How do exchange rate movements affect Chinese exports? – A firm-level investigation[†]

Hongbin Li Hong Ma[*] Yuan Xu Yanyan Xiong

School of Economics and Management

Tsinghua University, China

Abstract

We use detailed Chinese firm-level data for 2000–2007 to examine the effect of exchange rate movements on the export behavior of firms. We find that exchange rate movements have a significant and large pass-through to export price in destination currency，and a significant effect on export volume. Moreover, an appreciation of domestic currency reduces the probability of firm export and export firms' product scope in existing destinations. We also find that firms with different characteristics measures respond differently to the changes in exchange rates: firms with high productivity will price more to market, while those with low productivity adjust their export volume. Firms with larger destination market share and in a more concentrated market, however, price less to market. Using firms import intensity and import-weighted exchange rate changes, we also capture the impact of marginal cost changes on firms' export price as well as volume.

Keywords: exchange rate, firm-level, elasticity, pass-through, extensive margins
JEL Classification: F31, F32, F41, F14

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[*]Corresponding author: Hong Ma, School of Economics and Management, Tsinghua University, Beijing, 100084, China. Email: mahong@sem.tsinghua.edu.cn. Tel: 86-10-62794388. Fax: 86-10-62785562

1. Introduction

Gauging the impact of exchange rate movements on cross-border trade is of particular interests to academia and the policy circle, especially in the era of global imbalance. The rising demand for numerical estimations, however, often meets with scarcity of detailed trade volume and price data. Furthermore, recent breakthrough in trade theory, pioneered by Eaton and Kortum (2002) and Melitz (2003), emphasized the importance of firm heterogeneity that should be taken into account when studying exchange rate effects.

Fortunately, recent literature has made some advance in bringing firm-level data into a test. In particular, Berman, Martin and Mayer (2012, hereafter BMM) first analyzed the heterogeneous reaction of exporters to real exchange rate movements, using very rich French firm-level export data. They found exporters with high total factor productivity (TFP) react to a depreciation by increasing *more* in markups and by increasing *less* in export volumes. Thus heterogeneity in firms' pricing-to-market behavior may explain partially the moderate impact of exchange rate changes on aggregate exports. Amiti, Itskhoki, and Konings (2012, hereafter AIK), drawing on a large sample of Belgian firms, showed that the heterogeneous responses of firms to exchange rate changes may be related to firm's market share and its import intensity. Are BMM's and AIK's findings just special cases for European exporters? Can it be generally applied to other major exporting countries and developing countries?

In this paper, we use detailed China micro data and carefully examine how would bilateral real exchange rate changes affect firms' pricing behavior as well as trade volume. Specifically, we explore how firms adjust through both intensive (quantity and price) and extensive margins (market entry/exit, within-firm product adding/dropping). A big advantage of our dataset is that we have obtained information on the value and quantity of each product that each firm exports to each destination. So we can use unit value as proxy for the f.o.b. (free-on-board) export price at firm-product-destination level. Thus we could estimate both exchange rate elasticity and exchange rate pass-through at the firm level, which complements the literature that usually have only aggregate volume and price indices. Furthermore, by matching exporters with their balance sheet and production data, we could further examine the heterogeneity of response to exchange rate movements.

We start with the full sample of exporting firms. Our various estimations at the firm level show the following results. First, following a 10 percent appreciation of the RMB, Chinese exporters' export price on average drops by around a half percent, which reflects a very complete exchange rate pass-through into the *export* price. Secondly, in terms of export volume, an average exporter will reduce its export volume by 2-4 percent following a 10 percent RMB appreciation. Summing the price and quantity effects gives the total value response to exchange rate changes, which seems to be dominated by the quantity adjustment. The estimations are also consistent across broadly-defined sectors.

We then explore the underlying sources for such lack of pricing to market behavior and low exchange rate elasticity. We do this by exploring the different dimension of heterogeneity across firms. First, we study the response to exchange rate changes by firms with different revenue-based TFP. High-TFP firms are more likely to price to market, by reducing more of their export prices in RMB, although the PTM response is moderate. For our merged sample, a 10 percent appreciation of the RMB lead to about 1 percent decline in the price of the average exporter. However, a one standard deviation increase in TFP raises the price decline by another half per cent, indicating a less complete pass-through of 8.5 percent onto export price denominated in foreign currency. In contrast, firms with low productivity are unable to adjust their export price facing exchange rate shocks, and therefore, have nearly complete pass-through of exchange rate shocks into export prices in foreign currency. On the other hand, the average exporter decreases is export volume by 2.5 percent in response to a 10 percent appreciation. However for high–TFP firms, this number becomes even smaller due to their more responsive price adjustment.

Notice that the TFP measures based on revenue function may mix firms' marginal cost with markup. As shown by Bernard et al. (2009), more productive and larger exporters are also more likely to be importers simultaneously. This export-import linkage has been emphasized by the recent work of AIK (2012), who show that exporters with higher import intensity tend to reduce pass-through. In theory, a firm's export price could be decomposed into two parts: its marginal costs, as well as its markup. To further explore the impact of heterogeneity in those two dimensions, we further add firms' import exchange rate changes, import intensity (both as a proxy for marginal cost), and market share in the destination product market. We find depreciation in import-weighted exchange rate changes (an increase in import costs) increases exchange rate pass-through, while import intensity reduces exchange rate pass-through. Finally

firms' market share in the destination market also matters by reducing the pass-through significantly.

Moreover, we also examine the impact of exchange rate appreciation on firms' entry decision. Not surprisingly, RMB appreciation reduces the probability of firm export, as reflected by both the probability of surviving in the existing market and that of entering a new market.

Because of the substantial share that export-processing firms account for in China's foreign trade, we further investigate whether processing trade affects firm sensitivity with respect to the exchange rate. Processing trade relies heavily on imported intermediate inputs; therefore, an appreciation of the RMB may reduce the input costs for processing exporters. Furthermore, processing trade also implies more binding contracts. In many cases, processing exports are conducted by foreign owned enterprises, implying that the exports are more likely intra-firm. Interestingly, we find no statistically significant effect, in contrast to the study of Aziz and Li (2007), which uses aggregate data and reveals larger elasticity for non-processing exports than for processing exports. One possible explanation is that a large share of intermediate inputs were imported from East Asian countries, which were also experiencing currency appreciation during the same period. Thus, processing exporters do not have significant cost advantage over non-processing exporters.

In summary, our paper contributes to current literature in the following ways. First, this study is among the first to examine the effect of currency appreciation on trade using detailed micro data. Existing studies relying on aggregate data often run into problems such as aggregation bias (Dekle *et al.*, 2007), simultaneity (Adolfson, 2001), and measurement error in constructing aggregate indices. Studies using micro data are devoted mostly to developed countries (for example, BMM and AIK). In comparison, this paper uses detailed firm-level data, and generates sharply different results from those of extant literature on China that uses more aggregate data.[1] Second, this paper examines the pass-through to export prices using exporter-level data, which enables the direct analysis of the behavioral responses of export firms facing appreciation. Except for a few studies on developed countries (Martin and Rodriguez, 2004; Hellerstein, 2008; Fitzgerald and Haller, 2008), the majority of the existing research on exchange rate pass-through (ERPT) examines the pass-through to import or consumer prices (Campa and Goldberg, 2005;

[1] Tang and Zhang (2012) use monthly transaction data of Chinese exporters to investigate exchange rate elasticities and decisions of entry and exit. However, they neglect the enormous heterogeneity among firms.

Marazzi *et al.*, 2005). Only a few studies examine ERPT to export prices, but in these, more aggregate data are used (Vigfusson *et al.*, 2009; Bussiere and Peltonen, 2008; Cui *et al*., 2008). Third, our study is comprehensive in the sense that we consider almost every potential effect of currency appreciation, including both intensive (quantity and price) and extensive (entry, exit, and product scope) adjustments. Finally, aided by the detailed firm-level data, we are able to examine how measures of productivity, marginal costs, and market power affect firms' responses to appreciation. To the best of our knowledge, only BMM and AIK have done the same at such detail.

China's tremendous export growth and increasing influence in global economy is reason enough to direct attention to that country. China's export shipment to the world market more than quadrupled in 8 years, from 1999-2007, during which China joined the WTO in 2001. In Figure 1 we show China's recent soaring growth in import and export. The export ratio to China's GDP stays at as high as 20-35% for almost two decades. As also shown in Figure 1, Chinese share in US total imports has been steadily growing up, from less than 5% in 1992, to around 16% in 2008. A flood of low-cost Chinese imports have exerted huge pressure on domestic producers and caused exit of firms and layoff of workers[2].In particular, the ever-increasing trade deficit between the US and China adds further tension between the two largest countries in the world. China's pegged nominal RMB (Renminbi) has been claimed too low and responsible for the current global imbalance. Many have urged that fastening RMB appreciation would work to reduce its huge trade surplus. However, although RMB has steadily appreciated against the US dollar since 2005, Chinese export to the US and to the world hasn't been slowed down.[3] To understand the effect of exchange rate movements on the pattern of Chinese export, it is important to. Our paper provides the first empirical effort on this issue using firm level trade and production data.

The remainder of the paper is organized as follows. Section 2 briefly reviews related literature. Section 2 describes the data. Section 3 investigates the effect of RMB appreciation on firm adjustment at the intensive margins. Section 4 details the investigation on the effect of firm

[2] Autor, Dorn, and Hanson (2011), for example, find that the rising Chinese imports led to unemployment and reallocation of US workers.

[3] Since June 2005, RMB has steadily appreciated against the US dollar and has appreciated from 8.3 yuan per dollar to 6.8 yuan per dollar by June 2008 --- a total of 21 percent. During the global financial crisis, China re-pegged RMB to the US dollar until May 2010.

adjustment at the extensive margins. Section 5 further looks at whether firms of different types of trade or ownership respond differently to exchange rate movements. Section 6 concludes.

2. The Exchange Rate Effect on Trade: Related Literature

Closely related to the recent works by BMM (2012) and AIK (2012), this paper contributes to a large and growing literature on the impact of exchange rate on export quantity and price.

First, exchange rate movements may change the prices received by consumers in destination countries, consequently affecting export volume. A rich strand of literature estimates the elasticity of export quantity with respect to Chinese RMB movement. Earlier studies on China (Cerra and Dayal-Gulati, 1999; Cerra and Saxena, 2003; Eckaus, 2004) are of limited relevance because trade transactions before the mid-1990s were under the direct control of the government, and quantities could not be adjusted according to market prices (Marquez and Schindler, 2007).[4] Studies that use more recent data find that the elasticity is above unity (Aziz and Li, 2007; Ahmed, 2009; Garcia-Herrero and Koivu, 2009; Thorbecke and Smith, 2010), which is generally larger than the findings for developed countries (Hooper *et al.*, 2000). [5] The only exception is Cheung *et al*. (2009), who find an insignificant elasticity.

Second, firms may price to market (PTM) and therefore adjust their price–cost margin to re-optimize their export profits. Hence, exchange rate movements are typically not completely passed to importers or consumers in destination countries. Literature on pass-through to developed countries generally reveals low exchange rate pass-through to import prices at the aggregate level (Campa and Goldberg, 2005; Marazzi *et al.*, 2005).[6] Although the Chinese RMB has been a focal point of political and economic debate, little empirical evidence on the degree of pass-through of RMB appreciation exists. The only two existing studies are those of Bussiere

[4]Another criticism raised by Marquez and Schindler (2007) is that because Chinese trade prices are unavailable, studies use imperfect proxies for these prices. Thus, they instead estimate the effect of exchange rate changes on the nominal shares of Chinese trade in world trade. Using monthly data from 1997 to 2004, they find that a 10 percent appreciation of RMB decreases the share of aggregate Chinese exports by nearly one percentage point.

[5]Hooper *et al.* (2003) estimate the trade elasticities for G-7 countries. They find that the short-run elasticities are no larger than 0.5 (in absolute values) and the long-run elasticities are no larger than 1.5.

[6]Campa and Goldberg (2005) find that the average pass-through to import prices in OECD countries varies from 46 percent over a quarter to 64 percent over a year, with the pass-through to the US being relatively low at 23 percent to 42 percent. Marazzi et al. (2005) document a decline in the pass-through to US import prices from around 50 percent during the 1980s to about 20 percent in the last decade.

and Peltonen (2008) and Cui *et al.* (2008). Both studies use aggregate data but find strikingly different results: full pass-through in the first study but only 50 percent in the second.

Third, firms' responses to exchange rate shocks are not limited to the adjustment in *intensive margins* (i.e., quantity and price). Recent literature has emphasized the importance of the *extensive margins* of trade, which accounts for a large share of the variation in imports and exports across nations (Bernard *et al.* 2009). To be more specific, firms may enter/exit a specific market because of favorable/unfavorable exchange rate movements. Furthermore, within the existing trade relationship, firms may adjust the number and bundling of products they ship to each destination. In seminal work on US firms, Bernard *et al.* (2009) find that extensive margin adjustments are important for both cross-trade partners and over the long run; intensive margin adjustments matter only in the short run. Overall, empirical literature on the extensive margin adjustments in response to exchange rate shocks focus on developed countries (Bernard and Jensen, 2004; Greenway *et al.*, 2007; Baggs *et al.*, 2009).

3. Data

Our empirical tests are based on a large database on Chinese export firms. The database is constructed by combining firm export transactions with their balance sheet information.

3.1 Trade Data

The trade data come from the census of yearly export records of all export firms in China from 2000 to 2007, collected by the Chinese Customs Office.[7] The data include information on free-on-board export value and volume for each eight-digit harmonized system (HS) product to each destination country, firm ownership (state-owned, private, foreign, etc.), and type of trade for each transaction (i.e., processing vs. ordinary trade). Given that the f.o.b. values and quantities are at the most disaggregate product categories, the unit value serves as a suitable proxy for the f.o.b. price.

For 2000-2006, we also obtain the data on a monthly basis, we will focus on annual results because our balance-sheet data and data on importing countries' characteristics are all annual. There are also concerns of seasonality and lumpiness in monthly data. Most firms do not export a

[7] We thank the China Data Center at Tsinghua University for providing this dataset.

given product to a given market in every month. Briefly speaking, from 2000 to 2007, between 60,000 and 170,000 firms annually export altogether around 5,000 six-digit HS products to over 200 countries.[8] The total value of exports increases from US$ 250 billion in 2000 to US$ 970 billion in 2006. Using the same data source but for a short period, Manova and Zhang (2009, 2010) provide detailed documentation of the stylized facts of Chinese exporters and importers.

3.2 Firm Data

The second data set that we use is the 1998–2007 Annual Surveys of Industrial Enterprises (ASIE), conducted by the National Bureau of Statistics of China (NBSC). The Annual Surveys include all state-owned firms and non-state firms with revenues above 5 million yuan (about US$ 600,000). Comparing with the 2004 industrial census, this sample accounts for over 90% of industrial output and over 70% of industrial employment in 2004 ((Brandt et al., 2011). For the analysis in this paper we will focus on manufacturing firms. Our sample includes around 150,000-310,000 manufacturing firms, across more than 400 four-digit CIC (i.e., Chinese Industrial Classification) manufacturing industries and 31 provinces. We obtain for each firm the key balance sheet variables including sales, input costs, capital stock, etc., enabling us to construct firms' performance measures. We use labor productivity, defined as value-added over employment, as our first measure of firm performance. We also estimated the total factor productivity (TFP). To control for endogeneity between input levels and unobserved firm-specific productivity shocks, we use material inputs as proxy for productivity shock following Levinsohn and Petrin (2003).[9] For all productivity measures, we use 4-digit output and input deflators provided by Brandt et al. (2011) to deflate gross output and input. For capital stock,[10] we use regional fixed asset price indices as deflator, based on data from the NBS.

We merge the two above-mentioned data sets by exploiting the detailed information on firm name, address (zip code), telephone number, as well as manager's name. Note that not all firms that export can be matched with balance sheet information from the ASIE for the following

[8] The data actually report product code at eight-digit HS level. However the coding of 8-digit products changes over time and no appropriate concordance is available. So we decide to use 6-digit HS products. For robustness, we run additional regressions using 8-digit products and obtain very similar results.
[9] We did not use new investment as proxy following Olley and Pakes (1996) because many Chinese manufacturing firms did not have new investments during the sample period.
[10] Those deflators can be downloaded from http://www.econ.kuleuven.be/public/n07057/China/.

reasons. First, the industrial survey includes only firms of medium and large sizes, but many exporting firms are smaller. Second, trading intermediary companies, which account for a quarter of total export value (Ahn *et al.*, 2010), are not included in the ASIE surveys. After merging the two sources, our remaining sample accounts for around 50% of total value of Chinese exports.

3.3 Macro Variables of Destination Countries

The nominal exchange rate and the CPI data for China's trade partners come from the International Financial Statistics (IFS). The constant price real GDP and real GDP *per capita* for destination countries are collected from the newest version of the Penn World Tables (PWT 7.1).

Finally, following the convention, our real exchange rate (RER_{jt}) is defined as the Chinese Yuan per unit of foreign currency, adjusted by the foreign CPI divided by the Chinese CPI, or

$$RER_{jt} = NER_{jt} * CPI_{jt} / CPI_{China,t} \quad (1)$$

Therefore, an increase in RER_{jt} implies a real depreciation of the Chinese RMB.

3.4 Summary Statistics

Summary statistics are reported in Table 1. Since we are taking first difference on our key variables, we include only the firms that exported a product to a country at least two consecutive years from 2000 to 2007. In total, at the firm-product-destination level, we have more than 6 million observations as reported in Panel A, where an observation is defined as a firm exporting one 6-digit HS product to one destination in one year. There are around 180,000 firms in our sample. For our merged sample with firm production information, the number of firms reduces to around 60 thousand.

Because we focus more on single-product and major product firms in examining pricing behavior and elasticity, bottom panels present summary statistics for firms that export only one 6-digit HS product to a market in a year, or the major product that they export. After removing multiproduct firms, about 80% of firms remain in the sample. The summary statistics for the single-product sample is highly similar to that of the full export sample. For example, statistics

for labor productivity (defined as value-added/labor) are almost the same as that for the full sample.

[Insert Table 1]

4. Intensive Margin: Quantity and Price Responses

4.1 Benchmark regressions

We start with our benchmark regressions that connect export volume and price to exchange rate movement:

$$\ln(Q_{fpct}) = \alpha_0 + \alpha_1 \ln(RER_{ct}) + \delta' Z_{ct} + \mu_{fpc} + \lambda_t + \varepsilon_{fpct} \quad (2.1)$$

$$\ln(P_{fpct}) = \beta_0 + \beta_1 \ln(RER_{ct}) + \gamma' Z_{ct} + \mu_{fpc} + \lambda_t + \varepsilon_{fpct} \quad (2.2)$$

where we index firm by f, destination country by *c*, product by *p*, and year by *t*. The key explanatory variable is RER_{jt}, the annualized real exchange rate of the destination country relative to China: an increase in RER denotes a depreciation of the RMB against the currency in country *j*. We run the regressions in first difference, separately for export unit price and volume. We expect positive α_1 and β_1 which implies that appreciation leads to a reduction in export price as well volume. Following the traditional gravity literature but at the firm level, we add a set of variables in *Z* to control for market-specific factors.[11] Specifically, we add the GDP of the destination country to control for the size effect and GDP *per capita* to control for the income effect. To control for shocks that are firm-product-country specific, we include firm-product-country fixed effects. This also indicates that our coefficients are identified through within-firm-product-destination variations. This also eliminates the concern that CPIs for different countries are not cross-sectionally comparable. Finally year dummies are included to capture macro shocks that are common to all Chinese exporters, such as general technology advances or business cycles.

Results for the benchmark regressions are reported in Table 2, column (1) for the price regression, and column (5) for the volume. Hit by an exchange rate appreciation shock, an exporter may absorb part of the appreciation by reducing its f.o.b. price in home currency, so that

[11] Using a monopolistic competition model with heterogeneous firms and distribution costs of export, BMM (2010) rationalize this specification for the quantity equation.

its f.o.b. price in the destination currency increases by less than the increase in exchange rate. Therefore, the ERPT is already incomplete even before the product is shipped out; this phenomenon is also known as the pricing-to-market (PTM) behavior of firms. Different from most existing studies, which examine exchange rate pass-through (ERPT) to import or consumer prices, [12] our study thus complements extant literature by studying ERPT to export prices.

It can be seen from the coefficient estimates that given a 10 percent appreciation of RMB against the foreign currency, an average Chinese exporter will reduce its export price by only 0.56 percent, while its export volume will be decrease by 2 percent. This implies nearly complete exchange rate pass-through (ERPT) to the export price, and low exchange rate elasticity. The literature pioneered by Campa and Goldberg (1997, 2003) usually found low ERPT into import price or consumer price. The recent work by Gopinath and Rigobon (2008), for example, find that the ERPT into the US import prices is only 22%. In sharp contrast, this paper finds nearly complete pass-through using firm level estimations, which is in general consistent with the findings of BMM for high ERPT into French export prices. This may imply the importance of trade distribution costs, as shown by BMM (2012).

One concern of our sample is that it includes multiproduct exporters, who export multiple 6-digit HS goods into the same destination. The pricing strategies for multiproduct firms are quite different from those for single-product firms. Though we do not have additional controls for that, we check the robustness of our results by restricting our sample to exporters who only export a single product to a certain destination. The results for single product exporters are reported in columns (2) and (6); while results for major product exporters are reported in columns (3) and (7). Again, our estimated price and volume responses are consistent with that of the full sample.[13]

Our final regressions in Table 2 concern the fact that a large share of Chinese exports are done by intermediary companies. As Ahn, Khandelwal, and Wei (2011) reported, intermediaries account for approximately a quarter of Chinese exports. Those intermediary companies usually export more in broader range of products (Bai, Ma, and Krishna, 2012) and their pricing and quantity behavior could be quite different from those producer exporters. Therefore, in columns

[12] See, for example, Marazzi *et al.* (2005), Campa and Goldberg (2005), Ihrig *et al.* (2006). Vigfusson *et al.* (2008), Bussiere and Peltonen (2008), and Cui *et al.* (2009) provides estimates of ERPT for Chinese exports at more aggregate level.

[13] Admittedly, using sample of single product firms won't solve the problem perfectly, since we do not observe firms' product for domestic market.

(4)-(5), and (9)-(10), we report separately the results for trading companies and producing exporters. Brief speaking, trading companies are less responsive in their price to exchange rate changes, but are more responsive in volume.

In Table 3, we further decompose our sample into 8 broadly-defined industries and separately run equation (2) for each industry. We find consistently high pass-through across industries, with lowest pass-through for agricultural products and food, at around 81 percent. Exporters in Machinery & Electrical products (M&E), transportation, and miscellaneous industries have relatively complete ERPT but also high exchange rate elasticities for volume.

4.2 Productivity Heterogeneity and Responses to Exchange Rate Movements

The advantage of equations (2) is that we could include the universe of exporters in our sample. The disadvantage, however, is by including all exporters, we miss the important difference across firms in their performance measures. Thus in the following sections, we match the export data with information on firms' production and costs. Though our matching results in a large drop in the number of observations, the remaining sample can still account for a large share of exports compared with the full sample. Having firm information on production and costs enable us to add different dimensions of heterogeneity across firms into consideration.

Our first extension follows BMM (2012), in which we consider the responses of exporters with different productivity φ_{ft}. As explained in the data section, we use either simple labor productivity, or TFP estimated using the Levinsohn and Petrin (2003) method, which helps control the endogeneity of firms' input choices. We get very similar results using both measures throughout the paper. Therefore for brevity, we will just report the results using TFP, while the results using labor productivity is available upon request. Furthermore, we normalize firm level productivity measure by the average productivity across firms in the same sector.

Following BMM (2012), our empirical specifications are

$$\Delta \ln(Q_{fpct}) = \alpha_0 + \alpha_1 \Delta \ln(RER_{ct}) + \alpha_2 \Delta \ln(RER_{ct}) \times \ln(\varphi_{ft-1}) + \alpha_3 \Delta \ln(\varphi_{ft}) + \delta' Z_{ct} + \mu_{fpc} + \lambda_t + \varepsilon_{fpct} \quad (3.1)$$

$$\Delta \ln(P_{fpct}) = \beta_0 + \beta_1 \Delta \ln(RER_{ct}) + \beta_2 \Delta \ln(RER_{ct}) \ln(\varphi_{ft-1}) + \beta_3 \Delta \ln(\varphi_{ft}) + \gamma' Z_{ct} + \mu_{fpc} + \lambda_t + \varepsilon_{fpct} \quad (3.2)$$

Again we index firm by *f*, destination country by *c*, product by *p* and time by *t*. In regressions with single product exporters or major product exporters, the product dimension is suppressed and an observation is therefore a firm-destination-year pair. Besides RER_{ct}, the annualized real exchange rate of the destination country relative to China, we are also interested in the coefficient for the interaction term of RER and TFP, α_2. A positive α_2 implies that more productive exporters respond more to exchange rate changes. Our TFP measures are lagged one period to avoid possible endogeneity.

Table 4 reports the estimation results. First of all, column (1) shows after controlling for productivity, an average exporter have 90% ERPT: a 10% appreciation of RMB will lead to a 1% drop in RMB export price.[14] The ERPT, however, is heterogeneous across firms. Firms with high TFP, as indicated by a positive and significant α_2, will have bigger adjustments in prices, following the same magnitude of exchange rate changes. More specifically, a one standard deviation in ln(TFP), which is 1.07, leads to around 50% increase in the price elasticity. So for such a firm, a 10% appreciation of RMB will lead to a 1.5% drop in RMB export price, or equivalently 85% ERPT. Regarding the volume response to exchange rates, column (5) shows that high-TFP exporters are actually less responsive to exchange rate movement, an effect of more pricing to market.

Recognizing the multi-product feature of the sample, in column (2) we further control the product structure with firm-destinations. Following BMM (2012), we add a measure of product rank, for which we label the core product (the product with the highest export value) as rank 0, and product with the second highest export value as rank 1, and so on. This provides an additional control for within-firm heterogeneity in production efficiency. The results are shown in columns (2) and (6), respectively for price and volume. Again our basic results hold: the average ERPT is around 90 percent, while the exchange rate elasticity is about 0.4; while high-TFP exporters have lower pass-through and respond less in volume. Furthermore, a multiproduct firm adjusts its prices for the "core" product more than the "periphery" product, as indicated by the negative and significant coefficient for the rank-RER interaction (recall that a lower rank means closer to the "core"). In columns (3) to (4), and (7) to (8), we further restrict the sample to (1) exporters who only export a single product to a certain destination; and (2) the export price

[14] Notice that given our productivity normalization, the average exporter's responsiveness to exchange rate shocks is simply given by the ln(RER) coefficients.

and volume of the major product that an exporter exports to the world. As shown in Mayer, Melitz and Ottaviano (2011), exporters export most in the product that they have "core competence" and therefore focusing on core product exports may well serve the our purpose of examining the impact of TFP on the exchange rate effects. Again, we find consistently low price response and mediocre volume response, using different sample of exporters.

[Insert Table 4]

Our estimates of high ERPT is surprising at first glance, however it is consistent with recently firm level studies such as BMM (2012) and AIK (2012). In their study of French firms, BMM find that in reaction to a 10 percent appreciation, an average exporters decrease their export price in euro by between 0.6 and 1.4 percent， depending on the sample. While high-performance exporters significantly reduce their pass-through, low-performance exporters do not change their price when exchange rates vary. Based on a Cournot competition model, Atkeson and Burstein (2008) show that only large firms practice pricing-to-market. Using aggregate price indices, they find that pricing-to-market exists only because the pricing practice of large firms dominates. Moreover, this paper is not the only one that identifies a relatively high exchange rate pass-through for Chinese export prices. Bussiere and Peltonen (2008), for example, estimated the export and import equations for 41 countries including China, find that China's export prices do not appear to be significantly affected by the exchange rate changes. The same pattern is also identified for India in their study.

Several factors contribute to the high pass-through in China's exports. One is that the profit margin for export firms is already low so that they do not have much room to adjust price. Another reason is that instead of directly reducing price, firms may increase the quality of the products that they export. As documented by Manova and Zhang (2011), larger Chinese exporters usually export their product at higher unit values, indicating quality differentiation instead of just productivity heterogeneity. It is indeed also shown in our regressions that TFP have positive effects on both export price and volume. Finally, as Campa and Goldberg (2005) document, even though almost a full pass-through of exchange rate to export price is observed, there could still be much limited pass-through to import price if transportation and distribution costs denominated in the importer's currency accounts for a large share. In particular for China, the distribution cost for retailing and marketing in the US is extremely high compared with the actually export price. One study by Hale and Hobijn (2012) find that on average, 55 cents out of

every dollar spent on an item imported from China go for services produced in the United States. Furthermore, a substantial part of the remaining 45 cents are actually attributed to material and components that Chinese producer import from foreign countries. With the rising fragmentation of global production chain and China's deep involvement in processing trade, the foreign content of Chinese exports have been growing and estimated to account for 50% of Chinese export by the study of Wang and Wei (2009). A low value-added share in the total export and a large distribution cost that is denominated in the destination currency help understand the inertia of price and quantity responses of Chinese exports to exchange rate movements.

On the other hand, in columns (5) – (8), we estimated the exchange rate elasticities to be around 0.25 to 0.41 for an average exporter. This is much lower than the estimates by studies on China using more aggregate data. For example, Aziz and Li (2007) find an aggregate elasticity of RMB appreciation of about 1.5; Garcia-Herrero and Koivu (2009) find an elasticity of 2.3 for the sample period 1994–2005 and a lower elasticity of 1.6 for a more recent 2000–5005 sample; Ahmed (2009) finds a cumulative elasticity of 1.8; Thorbecke and Smith (2010) did not report on aggregate elasticity, but find that the elasticity for ordinary trade is around 1.2, and the elasticity for processing trade with respect to an appreciation throughout Asia is around 1. In contrast, Cheung *et al.* (2009) find that the effect of exchange rate on real exports is not statistically significant. However, our low exchange rate elasticity estimation is comparable to estimates worldwide. Estimating a gravity-type regression separately for 136 exporting countries at aggregate level, Colocelli (2009) finds that the distribution of estimated RER elasticity concentrate in the range of (0, 1) with a mean of 0.22.

By the nature of linear regression models, we could combine the quantity and price coefficients to estimate the impact of exchange rate changes on the export value.[15] Since the price elasticity is low so the volume elasticity estimate dominates the value elasticity. A 10 percent appreciation in RMB will lead to a 2.5 to 5.1 percent drop in the value exported by an average exporter.

In the above section, we use a measure of productivity to show the heterogeneous response of firms to exchange rate changes. Our productivity measures, however, are not perfect. The TFP estimation in this paper is based on firms' revenue instead of quantity, and the labor productivity

[15] Given that export value equals volume multiplying price, the elasticity of the export value is the sum of the elasticities of volume and price.

measure by definition incorporate the price of products. However, as De Loecker and Wolinsky (2011) pointed out, the markup is endogenous and therefore a revenue-based TFP measure would be biased. Thus both measures of productivity mix the effects of markup and marginal cost. That is: a high revenue-TFP firm may appear to be highly productive, either due to its lower marginal cost of production, or its higher market power and therefore higher markup (i.e., price to marginal cost ratio). Therefore in the next two sections we further explore the impact of exchange rate changes on trade through channels of marginal costs and markups.

4.3 Import Costs and Responses to Exchange Rate Movements

Most literature on pricing-to-market focuses on explaining exporters pricing behavior from the demand side. Exchange rate shocks, however, may have profound impact on an exporter engaging in global supply chain. Importantly, empirical findings by Bernard, Jensen, and Schott (2009), as well as AIK (2012) have shown that large exporters are often also intensive importers. The same is also true for Chinese exporters, as documented in Manova and Zhang (2011). Moreover, AIK (2012) shows strong correlation between firm's import intensity and firm size and other firm characteristics, therefore, import intensity could be used to proxy for marginal cost sensitivity to the exchange rate. Drawing on a sample of Belgian exporters, they show that increasing imports in total costs actually substantially reduce exchange rate pass-through.

We start in Table 5 to examine the impact of import costs in exchange rate responses. We propose two measures of import costs, first a measure of import intensity, following AIK (2012), as

$$\omega_{f,t} = \frac{IMPORT_{f.t}}{COST_{f,t}},$$

where we measure import value as the total imported intermediate inputs by a firm,[16] while firm cost is measured as the cost of total intermediate inputs.

Our second measure is more explicitly related to exchange rate movement. We construct a direct measure of import-weighted exchange rate changes, by utilizing the rich information we get from the Customs import data. To do this, we first match exporters and importer by using their unique customs id. Then we define an import-weighted RER changes as:

[16] We use the Broad Economic Classification (BEC) to identify intermediate inputs. We also regard all processing inputs as intermediate inputs.

$$\ln \theta_{f,t} = \sum_{c} MS_{fc,t} \times \Delta \ln(RER_{c,t})$$

We add $\omega_{f,t}$ and $\theta_{f,t}$ into regressions (3.1) and (3.2), by either replacing productivity measures $\varphi_{f,t}$ or as additional controls. Results on the impact of import costs are reported in Table 5. Column (1)-(2) and (5)-(6) report the results for the full sample, with additional control for product rank within a firm. Then column (3)-(4) and (7)-(8) report the results for the major sample. Extra regressions using the sample of single product firms are similar. First of all, the relatively complete ERPT is still the case across different specifications or samples, while higher TFP does lead to more pass-through but lower exchange rate elasticity. Secondly, considering the effect of import-weighted real exchange rate movement, a higher $\theta_{f,t}$ means a worsening terms of trade so imports get more expensive. In this case, exporters raise their export prices but also increase their export volume partly due to the improving terms of trade for foreign buyers. The interaction between $\theta_{f,t}$ and ln RER_{ct} has negative and significant coefficients, implying more expensive imports will reduce the exchange rate pass through onto export prices (columns (1) and (3)). While the same interaction term increase the exchange rate elasticity (columns (5) and (7)).

[Insert Table 5]

Thirdly, consider the import intensity, more intensive importers won't directly increase their export price, but they do so indirectly through affecting the effect of RER changes. More intensive importers will also price more to market (columns (2) and (4)). Finally intensive exporters usually also export more in volume, but have lower elasticity (columns (6) and (8)). It worth noting that with import intensity controlled, as in column (8) with the sample of major-product firms, the exchange rate elasticity for a firm with trivial import intensity approaches 0.86, a relatively closer number to the number estimated by studies using more aggregate data. Furthermore, as the importance of imports increases in a firm's cost structure, the elasticity becomes smaller.

4.4 Export Markup, and Responses to Exchange Rate Movements

Now we continue to investigate the connection between export market power and firms' response to exchange rate movements. The pricing-to-market literature has long recognized the

relationship between markup and exchange rate changes. As Knetter (1993) put it, if exporters' currency appreciates against that of the importers, they reduce their markups of price over marginal cost so as to stabilize prices in the local currency of importers. Furthermore, Campa and Goldberg (1995) find much weaker effect of exchange rates in industries with high markups. Feenstra, Gagnon, and Knetter (1996) further show that the pass-through of exchange rates depends on the firm's market share. Thus we will add a measure of firm's market share of a certain product in the destination market as an additional control, where market share is defined as,

$$S_{fpc,t} = \frac{Exports_{fpc,t}}{\sum_{f' \in F_{pc,t}} Exports_{f'pc,t}}$$

So we measure market share as firm *f*'s market share in product p and destination *c*, relative all Chinese exports in product *p* to destination *c*. Though Chinese exporters do face competition from home producers and exporters from other countries, such competition applies equally to all Chinese exporters so our measure of market share would not create a bias.

Our second measure for markup is the Hirfindahl index, a measure of market concentration, defined as,

$$HHI_{pc,t} = \sum_{f'=1}^{N} \left(\frac{EXP_{fpct}}{\sum_{f'=1}^{N} EXP_{f'pc,t}} \right)^2$$

Obviously, HHI approaches one when there is only one firm in the market. Larger HHI indicates less competition and therefore larger market power. Note HHI only varies by product and market.

Table 6 gives the results with markup measures and their interactions with RER as additional control. Again, coefficients on RER, and the interaction between RER and TFP all have the expected sign and magnitude. A firm with growing higher market share tends to price up, but also have lower price responsiveness to exchange rates, indicating an increase in pass-through. Therefore it is in interesting contrast to the effect of productivity on exchange rate pass-through. On the other hand, a firm with higher market will also sell more in volume and become less responsive to exchange rate shocks (i.e., lower exchange rate elasticities).

As for the market concentration measure (HHI), a firm in more concentrated market tends to sell less and sell cheaper. While such a firm will also become less sensitive in both price and volume reactions to the exchange rate changes.

[Insert Table 6]

4.5 Robustness Checks

We proceed to several robustness checks. First, we start in Table 7 by controlling for all regressors in the same time. Productivity, import intensity as well as export market share may well be correlated with other, so putting them together in one regression help us to understand which effects dominate the other. In Table 7, we report the regressions with full specification. Interestingly, after controlling all marginal costs and markup factors, the pass-through coefficient and exchange rate elasticity for average firms keep at the same magnitude. Furthermore, market share variable seems to have positive effect on firms' price response now.

[Insert Table 7]

Processing exports account for a substantial share in Chinese total exports. In 2004 for example, 55 percent of Chinese exports are processing exports. Export processing is also essential in understanding China's foreign trade imbalance. As Thorbecke and Smith (2010) document, China's trade surplus is entirely in processing trade. Given that processing exports depend on imported intermediate input, it is important to examine whether firms engaged in processing exports have different responses to exchange rate changes compared with firms involved in ordinary export. Previous empirical studies, as reviewed below, also show that disaggregating Chinese trade into processing and ordinary trade is essential. In addition, given the important role played by foreign-invested enterprises in promoting China's exports, we also distinguish export firms by ownership in some of our specifications.

According to conventional wisdom, processing exports should be less affected by exchange rate changes because an appreciation in domestic currency also implies a reduction in the cost of imported input. For example, Aziz and Li (2007) find a larger elasticity for non-processing exports (–2.25) than for processing exports (–1.5). To examine whether this is the case for our firm-level data, we include in our regressions processing export share and an interaction term between it and the RER. Columns (2) and (4) report the results. Surprisingly, processing share

does not seem to affect pass-through and elasticity. We further using the sample of processing transactions along in Table 8, with additional control on import intensity. Now comparing the processing sample (columns (3), (4), (7) and (8)) with the regression results in Table 5 (columns (1), (2), (5),(6) are adopted from Table 5). Now we do see an average processing firm do pass-through less than the general firm and have a lower elasticity of volume. However, given that the average productivity of processing firms and ordinary firms may differ and their import structure apparently differ, the difference in response to exchange rate shock between two types of firms remain to be further explored.

[Insert Table 8]

Another concern is that much of the observed effect could be due to price movements rather than exchange rate movements. In particular, the Chinese RMB was pegged to the US dollar (and therefore, the Hong Kong dollar) before July 2005, which means that the US-China and Hong Kong-Mainland China bilateral real exchange rate movements before 2005 come only from the variations in inflation differentials. This effect can be important because the US and Hong Kong are major export destinations for Mainland Chinese firms. To avoid the possible problems that this issue may cause, we exclude the US, and Hong Kong and other US dollar peggers from our sample.[17] The estimated results are reported in Table 8. It shows similar patterns as those in our benchmark tables: good exporters price more to market and adjust less in volume, facing a RMB appreciation.

[Insert Table 9]

5. Extensive Margin: Firm-Market Entry/Exit

We have examined the quantity and price adjustments for export firms with respect to exchange rate shocks, both of which are adjustments in the intensive margin. In this section, we examine the response to the exchange rate changes in the extensive margins of exports. That is, whether an appreciation deters entry and forces exit. Let x_{ijt} be a binary variable that takes on the value of 1 if firm *i* exports to destination *j* in year *t*, and 0 otherwise. We would like to see how the fluctuation in the bilateral exchange rate between home country and destination *j* affects the

[17] We adopt Klein and Shambaugh's (2006) classification for US dollar peggers.

probability of firm *i* of exporting to destination *j*. Following BMM (2012), we adopt both LPM and logit to study three scenarios, depending on a firm's export status. Columns (1)-(3) of Table 10 report logit estimates, while columns (4)-(6) report linear probability model estimates. Both sets of estimations contain destination market fixed effects. For logit model, we report the marginal effects of RER on the probability of positive exports. We report again LPM estimations in columns (7)-(9), but with firm-destination fixed effects.

First, we estimate the probability of existence, which is simply $\Pr(x_{ijt}=1)$,

$$\Pr(x_{ijt}=1)=\Phi(\alpha_0+\alpha_1\ln(PROD_{it-1}))+\alpha_2\ln(RER_{jt})+\delta' Z_{jt}+\mu_j+\lambda_t) \quad (4)$$

where $\Phi(.)$ is the C.D.F. function of a standard normal distribution.

Second, for firms already in the market in the previous year, we estimate the effect of exchange rate shocks on the likelihood $\Pr(x_{ijt}=1|x_{ijt-1}=0)$, i.e., the probability of entering a new market facing an exchange rate shock for firms who did not export to that market in the previous year, which is specified as follows:

$$\Pr(x_{ijt}=1 \mid x_{ijt-1}=0)=\Phi(\alpha_0+\alpha_1\ln(PROD_{it-1}))+\alpha_2\ln(RER_{jt})+\delta' Z_{jt}+\mu_j+\lambda_t) \quad (5)$$

where the productivity variable is lagged one period.

Finally, we estimate the probability of entering a new market facing an exchange rate shock for firms who are already exporting to that market in the previous year. That is, we estimate the probability of continuing exporting to the same market (i.e., $\Pr(x_{ijt}=1 \mid x_{ijt-1}=1)$) when the market is hit by a negative exchange rate shock. The probability is specified as

$$\Pr(x_{ijt}=1 \mid x_{ijt-1}=1)=\Phi(\alpha_0+\alpha_1\ln(PROD_{it-1}))+\alpha_2\ln(RER_{jt})+\delta' Z_{jt}+\mu_j+\lambda_t) \quad (6)$$

As expected, both the LPM and logit results reported in Table 10 show that exchange rate appreciation reduces the probability of firm export. Taking the logit model (Columns (1)–(3)) as an example, our estimation results suggest that a 10 percent depreciation increases the probability of exporting by 2.1 percent. Both probability of entering into a new market and the probability of remaining in a previously-exported market are increased, by 1.6 and 1.5 percent respectively, following a 10 percent RMB depreciation.[18] These numbers are strikingly similar to those reported in BMM, who, using French data, find that a 10 percent appreciation decreases

[18] It is worth emphasizing that our regression results should be interpreted with caution because our sample includes only exporting firms, similar to the sample of BMM.

export probability by 1.8 percent. Our estimates are in contrast to those of Greenaway *et al.* (2007), who do not find any significant effect for a sample of UK firms.

[Insert Table 10]

6. Conclusion

The revaluation of China's RMB has attracted global attention and much debates in recent years. In particular, the complaints on an undervalued RMB have intensified after the outbreak of the global financial crisis (Krugman, 2010; Bergsten, 2010). Strikingly, no consensus has ever been reached on either whether RMB should appreciate or how much RMB should appreciate.[19] Indeed, since July 2005 RMB has appreciated for nearly 21 percent in nominal term against the US dollar,[20] its current account surplus, however, continued to accumulate at an alarmingly fast pace. The controversial findings therefore call for careful empirical investigations on the true impact of RMB revaluation. The few existing empirical studies focus on national or industrial level and therefore are subject to aggregation bias.

In this paper, we adopt a rich firm-level dataset to provide first-hand evidence on exporters' reaction to RMB appreciation. We decompose the effect of exchange rate changes into both the intensive and the extensive margins. At the intensive margin, we find a small and significant effect of exchange rate on firm export quantity; we also find a small and significant effect of exchange rate on export price denominated in RMB, suggesting a large exchange rate pass-through to export price in the destination currency. At the extensive margin, we find significantly negative effects of exchange rate appreciation on the probability of a firm entering and surviving in the export market.

Importantly, firms are heterogeneous in their responses to exchange rate changes. At both margins, we find that firm level productivity matters: high-productivity firms adjust their export price but not quantity, whereas low-productivity firms adjust their export quantity. These

[19] For example, Yu (2010) and Huang (2010) both argue that China's currency regime may not be the main cause for its current account surplus. On the magnitude of RMB undervaluation, Cline and Williamson (2007) report the range from 7% to 67%. For more discussions, see Evenett (2010).

[20] And in real term, the RMB has strengthened by almost 50% against the dollar since 2005, according to The Economist (2010).

heterogeneous responses may explain the minimal effect of exchange rate movement found using aggregate data.

Our findings may have important implications for understanding the debate on China's exchange rate policy and its trade surplus. According to our estimation, an appreciation of RMB may not significantly reduce China's export, as can be seen from the overall small magnitude in firms' response to exchange rate movement. The reasons for such unresponsiveness deserve future research. Furthermore, the heterogeneity in responses for firms with different productivity suggests that less productive firms may suffer more from the appreciation, including a reduction in export volume and value, product churning, as well as other economic consequences such as more volatile job reallocation.

References:

Adolfson, (2001), "Export Price Responses to Exogenous Exchange Rate Movements", *Economics Letters* 71: 91-96.

Ahmed, S. (2009), "Are Chinese Exports Sensitive to Changes in the Exchange Rate?", Board of Governors of the Federal Reserve System Working Paper, No.287

Ahn, J., A. Khandelwal, S-J Wei, (2010), "The Role of Intermediaries in Facilitating Trade", forthcoming in *Journal of International Economics*.

Alessandria, G., and h. Choi (2007), "Do Sunk Costs of Exporting Matter for Net Export Dynamics?". *Quarterly Journal of Economics*, 122 (1), 289-336.

Amiti, Mary., Oleg Itskhoki, and Jozef Konings (2012), "Importers, Exporters, and Exchange Rate Disconnect", Princeton University *mimeo*

Atkeson, A. and A. Burstein (2008), "Pricing-to-market, Trade Costs, and International Relative Prices", *American Economic Review*, 98(5): 1998-2031.

Aziz, J. and X. Li (2007), "China's Changing Trade Elasticities", IMF Working Papers 07/266.

Baggs, J., E. Beaulieu, and L. Fung (2009), "Firm Survival, Performance, and the Exchange Rate Shocks", *Canadian Journal of Economics*, Vol. 42, No. 2

Bernard A., and J. Jensen (2004), "Why Firms Export", *Review of Economics and Statistics*, 86: 561-569.

Bernard, A, B. Jensen, S. Redding, and P. Schott, (2007), “Firms in International Trade”, *Journal of Economic Perspectives*, 21(3): 105—130.

Bernard, A., B. Jensen, S.J. Redding and P.K. Schott (2009), “The Margins of US Trade”, *American Economic Review P&P*, 99(2): 487-493

Berman, N., P. Martin, and T. Mayer (2010), “How do Different Exporters React to Exchange Rate Changes? Theory, Empirics and Aggregate Implications”, CEPR Discussion Papers 7493.

Bussiere, M. and T. Peltonen (2008), “Exchange Rate Pass-through in the Global Economy – the Role of Emerging Market Economies”, European Central Bank Working Paper Series, No.951.

Brandt, L, J. Van Biesebroeck and Y. Zhang, (2009), “Creative Accounting or Creative Destruction? Firm-Level Productivity Growth in Chinese Manufacturing”, NBER Working Paper 15152.

Campa J. and L. Goldberg (2005), “Exchange rate Pass Through into Import Prices”, *Review of Economics and Statistics*, Vol. 87(4), pp. 679-690.

Cerra, V. and S. Saxena (2003), “How Responsive is China’s Export Supply to Price Signals?”, *China Economic Review*, 14, 240-270.

Chaney, T., (2008), "Distorted Gravity: the Intensive and Extensive Margins of International Trade," *American Economic Review*, vol. 98(4): pages 1707-21.

Cheung, Y., M.D. Chinn and E. Fujii (2009), “China's Current and Account and Exchange Rate”, in “China's Growing Role in World Trade”, edited by Rob Feenstra and Shang-Jin Wei, NBER.

Cline, W.R. and J. Williamson, (2007), “Estimates of the Equilibrium Exchange Rate of the Renminbi: Is There a Consensus and, If Not, Why Not?” Peterson Institute for International Economics, working paper.

Cui, L, C. Shu and J. Chang (2009), “Exchange Rate Pass-through and Currency Invoicing in China’s Exports”, *China Economic Issues*, No.2/09.

Das, S.,M.J. Roberts and J. R. Tybout, (2007), "Market Entry Costs, Producer Heterogeneity, and Export Dynamics," *Econometrica*, vol. 75(3): 837-873.

Dekle R., H. Jeongy and H. Ryoo, (2007), “A Microeconomic Analysis of the Aggregate Disconnectbetween Exchange Rates and Exports”, University of Southern California, mimeo.

Eaton, J., S.Kortum, (2002),“Technology, geography, and trade”, *Econometrica* 70: 1741–1779.

Eaton, J., S.Kortum, and F.Kramarz. (2008), “An Anatomy of International Trade: Evidence from French Firms.” New York University, *mimeo*.

Eckaus, R. (2004), “Should China Appreciate the Yuan?”, MIT Working Paper 04-16.

Evenett, S. (2010), “The US-Sino Currency Dispute: New Insights from Economics, Politics and Law”. London: VoxEU.org and Center for Economic and Policy Research.

Fitzgerald, D. and S. Haller (2008), “Exchange Rates and Producer Prices: Evidence from Micro-Data”, mimeo, Stanford University.

Garcia-Herrero, A. and T. Koivu (2009), “China’s Exchange Rate Policy and Asia Trade”, Bank of International Settlements Working Paper 282.

Gopinath, G., O. Itskhoky and R. Rigobon (2010), “Currency Choice and Exchange Rate Pass-through”, *American Economic Review*, 100 (1): 304-336.

Greenway, D., R. Kneller and X. Zhang (2007), “Exchange Rate and Exports: Evidence from Manufacturing Firms in the UK”, manuscript, University of Nottingham

Hooper, P., K. Johnson, and J. Marquez(2000), “Trade Elasticities for the G-7 Countries.” *Princeton Studies in International Economics*, no. 87, August.

Hellerstein, R. (2008), “Who Bears the Cost of a Change in the Exchange Rate? Pass-through Accounting for the Case of Beer”, *Journal of International Economics*, 76 (1): 14-32.

Huang, Y. (2010). “What Caused China’s Current-Account Surplus?”, in S. Evenett, eds., *The US-Sino Currency Dispute: New Insights from Economics, Politics and Law*. London: VoxEU.org and CEPR.

Hummels, D., and P.J. Klenow (2005), “The Variety and Quality of a Nation’s Exports”, *American Economic Review*, 95(3), 704-723.

Ihrig, J., M. Marazzi and A. Rothenberg (2006), “Exchange Rate Pass-Through in the G-7 Economies”, International Finance discussion paper 851.

Klein, M., and J. Shambaugh, (2006), “The Nature of Exchange Rate Regimes”, NBER Working Paper 12729.

Paul Krugman, (2010) "Taking on China", *New York Times*, March.15.

Levinsohn. J, and A. Petrin, (2003),“Estimating Production Functions Using Inputs to Control for Unobservables”*Review of Economic Studies*, vol. 70(2): 317-341.

Manova, K. and Z. Zhang, 2009, “China's Exporters and Importers: Firms, Products, and Trade Partners”, NBER Working Paper 15249.

Manova, K. and Z. Zhang, 2010, “Export Prices across Firms and Destinations”, forthcoming in *Quarterly Journal of Economics*.

Marazzi, M., N. Sheets and R. Vigfusson, and J. Faust, J. Gagnon, J. Marquez, R. Martin, T. Reeve and J. Rogers (2005), "Exchange Rate Pass-Through to U.S. Import Prices: some New Evidence", Board of Governors of the Federal Reserve System, International Finance Discussion Paper No. 832.

Marquez, J. and J. Schinder (2007), "Exchange-Rate Effects on China's Trade", *Review of International Economics*, Volume 15, Issue 5, pages 837–853.

Martin, L. M., D. R. Rodriguez, (2004), "Pricing to market at firm level", *Review of World Economics*, volume 140, No. 2.

Melitz, M.,(2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate IndustryProductivity" , *Econometrica*, 71(6): 1695–1725.

Olley, S. and Pakes, A. (1996), "The Dynamics of Productivity in the Telecommunications Equipment Industry", *Econometrica*, 64 (6): 1263–1298.

Otani, Akira, S. Shiratsuka, and T. Shirota(2003), "The Decline in Exchange Rate Pass-through: Evidence from Japanese Import Prices", *Money and Economic Studies*, 21:53-81.

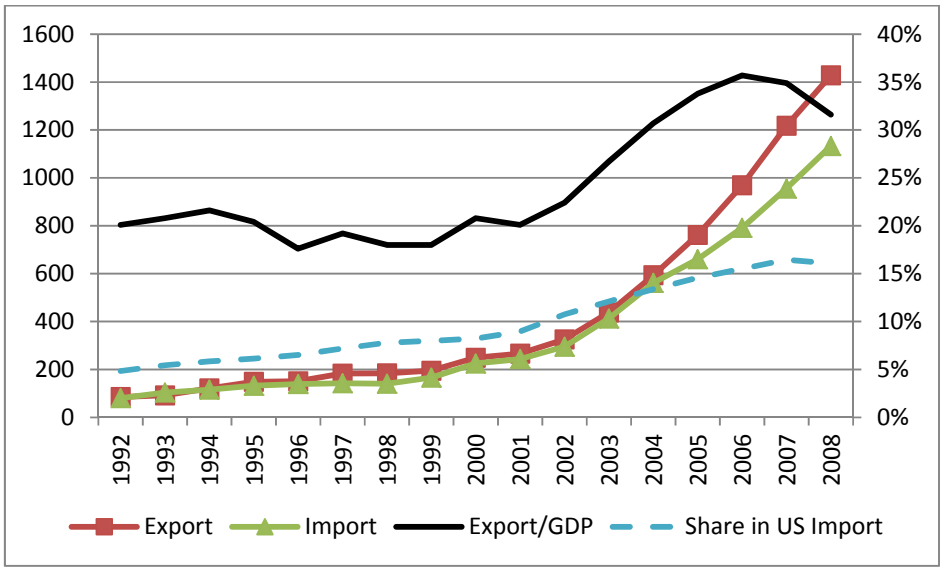
The Economist, (2010), "The Yuan-Dollar Exchange Rate", Nov.4th.

Thorbecke, W., and G. Smith (2010), "How Would an Appreciation of the RMB and Other East Asian Currencies Affect China's Exports?", *Review of International Economics*, 18(1): 95~108.

Vigfusson, R., N. Sheets, and J. Gagnon (2009), "Exchange Rate Pass-through to Export Prices: Assessing Cross-Country Evidence", *Review of International Economics*, 17(1), 17–33.

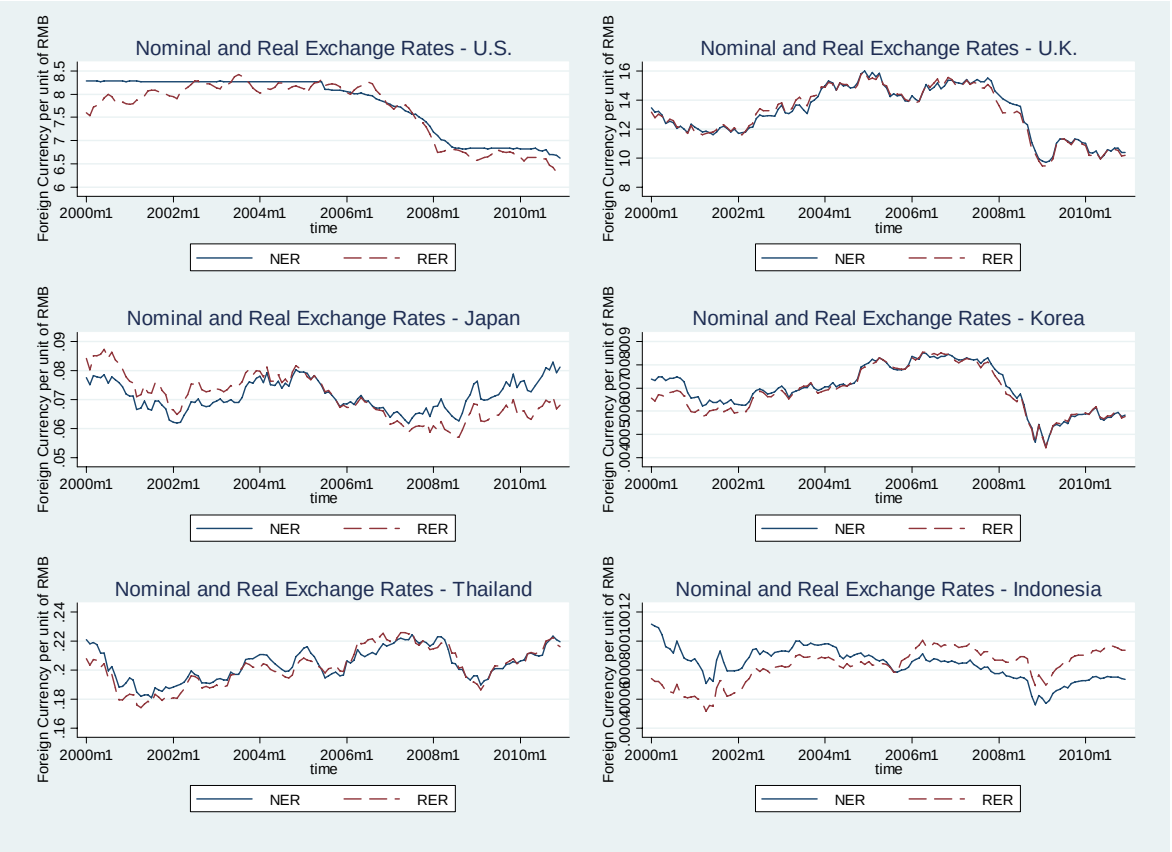
Yu, Y. (2010). "A Trade War is Entirely Unnecessary", in S. Evenett, eds., *The US-Sino Currency Dispute: New Insights from Economics, Politics and Law*. London: VoxEU.org and CEPR.

Figure 1: Growing China Influence in International Trade



Data Source: China export and import data from China Customs Office, China GDP from WDI, and US import data from US census. China export ratio to GDP and China's share in US import use the right axis.

Figure 2: Nominal and real exchange rates of China



Data Source: The nominal exchange rate data and CPI are all from International Financial Statistics (IFS).

Table 1: Summary Statistics （2001-2007）

Sample	Obs	Mean	Median	S.D.
Export Sample - All				
Firm level				
# of firms	181,082			
# of destinations a firm exports to	541,558	4	2	6
# of products a firm exports	541,558	5	2	15
average annual export value	541,558	3595328	468817	49000000
average growth rate of export volume	541,558	0.13	0.102	0.741
average growth rate of export price	541,558	0.035	0.031	0.224
Firm-Product level				
# of firm-product pairs	1,457,466			
# of destinations	3,000,515	2	1	2
average annual export value	3,000,515	573257	38594	13300000
average growth rate of export volume	3,000,515	0.04	0.033	0.986
average growth rate of export price	3,000,515	0.032	0.023	0.36
Firm-Product-Destination level				
# of firm_product_destination pairs	3,306,307			
average annual export value	6,117,089	307155	30242	6330197
average growth rate of export volume	6,117,089	0.054	0.043	1.023
average growth rate of export price	6,117,089	0.037	0.026	0.371
Merged Sample - All				
Firm level				
# of firms	61,389			
# of destinations a firm exports to	203,620	4	2	5
# of products a firm exports	203,620	3	2	5
average annual export value	203,620	3628014	1020183	15800000
average growth rate of export	203,620	0.133	0.104	0.611

volume				
average growth rate of export price	203,620	0.038	0.034	0.177
average # of employees	203,620	354	194	469
average value added per worker	203,620	85.2	45.71	158
Firm-Product level				
# of firm-product pairs	287,931			
# of destinations	677,539	2	1	3
average annual export value	677,539	919537	88401	8202814
average growth rate of export volume	677,539	0.168	0.074	1.502
average growth rate of export price	677,539	0.038	0.029	0.3
average # of employees	677,539	461	262	565
average value added per worker	677,539	78.09	40.78	178.01
Firm-Product-Destination level				
# of firm_product_destination pairs	777,953			
average annual export value	1,569,417	399792.7	48705	3174854
average growth rate of export volume	1,569,417	0.086	0.0747	0.973
average growth rate of export price	1,569,417	0.044	0.032	0.317
average # of employees	1,569,417	552	316	633
average value added per worker	1,569,417	82.44	44.06	184.28
Merged Sample - Single Product				
Firm level				
# of firms	50,991			
# of destinations a firm exports to	134,237	3	2	4
average annual export value	421,021	1398002	243467	9189004
average growth rate of export volume	421,021	0.134	0.112	0.762
average growth rate of export price	421,021	0.038	0.031	0.227
average # of employees	421,021	374	201	493
average value added per worker	421,021	91.37	48.47	176.2
Merged Sample - Major Product				

Firm level				
# of firms	61,389			
# of destinations a firm exports to	172,446	3	2	4
average annual export value	547,504	2918511	783930	15900000
average growth rate of export volume	547,504	0.256	0.18	0.77
average growth rate of export price	547,504	0.04	0.03	0.22
average # of employees	547,504	361	197	481
average value added per worker	547,504	88.4	46.5	169.7

Table 2: Export Response to Exchange Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δ ln unit value				Δ ln volume			
	full sample	single product	trading company	producing company	full sample	single product	trading company	producing company
Δ ln RER	0.056***	0.048***	0.031***	0.077***	0.192***	0.380***	0.243***	0.153***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.08)	(0.02)	(0.02)
Δ ln RGDP	-0.414**	-0.071	-0.403*	-0.472***	1.496***	3.063***	3.163***	0.242
	(0.17)	(0.28)	(0.23)	(0.18)	(0.58)	(0.92)	(0.70)	(0.61)
Δ ln RGDPPC	0.374**	0.022	0.391*	0.413**	-0.741	-1.837**	-2.528***	0.616
	(0.17)	(0.27)	(0.22)	(0.17)	(0.57)	(0.91)	(0.69)	(0.60)
Constant	0.086***	-0.010***	-0.012***	-0.007***	-0.460***	0.718***	0.656***	0.702***
	(0.002)	(0.004)	(0.002)	(0.002)	(0.009)	(0.013)	(0.008)	(0.006)
Observations	4106029	608563	1773787	2332242	4106029	608563	1773787	2332242

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Export Response to Exchange Rate: by industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Animals&Food	Minerals	Chemicals&Plastic	Textile	Metals	M&E	Transportation	Miscellaneous
				Δ ln unit value				
Δ ln RER	0.184***	0.102	0.001	0.041**	0.046*	0.060***	0.041	0.047*
	(0.03)	(0.09)	(0.02)	(0.02)	(0.03)	(0.02)	(0.04)	(0.03)
Δ ln RGDP	-0.538	-1.887	-0.647	-1.534***	-0.006	-0.242	-1.227	-0.725
	(0.47)	(3.69)	(0.65)	(0.42)	(0.76)	(0.74)	(1.62)	(0.96)
Δ ln RGDPPC	0.434	1.807	0.584	1.444***	0.001	0.113	1.048	0.615
	(0.45)	(3.67)	(0.64)	(0.42)	(0.74)	(0.73)	(1.62)	(0.94)
Constant	0.079***	0.015	0.078***	0.015***	0.102***	-0.020**	-0.035**	0.015
	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
				Δ ln volume				
Δ ln RER	0.011	0.09	0.294***	0.174**	0.443***	0.415***	0.749***	0.535***
	(0.13)	(0.33)	(0.08)	(0.08)	(0.10)	(0.07)	(0.18)	(0.08)
Δ ln RGDP	13.900***	-2.315	3.091	-2.103	-0.085	2.499	-4.039	13.510***
	(2.06)	(17.10)	(2.01)	(1.87)	(3.29)	(2.42)	(4.58)	(2.58)
Δ ln RGDPPC	-11.970***	3.014	-1.39	3.219*	1.795	-1.226	5.928	-11.508***
	(2.00)	(16.92)	(1.97)	(1.85)	(3.18)	(2.38)	(4.51)	(2.52)
Constant	-0.508***	0.609***	-0.301***	1.006***	-0.283***	0.911***	0.696***	0.626***
	(0.03)	(0.16)	(0.02)	(0.02)	(0.03)	(0.03)	(0.06)	(0.03)
Observations	59103	6846	153781	257515	98284	255627	37384	187029

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: TFP and Firm Response to Exchange Rate

	full sample		single product	major product	full sample		single product	major product
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	Δln unit value				Δln volume			
$\Delta \ln RER_t$	0.102***	0.091***	0.092***	0.105***	0.245***	0.391***	0.411***	0.403***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.04)	(0.05)	(0.06)	(0.06)
$\Delta \ln TFP_t$	0.008***	0.008***	0.008***	0.009***	0.032***	0.033***	0.029***	0.039***
	(0.001)	(0.001)	(0.00)	(0.001)	(0.002)	(0.002)	(0.00)	(0.003)
$\ln TFP_{t-1} * \Delta \ln RER_t$	0.045***	0.045***	0.039***	0.049***	-0.067**	-0.042	-0.037	-0.078**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)	(0.04)	(0.04)
rank		-0.005***				-0.149***		
		(0.001)				(0.01)		
rank * Δln RER		-0.007**				0.140***		
		(0.003)				(0.02)		
Δln RGDP	-0.132	-0.187	-0.032	-0.708*	-0.837	-0.183	3.033**	3.118**
	(0.31)	(0.31)	(0.43)	(0.37)	(1.10)	(1.16)	(1.39)	(1.30)
Δln RGDPPC	0.129	0.18	0.083	0.775**	1.830*	1.155	-1.896	-1.927
	(0.31)	(0.31)	(0.43)	(0.37)	(1.08)	(1.14)	(1.36)	(1.27)
Constant	-0.015***	-0.006	-0.017***	-0.004	0.597***	0.801***	0.583***	0.612***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Observations	1444647	1444647	421021	547504	1444647	1444647	421021	547504

Robust standard errors in parentheses, all regressions have firm-product-destination fixed effects and year dummies.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Import Cost and Firm Response to Exchange Rate

	full sample		major sample		full sample		major sample	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Observations	*1045157*	*1045157*	*355386*	*355386*	*1045157*	*1045157*	*355386*	*355386*
	Δln unit value				Δln volume			
Δln RER	0.098***	0.031	0.128***	0.210***	0.420***	0.639***	0.447***	0.857***
	(0.02)	(0.05)	(0.02)	(0.07)	(0.05)	(0.18)	(0.07)	(0.21)
Δln TFP	0.009***	0.009***	0.011***	0.011***	0.032***	0.030***	0.038***	0.036***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.004)	(0.004)
ln TFP * Δln RER	0.049***	0.052***	0.070***	0.069***	-0.065*	-0.061*	-0.086**	-0.074*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)	(0.04)	(0.04)
import-weighted RER	0.099***		0.105***		0.053		1.737**	
	(0.03)		(0.04)		(0.08)		(0.83)	
imp-weighted RER * Δ	-0.768***		-0.483*		1.537**		0.013	
ln RER	(0.22)		(0.28)		(0.67)		(0.10)	
import intensity		-0.001		-0.001		0.029***		0.028***
		(0.001)		(0.00)		(0.00)		(0.00)
import intensity * Δ		0.008*		0.009*		-0.023		-0.044**
ln RER		(0.01)		(0.01)		(0.02)		(0.02)
rank	-0.005***	-0.005***			-0.142***	-0.142***		
	(0.001)	(0.001)			(0.01)	(0.01)		
rank * Δln RER	-0.007**	-0.008***			0.119***	0.119***		
	(0.003)	(0.003)			(0.02)	(0.02)		

Robust standard errors in parentheses, all regressions have firm-product-destination fixed effects and year dummies. GDP and GDPPC of destination country are included as control. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6: Market Share and Firm Response to Exchange Rate

	full sample		major sample		full sample		major sample	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
observation	*1444647*	*1444647*	*547504*	*547504*	*1444647*	*1444647*	*547504*	*547504*
	Δln unit value				Δln volume			
Δln RER	0.109***	0.141***	0.122***	0.147***	0.408***	0.409***	0.445***	0.408***
	(0.016)	(0.02)	(0.021)	(0.02)	(0.05)	(0.06)	-0.06	(0.08)
Δln TFP	0.007***	0.008***	0.009***	0.009***	0.031***	0.033***	0.037***	0.039***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	-0.003	(0.003)
ln TFP * Δln RER	0.046***	0.048***	0.051***	0.053***	-0.028	-0.044	-0.073*	-0.079**
	(0.01)	(0.01)	(0.012)	(0.01)	(0.03)	(0.03)	(0.04)	(0.04)
export share	0.054***		0.052***		1.059***		1.113***	
	(0.00)		(0.00)		(0.01)		(0.02)	
export share * Δln	-0.068***		-0.053*		-0.348***		-0.324***	
RER	(0.02)		(0.03)		(0.08)		(0.11)	
HHI		-0.009***		-0.006		-0.129***		-0.106***
		(0.004)		(0.01)		(0.01)		(0.02)
HHI * Δln RER		-0.132***		-0.110***		-0.056		-0.026
		(0.03)		(0.04)		(0.09)		(0.12)
rank	-0.005***	-0.005***			-0.145***	-0.149***		
	(0.001)	(0.001)			(0.01)	(0.01)		
rank * Δln RER	-0.008***	-0.006*			0.129***	0.142***		
	(0.003)	(0.003)			(0.02)	(0.02)		

Robust standard errors in parentheses, all regressions have firm-product-destination fixed effects and year dummies. GDP and GDPPC of destination country are included as control. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7: Firm Response to Exchange Rate: Full Specification with major sample

	(1)	(2)	(3)	(4)
	Δln unit value		Δln volume	
Δln RER	0.170***	0.139***	0.454***	0.372**
	(0.031)	(0.048)	(0.098)	(0.152)
Δln TFP	0.010***	0.010***	0.034***	0.034***
	(0.001)	(0.001)	(0.004)	(0.004)
ln TFP * Δln RER	0.072***	0.073***	-0.085*	-0.089**
	(0.014)	(0.014)	(0.044)	(0.044)
import-weighted RER	0.098***	0.100***	-0.021	-0.02
	(0.036)	(0.036)	(0.101)	(0.101)
imp-weighted RER * Δln RER	-0.448	-0.437	1.361	1.398*
	(0.281)	(0.281)	(0.833)	(0.834)
import intensity	0	0	0.025***	0.024***
	(0.001)	(0.001)	(0.004)	(0.004)
import intensity * Δln RER	-0.009	-0.014*	-0.049**	-0.061**
	(0.007)	(0.008)	(0.022)	(0.027)
export share	0.075***	0.075***	1.462***	1.461***
	(0.006)	(0.006)	(0.025)	(0.025)
export share * Δln RER	0.156***	0.155***	-0.112	-0.112
	(0.060)	(0.060)	(0.200)	(0.200)
HHI	-0.051***	-0.051***	-0.913***	-0.912***
	(0.008)	(0.008)	(0.025)	(0.025)
HHI * Δln RER	-0.273***	-0.270***	-0.173	-0.166
	(0.070)	(0.070)	(0.224)	(0.224)
processing share		-0.009		0.036**
		(0.007)		(0.018)
processing share * Δln RER		0.037		0.096
		(0.041)		(0.130)
Observations	355386	355386	355386	355386

Table 8: processing export and RER Response

	major sample		processing sample		major sample		processing sample	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Observations	355386	355386	234154	234154	355386	355386	234154	234154
	Δln unit value				Δln volume			
Δln RER	0.128***	0.210***	0.120***	0.133***	0.447***	0.857***	0.469***	0.466***
	(0.02)	(0.07)	-0.024	-0.031	(0.07)	(0.21)	(0.08)	(0.10)
Δln TFP	0.011***	0.011***	0.010***	0.010***	0.038***	0.036***	0.040***	0.036***
	(0.001)	(0.001)	(0.00)	(0.00)	(0.004)	(0.004)	(0.00)	(0.00)
ln TFP * Δln RER	0.070***	0.069***	0.067***	0.069***	-0.086**	-0.074*	-0.118**	-0.119**
	(0.01)	(0.01)	(0.02)	(0.02)	(0.04)	(0.04)	(0.05)	(0.05)
import-weighted	0.105***		0.105**		1.737**		0.06	
RER	(0.04)		(0.05)		(0.83)		(0.13)	
imp-weighted RER *	-0.483*		-0.528		0.013		0.708	
Δln RER	(0.28)		(0.34)		(0.10)		(1.08)	
import intensity		-0.001		0.00		0.028***		0.071***
		(0.001)		(0.002)		(0.004)		(0.006)
import intensity *		0.009*		0.006		-0.044**		-0.004
Δln RER		(0.01)		(0.01)		(0.02)		(0.04)

Robust standard errors in parentheses, all regressions have firm-product-destination fixed effects and year dummies. GDP and GDPPC of destination country are included as control. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 9: Firm Response to Exchange Rate: Without US Dollar Peggers

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Δln unit value					Δln volume				
Δln RER	0.118***	0.136***	0.117***	0.141***	0.174***	0.354***	0.393***	0.345***	0.445***	0.271***
	-0.018	-0.022	-0.026	-0.022	-0.025	-0.062	-0.073	-0.086	-0.072	-0.082
Δln TFP	0.009***	0.011***	0.011***	0.009***	0.009***	0.029***	0.027***	0.025***	0.028***	0.029***
	-0.001	-0.002	-0.002	-0.001	-0.001	-0.003	-0.004	-0.004	-0.003	-0.003
ln TFP * Δln RER	0.045***	0.055***	0.054***	0.048***	0.050***	-0.014	-0.026	-0.018	-0.014	-0.008
	-0.013	-0.015	-0.015	-0.013	-0.013	-0.039	-0.045	-0.045	-0.04	-0.039
import-weighted RER		0.109**					-0.06			
		-0.042					-0.116			
imp-weighted RER * Δln RER		-0.366					3.326***			
		-0.297					-0.886			
import intensity			-0.002					0.024***		
			-0.001					-0.004		
import intensity * Δln RER			-0.009					-0.023		
			-0.007					-0.02		
export share				0.052***					1.126***	
				-0.005					-0.02	
export share * Δln RER				-0.072**					-0.135	
				-0.03					-0.114	
HHI					-0.003					-0.098***
					-0.006					-0.019
HHI * Δln RER					-0.142***					0.200*
					-0.036					-0.122
Observations	422284	271135	271135	422284	422284	422284	271135	271135	422284	422284

Robust standard errors in parentheses, all regressions have firm-product-destination fixed effects and year dummies. GDP and GDPPC of destination country are included as control. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 10: Entry Decision and Exchange Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Logit			LPM			LPM		
	exist	enter	continue	exist	enter	continue	exist	enter	continue
lnRER	0.868***	0.788***	0.633***	0.176***	0.135***	0.141***	0.179***	0.121***	0.077***
	(0.013)	(0.017)	(0.023)	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)	(0.007)
lnTFPt-1	0.020***	0.001	0.031***	0.004***	0.000	0.007***	0.008***	0.015***	-0.001
	(0.001)	(0.001)	(0.002)	0.000	0.000	0.000	0.000	(0.001)	(0.001)
lnRGDPPC	0.168**	0.484***	-0.14	0.086***	0.125***	-0.023	0.087***	0.338***	0.184***
	(0.071)	(0.088)	(0.136)	(0.014)	(0.016)	(0.029)	(0.018)	(0.023)	(0.049)
lnRGDP	0.621***	0.261***	1.149***	0.031**	-0.021	0.250***	0.030*	-0.304***	-0.174***
	(0.066)	(0.083)	(0.123)	(0.013)	(0.016)	(0.027)	(0.017)	(0.022)	(0.044)
Observations	3978513	2509446	1468996	3978513	2509446	1469067	3978513	1469067	1469067
Fixed Effects		Destination			Destination			Firm-Destination	
Marginal Effects									
lnRER	0.21***	0.163***	0.149***						
	(0.003)	(0.004)	(0.005)						
lnTFPt-1	0.005***	0.0003	0.007***						
	(0.000)	(0.000)	(0.000)						

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%