_m = \epsilon$. In this case, we have:

$$\frac{\partial lnP_x(\phi,\epsilon)}{\partial ln\epsilon} = \frac{P_m^{\frac{\rho}{\rho-1}}}{P_m^{\frac{\rho}{\rho-1}}+P_z^{\frac{\rho}{\rho-1}}}(\underbrace{\frac{\theta_m-1}{\theta_m}\frac{\partial|\Omega_m|}{\partial ln\epsilon}}_{\text{extensive margin}}\underbrace{+1}_{\text{intensive margin}}) \tag{A.19}$$

Note that $\frac{P_m^{\frac{\rho}{\rho-1}}}{P_m^{\frac{\rho}{\rho-1}}+P_z^{\frac{\rho}{\rho-1}}}$ is the share of imported inputs sourced from the export destination in total intermediate inputs. If an exporter does not source any intermediate inputs from the export destination, then $\frac{\partial lnP_x}{\partial ln\epsilon}=0$, indicating that there is no marginal cost change caused by real bilateral exchange rate movements. And a higher share of imported inputs in the total inputs indicates higher elasticity of quality to real exchange rate movements. As in Gopinath and Neiman (2014), the exporter chooses its optimal import scope to maximize profits:

$$|\Omega_m(\phi,\epsilon)| = argmax_{|\Omega_m|}\{\pi(\phi,q,\epsilon)-\epsilon f_m|\Omega_m|\} \tag{A.20}$$

We can show that, with some restrictions on the parameters,[34]we have $\frac{\partial|\Omega_m(\phi,\epsilon)|}{\partial ln\epsilon}<0$. In the empirics, we find that the exchange rate elasticity of import scope is quite small. Combining Equations (A.18) and (A.19), we can verify Lemma A.1.

Back to Equation (A.17), we can also get:

$$\begin{aligned}\frac{\partial lnp_c(\phi,q,\epsilon)}{\partial ln\epsilon} &= \mu\frac{\partial lnP_x(\phi,q,\epsilon)}{\partial ln\epsilon}+\alpha\frac{\partial lnq(\phi,\epsilon)}{\partial ln\epsilon}\\ &= \frac{\alpha}{\beta-(\alpha-1)(1-\sigma)}+\frac{\mu(\sigma-1-\beta)}{(\alpha-1)(1-\sigma)-\beta}\frac{\partial lnP_x(\phi,\epsilon)}{\partial ln\epsilon}\end{aligned} \tag{A.21}$$

Recall that we impose the parameter restriction $(\alpha-1)(1-\sigma)-\beta<0$. Combining Equation (A.21) with Equations (A.18) and (A.19), we know that in products with a low degree of quality differentiation ($\beta>\sigma-1$), we have that $\frac{\partial lnp_c(\phi,q,\epsilon)}{\partial ln\epsilon}>0$. For products with a high degree of quality differentiation ($\beta<\sigma-1$), the sign of $\frac{\partial lnp_c(\phi,q,\epsilon)}{\partial ln\epsilon}$ is ambiguous, depending on the relative size of

[34]By solving Equation (A.20), we get $\frac{\partial|\Omega_m(\phi,\epsilon)|}{\partial ln\epsilon} = \frac{\frac{p_cx}{\sigma}+\frac{\sigma-1}{\sigma}\frac{P_m^{\frac{\rho}{\rho-1}}}{P_m^{\frac{\rho}{\rho-1}}+P_z^{\frac{\rho}{\rho-1}}}\mu p_cx-\frac{\mu(\sigma-1)}{(\alpha-1)(1-\sigma)-\beta}\frac{P_m^{\frac{\rho}{\rho-1}}}{P_m^{\frac{\rho}{\rho-1}}+P_z^{\frac{\rho}{\rho-1}}}\epsilon f\beta q^\beta+\frac{\sigma-1}{\sigma}p_cx\frac{\alpha-1}{(\alpha-1)(1-\sigma)-\beta}}{\epsilon f_m+\frac{\theta-1}{\theta}\frac{\sigma-1}{\sigma}\frac{P_m^{\frac{\rho}{\rho-1}}}{P_m^{\frac{\rho}{\rho-1}}+P_z^{\frac{\rho}{\rho-1}}}\mu p_cx+\frac{\theta-1}{\theta}\frac{\mu(\sigma-1)}{(\alpha-1)(1-\sigma)-\beta}\frac{P_m^{\frac{\rho}{\rho-1}}}{P_m^{\frac{\rho}{\rho-1}}+P_z^{\frac{\rho}{\rho-1}}}\epsilon f\beta q^\beta]}$. The sufficient parameter restriction we present is: $\frac{p_cx}{\sigma}+\frac{\sigma-1}{\sigma}\frac{P_m^{\frac{\rho}{\rho-1}}}{P_m^{\frac{\rho}{\rho-1}}+P_z^{\frac{\rho}{\rho-1}}}\mu p_cx-\frac{\mu(\sigma-1)}{(\alpha-1)(1-\sigma)-\beta}\frac{P_m^{\frac{\rho}{\rho-1}}}{P_m^{\frac{\rho}{\rho-1}}+P_z^{\frac{\rho}{\rho-1}}}\epsilon f\beta q^\beta+\frac{\sigma-1}{\sigma}p_cx\frac{\alpha-1}{(\alpha-1)(1-\sigma)-\beta}<0$. This inequality is satisfied as long as $\frac{P_m^{\frac{\rho}{\rho-1}}}{P_m^{\frac{\rho}{\rho-1}}+P_z^{\frac{\rho}{\rho-1}}}\mu$ is sufficiently large and assuming that fixed cost parameters f and f_m are sufficiently small compared with the firm's total export revenue.

$\frac{\alpha}{\beta-(\alpha-1)(1-\sigma)}$ and $\frac{\mu(\sigma-1-\beta)}{(\alpha-1)(1-\sigma)-\beta}\frac{\partial lnP_x(\phi,\epsilon)}{\partial ln\epsilon}$. For exporters with large imported inputs share in total cost, $\mu\frac{P_m^{\frac{\rho}{\rho-1}}}{P_m^{\frac{\rho}{\rho-1}}+P_z^{\frac{\rho}{\rho-1}}}$, we have that $\frac{\partial lnp_c(\phi,q,\epsilon)}{\partial ln\epsilon}<0$.

In Corollary A.1, we summarize how exchange rate movements induce exporters to adjust input qualities.

Corollary A.1: Exchange rate movements induce exporters to adjust input quality. Under an appreciation of the home currency, exporters would downgrade input quality when producing products with low quality differentiation, and would upgrade input quality when producing products with high quality differentiation.

A2. Proof of Corollary A.1

Back to Equations (A.10), we get the exchange rate elasticities of the intermediate input bundle's quality (q_m) are as follows:

$$\begin{aligned}\frac{\partial lnq_m(\phi,q,\epsilon)}{\partial ln\epsilon} &= \mu\frac{\partial lnP_x(\phi,\epsilon)}{\partial ln\epsilon}+\alpha\frac{\partial lnq(\phi,\epsilon)}{\partial ln\epsilon} \\ &= \frac{\alpha}{\beta-(\alpha-1)(1-\sigma)}+\frac{\mu(\sigma-1-\beta)}{(\alpha-1)(1-\sigma)-\beta}\frac{\partial lnP_x(\phi,\epsilon)}{\partial ln\epsilon}\end{aligned} \tag{A.22}$$

Recall that we impose the parameter restriction $(\alpha-1)(1-\sigma)-\beta<0$. Based on Equation (A.22), we know that in products with a low degree of quality differentiation ($\beta>\sigma-1$), we have that $\frac{\partial lnq_m(\phi,q,\epsilon)}{\partial ln\epsilon}>0$. For products with a high degree of quality differentiation ($\beta<\sigma-1$), the sign of $\frac{\partial lnq_m(\phi,q,\epsilon)}{\partial ln\epsilon}$ is ambiguous, depending on the relative size of $\frac{\alpha}{\beta-(\alpha-1)(1-\sigma)}$ and $\frac{\mu(\sigma-1-\beta)}{(\alpha-1)(1-\sigma)-\beta}\frac{\partial lnP_x(\phi,\epsilon)}{\partial ln\epsilon}$. For exporters with large imported inputs share in total cost, $\mu\frac{P_m^{\frac{\rho}{\rho-1}}}{P_m^{\frac{\rho}{\rho-1}}+P_z^{\frac{\rho}{\rho-1}}}$, we have that $\frac{\partial lnq_m(\phi,q,\epsilon)}{\partial ln\epsilon}<0$.

A3. Exchange Rate Elasticities of Export Value and Volume

Next, we solve the exchange rate elasticities of export volume and value. Based on Equations (A.2) and (A.21), the exchange rate elasticities of export volume and value are as follows:

$$\frac{\partial lnx(\phi,q,\epsilon)}{\partial ln\epsilon}=1-\sigma\frac{\partial lnp_c(\phi,q,\epsilon)}{\partial ln\epsilon}+(\sigma-1)\frac{\partial lnq(\phi,\epsilon)}{\partial ln\epsilon} \tag{A.23}$$

$$\frac{\partial lnv(\phi,q,\epsilon)}{\partial ln\epsilon}=1+(1-\sigma)\frac{\partial lnp_c(\phi,q,\epsilon)}{\partial ln\epsilon}+(\sigma-1)\frac{\partial lnq(\phi,\epsilon)}{\partial ln\epsilon} \tag{A.24}$$

As we can tell from Equations (A.23) and (A.24), the exchange rate elasticities of export volume and value depend on the quality change component. When a real appreciation of the home currency induces higher quality upgrading, as in a *quality sorting* model, the negative impacts on export volume and value are smaller.

A4. Alternative Input Bundle Form: Cobb-Douglas Aggregator

We try to derive Proposition A.1 with an alternative and conventional assumption on the form of the input bundle. As in Fan et al. (2018), we assume that the intermediate input bundle is produced as follows:

$$X(\phi,\epsilon) = \psi exp[\int_{z\in[0,z^*]} b_i(z)lnm(z)dz + \int_{z\in[z^*,1]} b_i(z)lnm(z)dz] \tag{A.25}$$

where $\psi = exp[\int_{z\in[0,1]} b(z)lnb(z)dz]$. The cost share $b(z)$ satisfies $\int_{z\in[0,1]} b(z)dz = 1$. And $m(z)$ is the quality-adjusted input. The exporter chooses to source its inputs from a foreign country or not. For simplicity, we assume that the producers in the foreign country are more efficient at producing higher z varieties. The production of intermediate inputs requires only labor inputs. And the quality-adjusted cost of sourcing input z from the home country and foreign country are $c_m(z)$ and $c_m^*(z)$, respectively. For an input variety of a unit quality produced in the foreign country, the production cost is $\epsilon_m c_m^*(z)$, in home currency. And since we have normalized the wage rate of workers producing unit quality in the home country as one, we have that the production cost of producing variety z with a unit of quality is $c_m(z)$. We assume that the intermediate input market is perfectly competitive. According to Equation (A.25), we have:

$$P_x(\phi,\epsilon) = exp[\int_{z\in[0,z^*]} b_i(z)lnc_m(z)dz + \int_{z\in[z^*,1]} b_i(z)ln(\epsilon_m c_m^*(z))dz] \tag{A.26}$$

Let $\epsilon_m = \epsilon$. We have that the exchange rate elasticity of the quality-adjusted composite input price is :

$$\frac{\partial lnP_x(\phi,\epsilon)}{\partial ln\epsilon} = \underbrace{\int_{z\in[z^*,1]} b_i(z)dz}_{\text{intensive margin}} + \underbrace{\frac{\partial z^*}{\partial ln\epsilon}\{-ln[\epsilon c_m^*(z^* + \frac{\partial z^*}{\partial \epsilon})] + ln[c_m(z^* + \frac{\partial z^*}{\partial \epsilon})]\}}_{\text{extensive margin}} \tag{A.27}$$

In Equation (A.27), the first term denotes the intensive margin. The second term denotes the extensive margin. When the home currency appreciates, the first term denotes cost saving from the intensive margin. Following Fan et al. (2018), we neglect the change in the extensive margin in this case with a sufficiently small change in ϵ. With a similar argument in the case of the CES aggregator, we can derive Proposition A.1.

B. Additional Robustness Checks

Alternative Measures

In this subsection, we check whether our baseline results are robust to different imported inputs share and quality change measures. For the imported inputs share, we use two alternative measures. The first one is still constructed as the estimates from second-step of the Heckman two-step procedure, but it is with alternative tariff measures. The second measure is constructed as the share of imported inputs from country c in total intermediate inputs use. Since records on the total intermediate inputs use are only available from the Annual Survey of Industrial Firms (ASIF), we merge the ASIF data with the Customs data to construct the second new measure. We match the two data sets by firm names in Chinese characters. The number of observations after merging is greatly reduced, as discussed carefully in Yu (2015). In columns (1) and (2) in Table A.1, we report the estimation results based on the two alternative imported inputs share measures, respectively. As is shown, these results are quite similar to the baseline results (reported in Table 6).

[Insert Table A.1 Here]

For quality change, we use six alternative measures. The estimation results based on these measures are reported in columns (3)–(8) of Table A.1, respectively. In column (3), we use the one-period lag of quality change, which is measured as: $\Delta lnQ_{fpc(t-1)}$. In column (4), we use the simple average of quality change, which is measured as : $\overline{\Delta lnQ_{fpc}} \equiv \sum_t \frac{\Delta lnQ_{fpct}}{N_{fpc}}$. N_{fpc} is the number of observations for exporter $f's$ product p to destination c. In column (5), we use the moving average value (one period lag to four period lag) of quality change, which is measured as: $\overline{\Delta lnQ_{fpct}}^{MA} \equiv \sum_{t-1}^{t-4} \frac{\Delta lnQ_{fpct}}{N_{fpc(t-1),(t-4)}}$. $N_{fpc(t-1)(t-4)}$ is the number of observations for exporter $f's$ product p to destination c from period $t-4$ to period $t-1$. In column (6), we use the range of quality change, which is measured as: $Q_{fpc,range} \equiv lnQ_{fpc,max} - lnQ_{fpc,min}$ in which $Q_{fpc,max}$ and $Q_{fpc,min}$ are the highest and lowest quality of exporter f's exported product p to destination c, respectively. We find that our baseline results hold for regressions with the four alternative measures of quality change. In columns (7) and (8), we use importing country-sector-specific substitution elasticities for robustness checks. Following Khandelwal et al. (2013) and Fan et al. (2015), in most of the estimations, we obtain the sector-specific elasticities of substitution across the varieties within sectors from Broda and Weinstein (2006) which provides substitution elasticities' estimates for US imports. In column (7), we replace the substitution elasticities from Imbs and Mejean (2017), which provides estimates for sector level (at ISIC 3-digit, Revision 2) substitution elasticities for 28 developed and developing countries. To merge ISIC code substitution elasticities with our sample, we use the WITS's concordance table to convert the ISIC codes to HS 1996 classification codes. The sample size used in column (7) is only around one-third of our baseline sample in

Table 6. In column (8), we instead use the HS 3-digit level substitution elasticities for 73 countries provided by Broda et al. (2017). As the original data is recorded by HS 1992 classification, we use the WITS's concordance table to convert the HS 1992 classification to the HS 1996 classification. Based on the results re-estimated with importing country-sector-specific substitution elasticities, we find our baseline conclusion still holds.

Table A.1: Alternative Measures

Dep.Var.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta lnExportprice_{fpct}$	$IM\hat{s}hare_{fct}^{Avg.Tariff}$	$IMshare_{fct}^{totalinputs}$	Lag	Avg.	Moving avg.	Range	σ_{IM}	σ_{BR}
$\Delta lnRER_{ct}$	0.063***	0.044***	0.060***	0.082***	0.098***	0.078***	0.166***	0.148***
	(11.92)	(3.56)	(3.01)	(13.98)	(3.14)	(7.21)	(2.83)	(2.36)
$\Delta lnRER_{ct} \times Im\hat{p}ort_{fct} \times \widetilde{Q}_{fpct}$	-0.030*	-0.124**	-0.022	-0.093***	-0.390**	-0.033***	-0.167*	-0.020***
	(-1.74)	(-2.00)	(-0.91)	(-3.13)	(-2.16)	(-7.25)	(-1.77)	(-4.02)
$\Delta lnRER_{ct} \times \widetilde{Q}_{fpct}$	0.009*	0.001	0.009	0.002	0.020	0.001	0.003	0.015
	(1.92)	(0.15)	(0.98)	(0.36)	(0.84)	(0.64)	(0.19)	(0.67)
$\Delta lnRER_{ct} \times Im\hat{p}ort_{fct}$	0.093***	0.230***	0.194***	0.125***	0.127***	0.055	0.085	0.109**
	(6.58)	(5.63)	(2.72)	(6.95)	(3.35)	(0.92)	(1.05)	(1.98)
$Im\hat{p}ort_{fct} \times \widetilde{Q}_{fpct}$	0.011***	0.007***	-0.003**	0.014***	0.002	0.000	0.015***	0.017***
	(10.69)	(4.62)	(-2.21)	(13.21)	(0.18)	(0.84)	(8.92)	(3.60)
$Im\hat{p}ort_{fct}$	0.003**	-0.005*	0.010***	0.006***	0.002*	0.007***	0.010***	0.005*
	(2.44)	(-1.96)	(3.63)	(5.97)	(1.67)	(4.55)	(3.12)	(1.82)
$\widetilde{Q}_{fpct}$	0.095***	0.082***	-0.018***	0.080***	0.063***	0.000***	0.095***	0.066***
	(19.26)	(188.50)	(-15.64)	(154.56)	(27.46)	(3.81)	(82.87)	(24.17)
Fixed effects								
Product-country	Y	Y	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y	Y	Y
Observations	3,530,481	640,058	2,057,006	3,551,533	3,530,367	3,530,367	1,067,692	2,551,533
R-squared	0.342	0.349	0.049	0.103	0.182	0.030	0.572	0.806

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The data sample is restricted to manufacturing firms by excluding trade intermediaries and only keeping incumbent exporters with observations for consecutive periods. We use the imported inputs share ($IM\hat{s}hare_{fct}$) predicted from Heckman selection (column (1) in Table 3) second-step estimates in all columns except for columns (1) and (2). We use the imported inputs share ($IM\hat{s}hare_{fct}$) predicted from Heckman selection (column (3) in Table 3) second-step estimates in column (1). We use the imported inputs share ($IMshare_{fct}^{totalinputs}$) measured as the share of imported inputs from country c in total intermediate input use (including domestic intermediate inputs) in column (2). We use quality change measure 1 ($\widetilde{Q}_{fpct}^{1}$) in columns (1) and (2). In columns (3) to (6), we use the one-period lag ($\Delta lnQ_{fpc(t-1)}$), simple average ($\overline{\Delta lnQ_{fpc}}$), moving average value ($\overline{\Delta lnQ_{fpct}}^{MA}$) and the range of quality change ($Q_{fpc,range}$) to measure quality change, respectively. In columns (7) and (8), we use the substitution elasticities from Imbs and Mejean (2017) and Broda et al. (2017) to construct quality change measure ($\widetilde{Q}_{fpct}$). All regressions include gross domestic product (GDP) and GDP per capita controls.

Alternative Samples

In this subsection, we check whether our baseline results are robust to alternative samples and summarize the results in Table A.2. To exclude the impact of the product mix on heterogeneous ERPT, we only keep single-product exporters in column (1). In the baseline, the sample includes many multi-product firms. When faced with "tougher" destination markets caused by home currency appreciation, a multi-product firm will tend to reduce the product scope exported to this market and concentrate more on its core products (Bernard et al., 2011; Mayer et al., 2014). Those effects could interfere with the identification of our estimation. As product switching mainly happens for a firm's peripheral products, we only keep the observations for core product exports in column (2). A core product is defined as the firm's export product with the highest export value. In columns (1) and (2), we find that our baseline results still hold.

[Insert Table A.2 Here]

Considering the difference in pricing behavior between processing exporters and ordinary exporters as illustrated by previous literature (Fan et al., 2015; Feng et al., 2016; Bai et al., 2017), in Table A.2, column (3), we exclude processing exports and use the reduced sample consisting of ordinary exports for the regression.[35] We find out baseline results still hold for this sample, excluding processing exports. In column (4), we try to further address the potential sample selection issue by restricting our analysis to a sample with exporter-product-destination pairs always present in the sample period. The sample is much reduced under this restriction. We find that the coefficient before the triple interaction term is still negative and significant in this setting.

In Table A.2, column (5), we delete all observations during the global financial crisis (2008–2009) to control for the crisis's destination-year-varying impacts both on export quality and exchange rate. A large decrease in trade finance during the global financial crisis can cause a plummet in export quality downgrading. Meanwhile, the RMB exchange rate appreciation can also be seen as an outcome of the global financial crisis. Thus, our estimates of the impacts of the exchange rate on export prices and the *quality change* channel might be downward biased in the global financial crisis period. The results in column (5) support our previous analysis. The impact of *quality change* channel is strengthened for this reduced sample, excluding the global financial crisis's observations. In column (6), we use the sub-period of 2006-2011 for empirical analysis to exclude the exchange rate regime change's impact on our analysis. China initiated a market-oriented reform of the RMB exchange rate in 2005. In column (6), we find both channels, *marginal cost* channel and *quality change* channel exist in the sub-period of 2006-2011, and both of the impacts

[35] The Chinese Customs Data provides trade type identifier for each transaction record: "10" for ordinary exports; "14" and "15" for processing exports. For the subsample of ordinary exports, we only keep the observations with trade type identifier as "10".

are stronger than the average impacts during the full period 2000-2011. A possible explanation is an exporter's pricing decision is more responsive to exchange rate movements under a flexible exchange rate regime than a fixed exchange rate regime. The validity of such an explanation needs to be carefully examined and beyond the scope of our study.

Table A.2: Alternative Samples

Dep.var.	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta lnExport\,price_{fpct}$	Single	Core	W/O processing	Permanent exporters	W/O 2008-2009	2006-2011
$\Delta lnRER_{ct}$	0.040*	0.058***	0.048***	0.061***	0.042***	0.014
	(1.71)	(4.04)	(4.60)	(4.69)	(6.02)	(0.34)
$\Delta lnRER_{ct} \times IM\hat{share}_{fct} \times \widetilde{Q}_{fpct}$	-0.085***	-0.451***	-0.107**	-0.074**	-0.047*	-0.079**
	(-2.86)	(-2.90)	(-2.50)	(-2.13)	(-1.93)	(-1.98)
$\Delta lnRER_{ct} \times \widetilde{Q}_{fpct}$	0.002	0.040*	0.018***	0.032**	0.009*	0.041**
	(0.16)	(1.74)	(3.21)	(2.53)	(1.70)	(2.22)
$\Delta lnRER_{ct} \times IM\hat{share}_{fct}$	0.103**	0.134***	0.063***	0.214***	0.188***	0.110
	(2.46)	(3.25)	(3.61)	(6.25)	(10.23)	(1.43)
$IM\hat{share}_{fct} \times \widetilde{Q}_{fpct}$	0.010***	-0.005	0.003**	0.018***	0.012***	0.010***
	(6.49)	(-0.66)	(2.40)	(5.09)	(12.79)	(3.76)
$IM\hat{share}_{fct}$	0.012***	0.010***	0.005**	0.002	0.006***	0.007
	(6.28)	(5.17)	(2.06)	(0.78)	(4.19)	(1.16)
$\widetilde{Q}_{fpct}$	0.078***	0.049***	0.094***	0.098***	0.093***	0.099***
	(100.84)	(19.80)	(70.00)	(69.98)	(18.88)	(52.05)
Fixed effects						
Product-country	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
Observations	545,439	960,457	1,906,437	231,729	2,690,140	2,443,700
R-squared	0.345	0.266	0.312	0.368	0.348	0.354

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The data sample is restricted to manufacturing firms by excluding trade intermediaries. We use the imported inputs share ($IM\hat{share}_{fct}$) predicted from Heckman selection (column (1) in Table 3) second-step estimates in all columns. We use quality change measure 1 ($\widetilde{Q}^{1}_{fpct}$) in all columns. All regressions include gross domestic product (GDP) and GDP per capita controls. W/O = without.

Currency Area and Vehicle Currency

In Table A.3, we consider the impacts of the currency area on the robustness of our baseline results. When there is a strong correlation in exchange rate movements between importing countries and exporting countries, the exchange rate movements in exporting countries would still affect the importing behavior of firms from a different country. However, it is not easy to measure the exact exchange rate co-movement between two currencies. To take care of this issue, we divide all the sample countries into three subgroups, depending on their currency area: eurozone, pegged to the dollar zone, and the rest of the world (if the country does not locate in the eurozone or dollar zone). When exporters import inputs from the same currency area, we classify this export transaction as involving imports of intermediate input from the same currency area. We report the estimation results in column (1) in Table A.3, based on this redefinition of imported input share, and find that our baseline results still hold.

[Insert Table A.3 Here]

In column (2) in Table A.3, to control for the impacts of invoicing currency use, we drop observations with the export destination being the United States or any of the eurozone countries. A strand of literature focuses on the role of invoicing currency choices in determining the exchange rate pass-through (ERPT) (Gopinath et al., 2010). A general conclusion is that if the trade transaction is invoiced in the producer's currency instead of the local importer's currency, then the ERPT is more likely to be higher than in the latter case. And if the trade transaction is invoiced in a third country's currency, that is, a vehicle currency, the ERPT is close to the producer currency case (Chen et al., 2018). Although we cannot observe the actual settlement currency in Chinese export transactions, it is well recognized that the majority of China's export transactions are settled in U.S. dollars and euros.[36] Thus, we dropped the observations with the United States and eurozone countries as export destinations to base the analysis on the vehicle currency subsample. As is shown in column (2), our baseline results still stand.

[36] According to the data released in Gopinath (2015), only 5% of China's export transactions is invoiced in CNY. The rest of the trade transactions are invoiced predominantly in U.S. dollars and euros.

Table A.3: Currency Area and Vehicle Currency

Dep.Var.	(1)	(2)
$\Delta lnExportprice_{fpct}$	Alternative definition of importing exporters	Dropping US dollar zone and eurozone
$\Delta lnRER_{ct}$	0.073***	0.041***
	(16.38)	(4.51)
$\Delta lnRER_{ct} \times IMs\hat{h}are_{fct} \times \widetilde{Q}_{fpct}$	-0.137***	-0.170***
	(-4.05)	(-3.88)
$\Delta lnRER_{ct} \times \widetilde{Q}_{fpct}$	0.005*	0.006
	(1.79)	(0.38)
$\Delta lnRER_{ct} \times IMs\hat{h}are_{fct}$	0.021*	0.095***
	(1.87)	(2.74)
$IMsh\hat{a}re_{fct} \times \widetilde{Q}_{fpct}$	0.005***	0.008
	(8.42)	(0.68)
$IMsh\hat{a}re_{fct}$	0.001	0.004***
	(0.82)	(3.28)
$\widetilde{Q}_{fpct}$	0.083***	0.065***
	(246.00)	(21.36)
Fixed effects		
Product-country	Y	Y
Year	Y	Y
Observations	3,296,265	1,880,223
R-squared	0.340	0.285

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The data sample is restricted to manufacturing firms by excluding trade intermediaries. We use the imported inputs share ($IMs\hat{h}are_{fct}$) predicted from Heckman selection second-step estimates in all columns. We use quality change measure 1 ($\widetilde{Q}^{1}_{fpct}$) in all columns. All regressions include gross domestic product (GDP) and GDP per capita controls.

Exporter Size and Destination Heterogeneity

In Table A.4, we report the estimation results for subsamples divided by exporter size and destination income level. In columns (1) to (4), we conduct separate regressions for subsamples of large and small exporters. Large exporters are those with total export value greater than the 75th percentile of the distribution. Small exporters are those with total export value of less than the 25th percentile of the distribution. We find that our baseline results are not qualitatively affected by the exporter's size. If we interpret exporter's size as a measure of firm-specific capability, the regression results for subsamples of large and small exporters deliver the same message from the previous analysis: the firm-product specific ability of quality upgrading (or degrading) (net of firm-specific capability) matters for the *quality change* channel and ERPT.

[Insert Table A.4 Here]

In columns (5) to (8), we split the sample into subsamples of firms exporting to developed and developing countries. We find that the *quality change* channel is insignificant for the subsample with developing countries as export destinations. A possible explanation for this might be the limited space for quality upgrading of products exported to developing countries, resulting in the firm's export price and quality insensitivity to exchange rate movements.

Table A.4: Exporter Size and Destination Heterogeneity

Dep.Var.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta lnExport\,price_{fpct}$	Large exporters		Small exporters		Developed countries		Developing countries	
$\Delta lnRER_{ct}$	0.095***	0.054***	0.037**	0.038**	0.085***	0.061***	0.003	-0.060
	(3.59)	(10.86)	(2.06)	(2.47)	(4.93)	(16.72)	(0.15)	(-0.85)
$\Delta lnRER_{ct} \times IM\hat{share}_{fct} \times \widetilde{Q}_{fpct}$		-0.051**		-0.046***		-0.036***		0.087
		(-2.16)		(-2.86)		(-3.59)		(1.43)
$\Delta lnRER_{ct} \times \widetilde{Q}_{fpct}$		0.007***		0.023***		0.007***		-0.025
		(3.06)		(3.72)		(4.93)		(-1.10)
$\Delta lnRER_{ct} \times IM\hat{share}_{fct}$		0.158***		0.167***		0.106***		0.130
		(9.76)		(4.66)		(11.75)		(0.65)
$IM\hat{share}_{fct} \times \widetilde{Q}_{fpct}$		0.011***		0.013***		0.012***		0.021**
		(18.62)		(10.25)		(38.63)		(2.55)
$IM\hat{share}_{fct}$		-0.015***		0.020***		0.005***		0.001
		(-10.02)		(7.52)		(6.59)		(0.17)
$\widetilde{Q}_{fpct}$		0.093***		0.090***		0.090***		0.094***
		(69.58)		(70.25)		(58.11)		(57.28)
Fixed effects								
Product-country	Y	Y	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2,466,612	1,483,485	1,813,461	420,596	7,547,701	3,337,448	431,259	65,322
R-squared	0.062	0.360	0.632	0.384	0.022	0.340	0.110	0.420

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The data sample is restricted to manufacturing firms by excluding trade intermediaries. Large exporters are those with total export value above the distribution's 75th percentile. Small exporters are those with total export value below the distribution's 25th percentile. We classify a country as a developed country if its real gross domestic product (GDP) per capita is greater than $10,000 (in 2011 U.S. dollars). If a country's real GDP per capita is less than $4,000, it is classified as a developing country. We use the imported inputs share ($IM\hat{share}_{fct}$) predicted from Heckman selection (column (1) in Table 3) second-step estimates in all columns. We use quality change measure 1 ($\widetilde{Q}^{1}_{fpct}$) in all columns. All regressions include GDP and GDP per capita controls.

C. Annual Growth Rates of the Sub-samples

Table A.5: Annual Growth Rates of Export Quality and Imports of Intermediate Inputs (%)

A. Full sample	Quality ($\widetilde{Q}_{fpct}$)	Input imports value ($\Delta lnImport_{ft}$)
2001	21.48%	-6.85%
2006	0.97%	5.43%
2011	0.10%	18.59%
Annual growth rate 1	2.64%	0.20%
Annual growth rate 2	9.28%	4.10%
B. Subsamples	Quality ($\widetilde{Q}_{fpct}$)	Input imports value ($\Delta lnImport_{ft}$)
Large exporters	13.42 %	13.96 %
Small exporters	-3.93 %	8.75 %
Destination as developed countries	2.30 %	10.21 %
Destination as developing countries	1.53 %	9.44 %

Note: The data sample is restricted to manufacturing firms by excluding trade intermediaries and only keeping incumbent exporters with observations for consecutive periods. Annual growth rate 1 is the geometric average value of annual growth rates during 2000-2011. Annual growth rate 2 is the geometric average value of annual growth rates for the whole sample, excluding 2008 and 2009. Large exporters are those with total export value above the 75th percentile of the distribution. Small exporters are those with total export value below the 25th percentile of the distribution. We classify a country as developed if its real gross domestic product (GDP) per capita is greater than $10,000, in 2011 U.S. dollars. If a country's real GDP per capita is less than $4,000, it is classified as developing.

D. Export Value and Quantity

Table A.6: Discussion on Export Value and Quantity

	(1)	(2)	(3)	(4)
Dep.var.	$\Delta lnEXquantity_{fpct}$	$\Delta lnEXvalue_{fpct}$	$\Delta lnEXquantity_{fpct}$	$\Delta lnEXvalue_{fpct}$
$\Delta lnRER_{ct}$	0.206*	0.266*	0.252***	0.286***
	(1.65)	(1.74)	(14.55)	(11.80)
$\Delta lnRER_{ct} \times IM\hat{share}_{fct} \times \widetilde{Q}_{fpct}$	-0.526*	-0.681*	-0.574***	-0.747***
	(-1.73)	(-1.88)	(-12.83)	(-7.05)
$\Delta lnRER_{ct} \times \widetilde{Q}_{fpct}$	0.033	0.054	-0.035***	-0.017
	(0.51)	(0.66)	(-5.94)	(-0.61)
$\Delta lnRER_{ct} \times IM\hat{share}_{fct}$	-0.239	-0.144	-0.197*	-0.096
	(-0.77)	(-0.43)	(-1.94)	(-0.87)
$IM\hat{share}_{fct} \times \widetilde{Q}_{fpct}$	0.010	0.022	0.023***	0.038***
	(0.64)	(1.25)	(16.31)	(3.99)
$IM\hat{share}_{fct}$	-0.025	-0.020	-0.051***	-0.036***
	(-1.54)	(-1.37)	(-4.51)	(-3.50)
$\widetilde{Q}_{fpct}$	0.418***	0.504***	0.417***	0.504***
	(95.31)	(116.34)	(115.38)	(103.55)
Fixed effects				
Product-country	Y	Y	Y	Y
Firm-year			Y	Y
Year	Y	Y		
Observations	3,530,367	3,530,367	3,378,144	3,378,144
R-squared	0.416	0.602	0.507	0.668

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. $\Delta lnEXquantity_{fpct}$ and $\Delta lnEXvalue_{fpct}$ are the first difference in log export quantity and log export value, respectively. The data sample is restricted to manufacturing firms by excluding trade intermediaries. We use the imported inputs share ($IM\hat{share}_{fct}$) predicted from Heckman selection (column (1) in Table 3) second-step estimates in all columns. We use quality change measure 1 ($\widetilde{Q}^1_{fpct}$) in all columns. All regressions include gross domestic product (GDP) and GDP per capita controls.

E. Subsample Analysis Restricted to Ordinary Trade

Table A.7: Exchange Rate Movements on Export Quality and Net-Quality Export Prices: Ordinary Exports

	(1)	(2)	(3)	(4)
Dep. var.	$\Delta lnQuality_{fpct}$		$\Delta lnprice\ adjusted_{fpct}$	
	Differentiated	Homogeneous	Differentiated	Homogeneous
$\Delta lnRER_{ct}$	-0.230***	-1.048*	0.304***	1.144*
	(-4.64)	(-1.70)	(5.76)	(1.71)
$\Delta lnRER_{ct} \times IM\hat{share}_{fct}$	-0.425***	0.546	0.547***	-0.544
	(-3.76)	(0.40)	(4.48)	(-0.36)
$IM\hat{share}_{fct}$	-0.027***	-0.040	0.035***	0.037
	(-2.67)	(-0.40)	(3.24)	(0.34)
Fixed effects				
Product-country	Y	Y	Y	Y
Year	Y	Y	Y	Y
Observations	1,445,212	11,111	1,445,212	11,111
R-squared	0.045	0.220	0.043	0.218

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The data sample is restricted to ordinary exports of manufacturing firms by excluding trade intermediaries and processing exports. We use the median values of substitution elasticities among goods from Broda and Weinstein (2006) to construct the quality measure. $lnprice\ adjusted_{fpct}$ is measured as log value of export price ($lnExportprice_{fpct}$) less log value of export quality($lnQuality_{fpct}$). We use the imported inputs share ($IM\hat{share}_{fct}$) predicted from Heckman selection (column (1) in Table 3) second-step estimates in all columns. Product quality differentiation is classified according to Rauch (1999). All regressions include gross domestic product (GDP) and GDP per capita controls.

Table A.8: Exchange Rate Movements, Imported Intermediate Inputs and Quality Change: Ordinary Trade

Dep.var.	(1) $\Delta IMshare_{fct}$	(2) $\Delta lnIMprice_{fqct}$	(3) $\Delta lnQuality_{fpct}$
$\Delta lnRER_{ct}$	-0.013***	0.314***	0.159***
	(-4.20)	(39.08)	(4.40)
$\Delta lnRER_{ct} \times \widetilde{Q}_{ft}$		-0.009**	
		(-2.53)	
$\widetilde{Q}_{ft}$		0.005***	
		(20.22)	
$\Delta lnRER_{ct} \times \Delta lnIMprice_{ft}$			-0.173**
			(-2.03)
$\Delta lnIMprice_{ft}$			0.039***
			(5.22)
Fixed effects			
Country	Y		
Product-country		Y	Y
Year	Y	Y	Y
Observations	926,163	2,853,234	2,408,643
R-squared	0.004	0.014	0.053

Note: Robust standard errors are corrected for clustering at the destination country level. The t statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level. The data sample is restricted to ordinary exports (imports) of manufacturing firms by excluding trade intermediaries and processing exports (imports). We use the firm average quality change ($\widetilde{Q}_{ft}$) in column (2). We construct the imported inputs price change ($\Delta lnIMprice_{ft}$) as the average value of change in firm-product-country level log imported inputs prices ($\Delta lnIMprice_{fqct}$) in column (3). Regressions include the source country's gross domestic product (GDP) and GDP per capita controls in columns (1) and (2). Regression includes the destination country's GDP and GDP per capita controls in column (3).