Economics
The Open-Access, Open-Assessment E-Journal

Vol. 11, 2017-23 | August 22, 2017 | http://dx.doi.org/10.5018/economics-ejournal.ja.2017-23

Exchange rate movements and export market dynamics: evidence from China

Xiaobing Huang

Abstract

This paper highlights the relationship between foreign exchange rate fluctuations and firms' export market dynamics using a Chinese firm-level production data and a firm-level trade data over the period of 2000–2006. This study adopts a discrete-time survival model in our empirical investigation and further executes several extensions and robustness checks to the baseline results. The main results of the paper can be summarized as follows: First, an exchange rate appreciation increases the likelihood of export market exit and decreases the probability of export market entry. Second, high productivity firms are less likely to exit from export markets and more likely to enter export markets in the period of exchange rate appreciation. Third, exchange rate appreciation decreases the likelihood of export market entering and increases the likelihood of export market exiting more for private-owned firms, young firms and non-eastern firms. Finally, other sources of heterogeneity, such as extensive margins, import demand elasticity, different destinations, U.S. dollar peg, and the liberalization of trading rights is also important to the effects of exchange rate changes.

JEL F14 F31 F32 F41

Keywords Exchange rate movements; export market dynamics; firm heterogeneity; China

Authors

Xiaobing Huang, ✉ School of Business, Gannan Normal University, Jiangxi Province, China, huangxiaobing1234@126.com

Citation Xiaobing Huang (2017). Exchange rate movements and export market dynamics: evidence from China. *Economics: The Open-Access, Open-Assessment E-Journal*, 11 (2017-23): 1–27 . http://dx.doi.org/10.5018/economics-ejournal.ja.2017-23

Received March 17, 2017 **Published as Economics Discussion Paper** March 24, 2017
Revised July 7, 2017 **Accepted** July 10, 2017 **Published** August 22, 2017

1 Introduction

It is well known that exchange rate is a significant institutional factor affecting aggregate trade and individual exporting behavior. In reality, facing exchange rate movements, exporters not only adjust their export volume and export price, but also switch their products mix or even export market dynamics (entry or exit). Understanding the influence of exchange rate fluctuations on the international trade is of special interests to both researchers and policy makers, especially in the wave of global imbalance. A large and growing number of studies have shed light on the effect of foreign exchange rate fluctuations on export performance including export volume (the exchange rate elasticity of export quantity) and export price (exchange rate pass-through, ERPT) (Shambaugh, 2008; Colacelli, 2009).[1] Another strand of literature highlights the relationship between exchange rate movements and extensive or intensive margin of trade on the product side (Bernard and Jensen, 2004a; Baggs et al., 2009). In the vast relevant literature there are even some evidences that link the effect of exchange rate movements to firm-level characteristics trigged by the growing studies of firm's heterogeneity (Das et al., 2007; Bernard et al., 2011) and the better availability of firm-level data, such as Berman et al. (2012) and Li et al. (2015). But very little attention is paid to the reaction of exporters to foreign exchange rate movements in terms of export market dynamics.

Since the reform and opening policy began, China's foreign trade and trade surplus has been growing rapidly. Meanwhile Chinese currency (RMB) has been appreciating in recent years according to the statistics from the Bank of International Settlements (see Figure 1). China's ballooning current account surplus and rapid accumulation of international reserves have been under the limelight for a long time. Many people concern whether Chinese authorities are heavily managing their currency and contributing to global imbalance. Many other people question whether faster currency appreciation would reduce China's trade surplus tremendously. However, relevant studies are still inconclusive owing to different empirical methods and data coverage.

In order to fill the gap of previous studies, this study investigates in this paper the relationship between foreign exchange rate fluctuations and firms' export market dynamics using a firm-level production data from China National Bureau of Statistics and a firm-level trade data from China Customs over the period of 2000–2006. The author adopts a discrete-time survival model in our empirical investigation and further executes several extensions and robustness checks to the baseline results. The main results of the paper can be summarized as follows: First, an exchange rate appreciation increases the likelihood of export market exit and

[1] Goldberg and Knetter (1997) provide a very good survey on the relationship between international prices and exchange rates.

Figure 1: China's foreign trade and real effective exchange rates

decreases the probability of export market entry. Second, high productivity firms are less likely to exit from export markets and more likely to enter export markets in the period of exchange rate appreciation. Third, exchange rate appreciation decreases the likelihood of export market entering and increases the likelihood of export market exiting more for private-owned firms, young firms and non-eastern firms. Finally, other sources of heterogeneity, such as extensive margins, import demand elasticity, different destinations, U.S. dollar peg, and the liberalization of trading rights is also important, but our results are robust to alternative redefinition of dynamics, alternative productivity measures and alternative estimation approaches.

This paper may contribute to relevant literatures in three aspects. First, this study uses a longitudinal firm-level data merged from a production data and a trade data, which allows the author to calculate destination specific exchange rate movements and control more firm-level factors affecting firms' export dynamics. Second, this study relates the effects of exchange rate movements on export market dynamics to several firm characteristics, which allows the author to gain a better understanding on how exchange rate movements affect export market dynamics and more policy implications. Finally, this study adopts a discrete time survival model which is a natural framework to address the question of success and failure in export markets with our data.

This paper mostly relates to a small but growing number of studies linking exchange rate movements to export market dynamics. Baggs et al. (2009) show that the impact of real exchange rate changes on firm survival is far larger than the effect of CUSTA tariff reduction. Tang and Zhang (2012) find that a significant impact of real appreciation of the renminbi on the extensive margins of Chinese

exporters. Berman et al. (2012) find that a 10% depreciation increases the entry probability by around 1.4 percentage points and the probability of remaining an exporter by a range between 1.3 and 2.1 percentage points. Goerg and Spaliara (2013) find a positive relationship between exchange rate and the hazard of exit in their paper studying the effect of financial pressure on export market exit. Greenaway et al. (2007), on the other hand, find no significant effect of exchange rate on entry decisions for a sample of UK firms. Li et al. (2015) find that a 10% appreciation reduces the probability of new entry by 0.6% and the probability of continuing in the export market by 1.1%.

My research also makes a contribution to recent studies examining the effect of exchange rate on export volume and export price. First, a number of papers investigate the relationship between exchange rate devaluation and export growth, most of them find that large depreciations of the real exchange rate Ire an important determinant of export surges (Fang et al., 2006; Bernard and Jensen, 2004b; Freund and Pierola, 2013; Haddad and Pancaro, 2010). Second, with respect to export price, many studies find that exchange rate fluctuations have small effects on the prices of internationally traded goods, which is considered as the exchange rate disconnect puzzle (Goldberg and Knetter, 1997; Campa and Goldberg, 2005, 2010). Possible explanations for incomplete pass through include short-run nominal rigidities (Engel, 2003; Gopinath and Itskhoki, 2010; Gopinath et al., 2010; Gopinath and Rigobon, 2008), pricing-to-market strategies (Atkeson and Burstein, 2008; Knetter, 1989, 1993), or local distribution costs (Burstein et al., 2003; Corsetti and Dedola, 2005). Furthermore, some studies shed light on the investigation of the heterogeneous pricing response of exporters to exchange rate changes owing to the increasing availability of firm-level trade data. Amiti et al. (2014) find that exporters with high market shares have a lower exchange rate pass-through. Chatterjee et al. (2013) find pricing-to-market is stronger for the products the firm is most efficient at producing.

The remainder of the paper is organized as follows. Section 2 introduces the dynamics of Chinese exporting firms. Section 3 describes the datasets that I employed in this paper. Section 4 analyzes the baseline empirical results. Section 5 demonstrates some extensions and robustness checks. The last section concludes the paper.

2 Dynamics of Chinese exporting firms

Exporting activities take more risks and costs than domestic businesses due to institutional differences, complicate transaction procedures and market fluctuations. This section examines the dynamics of Chinese firms at foreign markets using **the filtered production data** from 2000 to 2006. This study uses the information on the yearly export delivery value to identify whether a firm enters

into or exits from foreign markets. The appearance of a positive value indicates an entry of a firm in year t into foreign markets, and the disappearance of a positive export delivery value indicates an exit of a firm in year t from foreign markets. If a firm re-enter into the export market after exits, I treat such a firm as a new entry firm at that year.[2] Table 1 and Figure 2 present brief description of firm survival of Chinese manufacturing firms. This study treats the cohort of firms active in 2000 as benchmark and observes their performance in subsequent years.

Table 1 and Figure 2 suggest three main findings with respect to the dynamics of exporting firms. First, the surviving ability of Chinese firms in foreign markets is weaker than domestic firms, about 42% of all firms can survive for 7 years, but only 29% of the firms who export in 2000 succeed to export until 2006. Second, the longer firms are active in foreign markets, the stronger they become. On the one hand, exporting firms are more likely to exit from foreign markets in the beginning years, 25% of exporting firms exit from foreign markets after 1 year, but this number is 9% after 6 years. On the other hand, firms who succeed to export for 5 years gain a better performance than firms being exporters for 4 years in terms of export value, sales and employee numbers. Finally, when comparing exporting firms with all firms (exporters and domestic firms), I find that exporting firms are better in all aspects, which can likely be explained by the self-selection effect and the positive learning externalities because this causality can run in both directions. What I find here serves as evidence verifying the importance of firm heterogeneity in international trade.

Table 2 displays the firm entry and exit rates at foreign markets over the period 2000–2006. This paper defines entrants in year t as firms that are absent in $t-1$, but appeared in t. This study defines exiters in year t as firms that are active in $t-1$ but absent in t. The exit and entry rates are calculated as the share of entering firms and exiting firms in total number over the exporting firms in that year.

As indicated in Table 2, the exit and entry of exporting firms in foreign markets are turbulent, the annual turnover rate fluctuates between 46% and 60% over the period of 2000–2006.[3] The number of entrants into foreign markets account on average for 25% of the total number of exporting firms each year, while an average of 28% of the exporting firms exit from foreign markets each year. These figures are very close to the turnover rate of Columbian firms (Eaton et al, 2007), whereas they are much higher than those of many other countries (e.g. Bartelsman et al., 2013). The high churning rate of exporting firms likely reflects their more intense dynamics on exporting markets.

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[2] This approach will cause left truncation. Some exporting firms will vanish from the dataset if their sales value is below 5 million RMB, even though they still export.

[3] Firm turnover rate is the sum of entry rate and exit rate.

Table 1: Survival and performance of Chinese manufacturing firms

Firm type	Firm surviving time	1 year	2 years	3 years	4 years	5 years	6 years	7 years
All Firms	Number of firms	83628	71920	64393	54358	48504	41041	35123
	Sales	53601	57298	62626	72452	79612	91789	104264
	Export value	9388	9871	11378	14041	162306	17806	20335
	Number of employees	192	205	214	238	250	257	266
Exporting firms	Number of firms	33451	25088	22746	17394	15387	11707	9700
	Sales	114113	116379	124068	143578	151258	163188	192989
	Export value	39289	39947	44353	53075	57342	63263	76541
	Number of employees	299	326	354	378	401	436	441

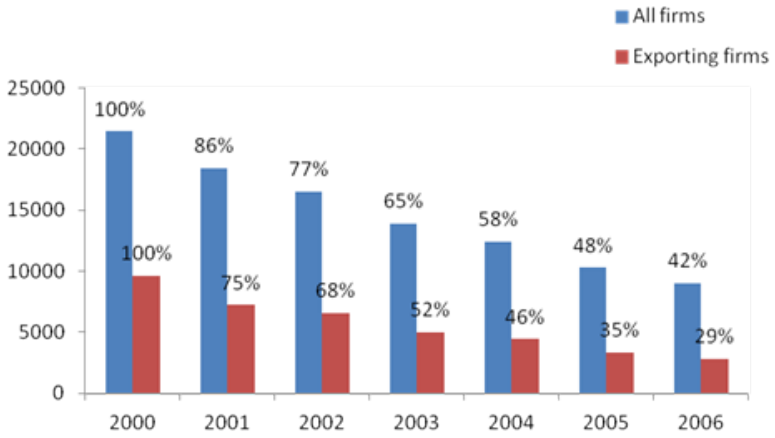
Note: I use firm codes to decide whether firm survives or not for all firms. Export volume, sales and number of employees are average value in 1000 RMB.

Table 2: Firm entry and exit rates at foreign markets

	2001	2002	2003	2004	2005	2006
Number of exporting firms	38038	44212	50508	81970	83286	101180
Number of exiting firms	8444	13086	13889	19754	21238	29241
Exit rate	22.2%	29.6%	27.5%	24.1%	25.5%	28.9%
Export value of exiting firms	38235	39652	41176	42772	42378	42254
Number of entering firms	9129	13794	14344	22377	22320	31466
Entry rate	24.0%	31.2%	28.4%	27.3%	26.8%	31.1%
Export value of entering firms	41165	43327	48901	53446	58761	60012

Note: Export value of exit firms refers to the observations of last year, and the export value is mean value in 1000 RMB.

Figure 2: Duration dependence of Chinese manufacturing firms



3 Data and methodology

3.1 Data

To investigate the impact of exchange rate fluctuations on firm's exports, this paper employs two Chinese datasets in our paper. One is the production data from Annual Surveys of Industrial Production (ASIP) from 2000 to 2006 conducted by the Chinese Government's National Bureau of Statistics (NBS). The firm-level dataset is a census of all non-state firms with more than 5 million RMB in sales (about $600,000) plus all state-owned firms, which covers between 162,885 firms (in 2000) and 301,961 firms (in 2006). The dataset provides not only some basic information, such as name, address, age, ownership, but also financial information, such as output, wage, employment, added-value, export delivery value, profit and fixed-assets.

The firm-level dataset contains much noisy information. The author filters the data by following steps. First, the author deletes the samples if the observations of key variables miss, for example, export values, quantities, added-value, number of employees, fixed-assets. Second, the author drops the observations with negative values which it is impossible, such as employees. Third, the author omits the samples whose employees are less than 8 persons.[4] Finally, following Feenstra et al. (2013b), the author cleans samples violating accounting standards as follows:

[4] According to the china company law, the number of employee for a company must be more than 8, otherwise it only can be considered as small private business rather than company.

(1) liquid assets are greater than total assets;

(2) total fixed assets are greater than total assets;

(3) the net value of fixed assets is greater than total assets;

(4) the firm's identification number is missing.

After filtering, the author obtains a sample with 1649163 observations, which accounts for about 60% of the original dataset.

The other dataset the author uses is the product-level trade data from the China's General Administration of Customs, which covers all exporters and importers from 2000 to 2006. It records a variety of information for each trading firm's product list, including trading price, quantity and unit value at the HS 8-digit level.

The author merges the above two databases according to the contact information of firms, because there is no consistent coding system of firm identity between these two databases. Following Yu (2014), the author goes through two steps to match these two datasets. First, the vast majority of firms are matched by company names exactly. Second, the author adopts telephone number and zip code to identify firms as a supplement. Table 3 describes the matched dataset.

Table 3: Description of merged data

	Trade data		Production data		Merged data
Year	Transactions	Firms	Raw firms	Filtered firms	Firms
2000	10,586,696	80,232	162,883	83,628	21,425
2001	12,667,685	87,404	169,031	100,100	24,959
2002	14,032,675	95,579	181,557	110,530	28,759
2003	18,069,404	113,147	196,222	129,508	33,901
2004	21,402,355	134,895	277,004	199,927	49,891
2005	24,889,639	136,604	271,835	198,302	49,925
2006	16,685,377	197,806	301,960	224,854	49,680
All years	118,333,831	286,819	615,951	438,165	91,299

Note: Column (2) reports the number of observations of HS eight-digit monthly transaction-level trade data from China's General Administration of Customs by year. Column (4) reports the number of firms covered in the transaction-level trade data by year. Column (5) reports the number of firms covered in the firm-level production data set compiled by China's National Bureau of Statistics without any filter and cleaning. Column (6) presents number of firms covered in the merged date using the trade data set and the raw production dataset.

3.2 Methodology

3.2.1 Specification

To evaluate the effects of foreign exchange rate movements on export market dynamics, this study uses a complementary log-log model (cloglog), which is a discrete-time version of the Cox proportional hazard model.[5] The author prefers this model because the annual nature of the data causes right-censoring: firms had not exited from export markets until 2006.

The proportional hazard model consists of two parts: the baseline hazard $\lambda_0(t)$, describing how the risk of event per time unit changes over time at baseline levels of covariates; and the effect parameters $\exp(\beta'_k)$, describing how the hazard varies in response to explanatory covariates. The hazard rate is given by:

$$\lambda(t,K) = \lambda_0(t)\exp(\beta'_k)$$

The discrete-time hazard function, $h(j,\mathrm{X})$, shows the interval hazard for the period between the beginning and the end of the j^{th} year after the first appearance of the firm. This hazard rate, which is the rate at which firms fail at time t given that they have survived in $t-1$, takes the following form:

$$h(j,K) = 1-\exp\left[-\exp(\beta' K + \gamma_j)\right]$$

where the identification of β parameter is our primary interest, which exhibits the effect of the explanatory variables on the hazard rate.

The benchmark model to connect the firms' probability of entry and exit the export markets to exchange rate movements and other control variables is set up as follows.

$$h(j,K) = 1-\exp\left[-\exp(\beta_0 + \beta_1 REER_{ct} + \beta_2 Z_{it-1} + \gamma_j)\right]$$

The sign and significance of β_1 shows the direction and importance of exchange rate movements on export market dynamics. Positive estimates normally suggest that the larger values of the explanatory variables increase the hazard, or equivalently, decrease the probability of survival. But this is not the case for RMB exchange rate movements, positive estimates of RMB appreciation suggest a negative impact of RMB appreciation on the hazard, since a decrease of RMB exchange rate implies an appreciation of RMB against foreign currency.

[5] To capture the particular nature of the dataset, given that it is collected on a yearly basis, the cloglog model is more appropriate than the standard Cox model. See Jenkins (2005) for an excellent overview of complementary log-log and proportional hazard models.

As for the dependent variable, I define entrants in year t as those firms don't export to country c in year $t-1$ but in year t and denote $Entry_{ict}$ as entrants which is binary variable. I define exiters in year t as those firms that export to country c in year $t-1$ but not in year t and denote $Exit_{ict}$ which is also a binary variable. I treat firms as new entrants if they reenter into export markets after exiting.

With respect to the independent variables, REER_{ct} is the real effective exchange rate of RMB against country c in year t . Z_{it-1} denotes the vector of control variables including firm productivity, firm size, firm age. In order to deal with the lagged effect of productivity and the possible concern of endogeneity, I include their one year lagged term of firm productivity. Firm size is measured by the number of employees. Firm age is measured by the difference between firm establishing year and the current year. Moreover, I include a full set of time, ownership, industry and regional dummies in order to control many firm-specific and year-specific fixed factors.[6]

Firms are heterogeneous in their productivity and other firm characteristics, therefore their reactions to exchange rate movements may also be heterogeneous. The benchmark model is modified to interact exchange rate movements with firm productivity and other control variables in order to assess how the effect of exchange rate movements relates to firm heterogeneities.

$$h(j,K)=1-\exp\left[-\exp\left(\begin{array}{l}\beta_0+\beta_1\ln REER_{ct}+\\ \beta_2\ln\mathrm{REER}_{ct}*productivity_{it}+\beta_3 Z_{it-1}+\gamma_j\end{array}\right)\right]$$

The basic statistical information of key variables is reported in Table 4.

6 This paper divides China into four regions, the eastern region, the middle region, the northern region and the western region. The eastern region consists of Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong; Middle region consists of Anhui, Jiangxi, Henan, Hubei, Hunan; The northern region consists of Beijing, Tianjin, Hebei, Liaoning, Jilin, Heilongjiang; the western region consists of Shanxi, Sichuan, Chongqing, Guizhou, Yunnan, Tibet, Shanxi, Gansu, Qinghai, Ningxia, Inner Mongolia, Guangxi. Five types of enterprises are distinguished in China: state-owned enterprises (SOEs), collective enterprises (COEs), private-owned enterprises (POEs), Hongkong-Macao-Taiwan-invested enterprises (HIEs) and Foreign–invested enterprises (FIEs). The industry dummies are two-digit sector level.

Table 4: Descriptive statistics of key variables

	Mean	Std.dev	Min	Max
Firm entry	0.021	0.143	0	1
Firm exit	0.026	0.161	0	1
Firm size	236	1282.3	8	569670
TFP	2.76	0.97	2.14	3.36
REER	1.37	0.23	0.00058	207
Firm age	8.66	9.54	1	178

3.2.2 Construction of REER

Data on year-average bilateral nominal exchange rates (NER) are obtained from the International Financial Statistics (IFS) of the International Monetary Fund. The real effective exchange rate (REER) is defined as the weighted Chinese RMB against foreign currency, multiplied by foreign CPI and divided by Chinese CPI. The consumer price indices (CPIs) are also obtained from the International Financial Statistics (IFS).[7]

$$REER_{ct} = NER_{ct} \times \frac{CPI_{ct}}{\mathrm{CPI}_{CHN,t}}$$

As indicated in above equation, an increase of REER is associated with a depreciation of the RMB against foreign currency.

3.2.3 Measurement of TFP

There are several methods for productivity estimation including Solow's residual method, data envelopement analysis (DEA) method, Olley-Pakes (OP; 1996) method, and Levinsohn-Petrin (LP; 2012) method. Solow's residual method is most used for its simplicity, but it generates simultaneity bias and selectivity bias. Olley and Pakes (1996) proposed a semi-parametric estimator to reduce simultaneity bias, which has become the most popular method for estimating firm productivity.

In this section, this study also adopts the OP method to estimate firm productivity using added value as the dependent variable. The author uses fixed assets and the number of employees as measures of the explanatory variables capital and labor and

[7] The IMF IFS data have no information of CPI for Taiwan. CPI indices for Taiwan are obtained from National Statistics of Republic of China.

the perpetual inventory method to calculate capital stocks assuming a 15% depreciation rate.[8] All variables are deflated by appropriate price indices.[9] The productivity is estimated at two digit CIC sector-level using the filtered production dataset. Summary statistics for entrants and exiters respectively are provided in Table 5.

Table 5: Productivity of entering exporters and exiting exporters

		2006	2007	2008	2009
Productivity of exiting firms		3.94	4.09	4.14	4.22
By ownership:	SOEs	3.32	3.45	3.80	3.89
	POEs	4.07	4.23	4.33	4.27
	FIEs	4.06	4.21	4.21	4.25
	COEs	3.80	3.87	3.97	4.10
	HIEs	3.94	4.08	4.18	4.22
By location:	East	4.92	4.03	4.15	4.15
	Middle	4.02	4.13	4.25	4.33
	Ist	3.73	3.81	3.94	4.19
	North	3.96	4.05	4.13	4.23
By sector:	Main	4.06	4.16	4.20	4.33
	Rest	3.93	4.03	4.09	4.18
Productivity of entering firms		4.02	4.08	4.23	4.26
By ownership:	SOEs	3.51	3.93	3.82	3.84
	POEs	4.15	4.26	4.32	4.46
	FIEs	4.09	4.16	4.31	4.33
	COEs	3.88	3.92	4.23	4.19
	HIEs	4.01	4.06	4.21	4.21
By location:	East	4.07	4.12	4.32	4.29
	Middle	4.06	4.06	4.16	4.37
	Ist	3.87	3.88	3.94	4.04
	North	3.97	4.06	4.39	4.13
By sector:	Main	4.07	4.16	4.24	4.34
	Rest	3.92	4.00	4.08	4.16
Productivity of surviving firms		4.05	4.11	4.25	4.29
By ownership:	SOEs	3.59	3.78	3.95	4.05
	POEs	4.14	4.18	4.19	4.26
	FIEs	4.08	4.15	4.20	4.30
	COEs	3.80	3.86	3.97	4.09
	HIEs	4.09	4.17	4.20	4.31
By location:	East	4.06	4.12	4.16	4.26
	Middle	4.14	4.21	4.29	4.42
	Ist	3.81	3.94	4.04	4.22
	North	3.99	4.08	4.11	4.24
By sector:	Main	4.06	4.15	4.20	4.33
	Rest	4.04	4.10	4.17	4.27

[8] Some papers adopt other lower depreciation rates, such as 10% or 5%. The choice of different depreciation rates does not affect our qualitative results.

[9] All kinds of price indices are from China Statistical Yearbook.

4 Baseline Results

4.1 Exchange rate movements and export market exit

The connection between exchange rate movements and the export market exit is explored in this section. Table 6 reports the estimation results by adopting cloglog regression. Column 1 presents the estimation results without considering the firm-industry-year triplet specific fixed effects, Column 2 includes these specific fixed effects, and Columns 3–6 interact the exchange rate movements with firm heterogeneities including productivity, age and dummies.

As noted in Table 6, the author finds that the coefficients of exchange rate movements in all specifications are negative and significant at the 1% level, implying that exchange rate changes play a positive effect on the likelihood of firms exiting from the export markets. The author finds the hazard ratios of exchange rate movements lie between 0.014 and 0.019, which means an appreciation in RMB by 10% (a decrease of RMB exchange rate) leads to an increase in the hazard of export market exit by a range between 0.14% and 0.19%. Moreover, as indicated in the table, the estimated coefficients of the interaction term between exchange rate and firm productivity is found to be negative and significant, which suggests a weaker effect of exchange rate appreciation on export market exit to high productivity firms, namely, high productivity firms are less likely to exit from export markets in the period of exchange rate appreciation.

As indicated by the interactions between exchange rate movements and firm-specific effects, the author finds that private firms gain stronger response to the exchange rate volatility, while the responses of younger firms and eastern firms are weaker than their counterparts. This result shows that facing the exchange rate appreciation (1) private-owned enterprises are more likely to exit from export markets, (2) younger exporters are more likely to exit from export markets, (3) firms from eastern China enjoy lower propensity of failure in export markets.

As for other controls, the author finds a negative relationship between the probability of exiting and firm age and firm size, although their effects are of less importance for the export market exit.

4.2 Exchange rate movements and export market entry

Table 7 shows the estimation results of the relationship between the exchange rate fluctuations and the export market entry by using probit regression and the marginal effects are reported in this table. The first column presents the estimation results without considering the firm-industry-year triplet specific fixed effects, while Column 2 includes them, and Columns 3–6 relates the impact of exchange rate movements to firm heterogeneity by introducing the interaction terms.

Table 6: Exchange rate movements and export market exit

	(1)	(2)	(3)	(4)	(5)	(6)
lnreer	-4.085***	-3.932***	-6.258***	-6.262***	-6.462***	-6.562***
	(-77.74)	(-77.34)	(-33.27)	(-29.97)	(-33.70)	(-33.82)
lntfp(-1)	-0.159***	-0.122***	-4.878**	-4.935**	-5.321***	-5.323***
	(-26.21)	(-19.97)	(-2.173)	(-2.314)	(-3.317)	(-3.311)
lnage	-0.006***	-0.541***	-0.541***	-0.540***	-0.681***	-0.685***
	(-20.08)	(-21.04)	(-21.05)	(-21.00)	(-26.15)	(-26.24)
lnsize	-0.337***	-0.231***	-0.231***	-0.232***	-0.244***	-0.245***
	(-15.26)	(-9.768)	(-9.770)	(-9.801)	(-10.25)	(-10.33)
lnreer* lntfp(-1)			-0.167*	-0.180**	-0.268***	-0.271***
			(-1.871)	(-2.011)	(-3.043)	(-3.064)
lnreer*private				0.0340***	0.0176**	0.0177**
				(4.333)	(2.256)	(2.259)
lnreer*age					-0.026***	-0.0281***
					(-34.31)	(-34.42)
lnreer*east						-0.0993***
						(-12.09)
Ownership	NO	YES	YES	YES	YES	YES
location	NO	YES	YES	YES	YES	YES
Industry	NO	YES	YES	YES	YES	YES
Year	NO	YES	YES	YES	YES	YES
Log likelihood	-145451	-145650	-145556	-145555	-145482	-145488
Observations	604,443	512,522	452,881	442,327	402,903	402,903

Note: Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

From Table 7, the author observes that the variable of RMB exchange rate movement carries positive coefficients in all specifications, indicating that a RMB appreciation decreases the likelihood of entering the export markets. The author finds large entry effect caused by RMB apperception. A 10% RMB appreciation will give birth to a decrease in probability of export entry by about 70%. The potential reason to that large effect is that Chinese exporters enjoy low market power because of high competition and low position in the global value chain, so that they are very sensitive to appreciation. Furthermore, the estimated coefficients of the interaction terms between exchange rate and firm productivity is negative and significant at 1% level, which suggests that the productivity growth of firms can decrease the negative effect of exchange rate appreciation on export market entry.

Table 7: Exchange rate movements and export market entry

	(1)	(2)	(3)	(4)	(5)	(6)
lnreer	6.573***	6.610***	7.645***	7.651***	7.755***	7.855***
	(41.49)	(39.47)	(29.36)	(28.45)	(22.89)	(22.79)
lntfp(-1)	0.274***	0.189***	5.892***	5.874***	5.727***	5.734***
	(4.378)	(2.932)	(13.66)	(13.61)	(13.17)	(13.22)
lnage	0.0880***	0.0774***	0.0778***	0.0779***	0.0756***	0.0756***
	(31.10)	(26.97)	(27.06)	(27.09)	(26.19)	(26.19)
lnsize	0.0758***	0.0713***	0.0714***	0.0713***	0.0715***	0.0718***
	(31.68)	(27.64)	(27.66)	(27.66)	(27.70)	(27.70)
lnreer* lntfp(-1)			-1.300***	-1.296***	-1.263***	-1.269***
			(-13.63)	(-13.58)	(-13.14)	(-13.34)
lnreer*private				0.0247***	0.0270***	0.0272***
				(-2.795)	(-3.022)	(-3.082)
lnreer*age					-0.0517***	-0.0523***
					(-6.581)	(-6.577)
lnreer*east						-0.0485***
						(-5.366)
Ownership	NO	YES	YES	YES	YES	YES
location	NO	YES	YES	YES	YES	YES
Industry	NO	YES	YES	YES	YES	YES
Year	NO	YES	YES	YES	YES	YES
Log likelihood	-154721	-154532	-154530	-154629	-154376	-154388
Observations	604,443	512,522	452,881	442,327	402,903	402,903

Note: Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Results of the interactions reported in Columns (4)–(6) of Table 7 suggest that the effect of exchange rate movements on export market entry is stronger for private firms. Younger firms and non-eastern firms, which means that the private-owned enterprises, younger firms and non-eastern firms are less motivated to enter into export markets than other firms when facing exchange rate appreciation.

In a nutshell, following findings are reached. First, exchange rate movements have a negative impact on firms' export market dynamics. An exchange rate appreciation increases the likelihood of export market exit and decreases the probability of export market entry. This finding is in line with the results of relevant literature (Ilmakunnas and Nurmi, 2010; Alvarez and López, 2005; Goerg and Spaliara, 2013). What is more, in comparison with foreign studies, I find that Chinese firms are more sensitive to the exchange rate appreciation than other countries. The most likely reason is that Chinese exporters almost have low mark-up because they are locked in the low-end of global value chain (Li et al., 2015).

Moreover, the effect of exchange rate appreciation on export market dynamics negatively relates to firm productivity, which indicates that higher productivity can help firms to overcome the adverse effect brought by appreciation. The possible explanation to this result is that higher productivity firms are more capable of affording the entry costs and absorbing the exchange rate appreciation (Roberts and Tybout, 1997; Bernard and Jensen, 2004a; Berman et al., 2012).

Eventually, the influence of exchange rate appreciation on export market dynamics is stronger for private-owned firms, but weaker for older firms and eastern firms. The fact that private firms suffer more from the appreciation can be explained by following two possible reasons: first, the POEs are fully exposed to market competition, whereas the SOEs are protected by government (Zhang et al., 2003); second, the SOEs usually export low-elasticity products which aren't sensitive to exchange rate movements (Shi et al., 2008), by contrast, the POEs generally export low-end products which are vulnerable to exchange rate movements. The higher hazard of exiting and the lower propensity of entering for younger firms caused by exchange rate appreciation may be explained by their poor market experience and lower financial ability. The weaker response of eastern firms to exchange rate appreciation on export market dynamics can be attributed to the high agglomeration in eastern China (Yu, 2014).

5 Extensions and robustness checks

In this section, this study explores a few scenarios of extensions and robustness checks to the relationship between exchange rate movements and export market dynamics.

5.1 Extensions

5.1.1 Extensive margins

The relationship between exchange rate movements and export market dynamics may be affected by the adjustment of exporters in extensive margin as well as intensive margin, thus exporters may be more able to survive in export markets when exporting many products to many destinations and exporters who export single product or export to single destination may be more vulnerable in export markets (Hummels and Klenow, 2005). This paper identifies the role of extensive margins by interacting the number of products and destinations with exchange rate movements. The results reported in Colum 1–2 of Table 8 show that the expanding of export variety and destinations increases firms' possibility of entering foreign

Table 8: Results of extensions: extensive margins, elasticity and destinations

	(1)	(2)	(3)	(4)	(5)	(6)
	The number of products and destinations		Different demand elasticity		Different destinations: OECD or not	
	exit	entry	exit	entry	exit	entry
lnreer	-6.239***	7.133***	-6.314***	7.136***	-6.313***	7.688***
	(-35.96)	(23.06)	(-37.11)	(18.44)	(-124.3)	(231.4)
lntfp(-1)	-1.165***	1.240***	-1.876***	1.218***	-2.532***	1.729***
	(-6.742)	(11.36)	(-5.279)	(7.995)	(-16.15)	(6.824)
lnage	-0.0316***	0.0245***	-0.152***	0.0447***	-0.0688***	0.125***
	(-23.53)	(21.04)	(-64.58)	(21.86)	(-79.89)	(15.61)
lnsize	-0.0118***	0.0338***	-0.0244***	0.0949***	-0.230***	0.0490***
	(-8.107)	(26.77)	(-45.08)	(20.14)	(-245.8)	(26.56)
lnreer* lntfp(-1)	-0.0379***	-0.0534***	-0.029	-0.064***	-0.573***	-0.147***
	(-6.973)	(-11.33)	(-0.427)	(-7.626)	(-16.43)	(-6.168)
lnproducts	-0.0918***	0.0499***				
	(-17.94)	(11.25)				
lndestinations	-0.0217***	0.0144**				
	(-31.71)	(2.426)				
high elasticity			0.0612	-0.00156		
			(0.228)	(-0.650)		
non-OECD					-0.0369***	-0.0337***
					(-105.4)	(-146.6)
lnreer*products	-0.0410***	-0.0557***				
	(-8.301)	(-13.01)				
lnreer*destinations	-0.0116***	-0.0153***				
	(-20.20)	(-30.76)				
lnreer*high elasticity			0.0166***	0.0122***		
			(10.53)	(8.867)		
lnreer*non-OECD					0.952***	0.0418***
					(258.9)	(7.797)
Ownership	YES	YES	YES	YES	YES	YES
location	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES	YES
Observations	451,546	451,546	466,248	466,248	447,658	447,658
Log likelihood	-144346	-155794	-134238	-154377	-135794	-154339

Note: Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Marginal effects are reported in this table for the results of entry.

markets and decreases risk of exiting. Besides, the firms who export more productsto more destinations are more likely to enter but less likely to exit from the foreign markets and such in the period of exchange rate appreciation because of their richer exporting experience and higher risk resistance capacity.

5.1.2 Import demand elasticity

The responses of exporters to exchange rate movements may be different across goods with different import demand elasticity. The author discriminates all HS goods as high-elasticity goods and low-elasticity goods according to Broda et al. (2006) and explore the heterogeneous effects of exchange rate movements on export market dynamics for goods with different import demand elasticity by interacting the exchange rate movements with the dummy of high-elasticity goods which equals one if the import demand elasticity of that goods surpasses median. The results displayed in Colum 3–4 of Table 8 suggest that a RMB appreciation is associated with a lower probability of entering and a higher probability of exiting for firms that export goods with high elasticity.

5.1.3 Different destinations

The exporters' reaction to exchange rate movements may relate to the destinations they export. Since non-OECD countries are likely to conceive more exchange rate fluctuations and inflation volatility compared with OECD countries (Li et al., 2015). Columns 5–6 of Table 8 report how the exporters' reaction to exchange rate appreciation differs across different markets by adding the interaction term between exchange rate movements and the dummy of non-OECD countries. The results indicate that firms are less likely to enter the non-OECD countries than OECD countries and firms who export to the non-OECD countries enjoy higher hazard of exiting during RMB appreciation.

5.1.4 The role of U.S. dollar peggers

The RMB exchange rate was pegged to the US dollar before 2005, which indicates that the inflation is the only source of exchange rate movements between RMB and U.S. dollar. Meanwhile, U.S. and other U.S. dollar peggers (e.g. Hong Kong) as defined in Klein and Shambaugh's (2006) are the major destinations of Chinese exports. Therefore, one concern is that much of the variation in real exchange rate could be due to price movements in different regions instead of nominal exchange rate movements. This study evaluates its effects by interacting exchange rate movements with the dummy of U.S., Hong Kong and another U.S. dollar peggers before 2005. I find in Columns 1–2 of Table 9 that firms are more likely to enter

Table 9: Results of extensions: peggers and trading rights

	(1)	(2)	(3)	(4)
	U.S. dollar pegger		Trading rights	
	exit	entry	exit	entry
lnreer	-3.651***	4.628***	-3.411***	4.633***
	(-34.83)	(22.75)	(-7.100)	(40.86)
lntfp(-1)	-1.427***	5.765***	-0.658***	1.411***
	(-3.618)	(13.33)	(-3.096)	(3.766)
lnage	-0.0714***	0.0813***	-0.105***	0.0723***
	(-27.59)	(28.24)	(-87.32)	(20.88)
lnsize	-0.0991***	0.0191***	-0.0498***	0.0767***
	(-6.449)	(11.40)	(-62.09)	(6.342)
lnreer* lntfp(-1)	-0.294***	-1.272***	-0.152***	-0.377***
	(-3.368)	(-13.30)	(-3.227)	(-6.554)
peggers	0.0132	0.0290		
	(0.696)	(1.056)		
lnreer*peggers	-0.0191***	-0.0498***		
	(-11.40)	(-62.09)		
lnreer*year2005-06			0.00153***	-0.00102***
			(18.29)	(-26.31)
Ownership	YES	YES	YES	YES
location	YES	YES	YES	YES
Industry	YES	YES	YES	YES
Year	YES	YES	YES	YES
Observations	452,784	452,784	489,366	489,366
Log likelihood	-131324	-147743	-136644	-155487

Note: Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Marginal effects are reported in this table for the results of entry.

the markets of U.S. dollar peggers and firms who export to U.S. dollar peggers are less likely to exit in the period of RMB appreciation.

5.1.5 The liberalization of foreign trading rights

The foreign trading rights are restricted to Chinese state-trading enterprises before July 2004. Trading rights have been fully liberalized by the enforcement of The Revised Foreign Trade Law in July 2004 which provides for trading rights to be granted automatically through a registration process for all domestic and foreign enterprises and individuals. The liberalization of foreign trading rights would

undoubtedly stimulate a great number of firms to enter export markets and therefore lead to more intense export market competition as described in Table 2.

To capture the impact of foreign trading rights liberalization, the author includes the interaction term between exchange rate movements and the year dummy, which takes value one over the period 2005–2006, and zero otherwise. The results reported in Columns 3–4 of Table 9 show that firms are more likely to start their exports after the liberalization of foreign trading rights even in the period of exchange rate appreciation and firms are more likely to exit under such circumstance because of more intense competition.

5.2 Robustness checks

5.2.1 Alternative definition of export market dynamics

Our empirical results may be sensitive to the identification of export market exit, entry and survival. This paper therefore redefines export market exit, entry and survival by following the approach adopted by Goerg and Spaliara (2013) in Columns 1–2 of Table 10. Exiter is redefined as the firm exported in $t-1$ and $t-2$ but not in t. Entry is redefined as firm exported in $t-1$ and $t-2$ but not in t. Furthermore, owing to the higher possibility of exiting the export market during the first year as shown in Section 2, the author has also tried excluding the one-year observations (with duration =1) from the sample in Columns 3–4 of Table 10. As it can be seen from Columns 1–4, the results basically remain unchanged compared to the baseline analysis.

5.2.2 Alternative measures of productivity

Since productivity is an important determinant of export market survival as discovered by (Girma et al., 2004; Ilmakunnas and Nurmi, 2010; Askenazy et al., 2011), this study checks the robustness of our results by employing productivity estimated by solow residual in Columns 5–6 of Table 10 and measured by labor productivity in Columns 7–8 of Table 10 which is defined as added-value against the number of employees separately. I observe that the results are still in line with our previous findings in Section 4.

5.2.3 Alternative estimation approaches

The empirical results may suffer from the impropriate estimation method. In order to avoid potential biases related to this, this study adopts several alternative

Table 10: Robustness checks: Redefinition of dynamics and alternative productivity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Redefinition of dynamics		Without one-year		Solow residual		Labor productivity	
	exit	entry	exit	entry	exit	entry	exit	entry
lnreer	-3.492***	5.679***	3.532***	5.532***	-4.620***	5.651***	-3.628***	6.122***
	(-32.05)	(22.12)	(8.682)	(10.611)	(-34.30)	(34.83)	(-22.75)	(8.682)
lntfp(-1)	-1.422***	5.749***	-1.882***	2.812***	-1.243***	1.427***	-5.765***	4.882***
	(-3.586)	(13.24)	(-4.060)	(5.988)	(-3.113)	(3.618)	(-13.33)	(4.060)
lnage	-0.0657***	0.0742***	-0.0753***	0.1056***	-0.0689***	0.0714***	-0.0813***	0.0753***
	(-25.39)	(25.75)	(-61.66)	(6.77)	(-26.47)	(27.59)	(-28.24)	(61.66)
lnsize	-0.0249***	0.0738***	-0.329***	0.233***	-0.0247***	0.00991***	-0.0191***	0.329***
	(-10.55)	(28.74)	(-251.5)	(2.56)	(-10.44)	(6.449)	(-11.40)	(251.5)
lnreer* lntfp(-1)	-0.290***	-1.268***	-0.208***	-0.374***	-0.251***	-0.294***	1.272***	-0.208***
	(-3.305)	(-13.20)	(-4.300)	(-7.366)	(-2.840)	(-3.368)	(13.30)	(-4.300)
lnreer*private	0.0272***	0.0303***	-0.0239***	0.0391***	0.0181**	0.0132*	0.0290***	0.0239***
	(3.244)	(3.131)	(-4.879)	(8.820)	(2.299)	(1.696)	(3.256)	(4.879)
lnreer*age	-0.0257***	-0.0516***	-0.0300***	-0.0411***	-0.0320***	-0.0256***	-0.0556***	-0.0300***
	(-34.08)	(-6.577)	(-6.837)	(-7.542)	(-39.46)	(-33.91)	(7.091)	(-6.837)
lnreer*east	-0.0798***	-0.0423***	-0.0811***	-0.0165***	-0.795***	-0.0805***	-0.0395***	-0.0811***
	(-9.737)	(-4.695)	(-17.46)	(-20.38)	(-21.41)	(-9.831)	(-4.390)	(-17.46)
Ownership	YES	YES	YES	YES	YES	YES	YES	YES
location	YES	YES	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES	YES	YES	YES
Observations	402,903	402,903	402,903	402,903	402,903	402,903	402,903	402,903
Log likelihood	-136432	-144863	-116638	-145733	-115852	-144565	-115918	-146845

Note: Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Marginal effects are reported in this table for the results of entry.

estimation approaches including: (1) the Probit model, which estimates the odds ratio rather than hazard ratio, (2) the truncated regression model to address the concern of left truncation as I mentioned in Section 2. (3) the random-effects complementary log-log model, which allows for unobserved firm heterogeneity. Table 11 reports the estimation results of Probit regression model, truncated regression model and complementary log-log model with random effects separately. I again obtain consistent findings with baseline results.

Table 11: Robustness checks: alternative estimation approaches

	(1)	(2)	(3)	(4)	(5)	(6)
	Probit regression		Truncated regression		Random effects	
	exit	entry	exit	entry	exit	entry
lnreer	-5.182***	6.044***	-6.181***	7.134***	-5.411***	6.361***
	(34.28)	(20.77)	(23.12)	(23.25)	(7.100)	(125.3)
lntfp(-1)	-3.333***	3.521***	-3.68***	3.243***	-3.658***	4.415***
	(6.986)	(3.62)	(13.60)	(11.48)	(-3.096)	(-15.38)
lnage	-0.158***	0.190***	-0.184***	0.00244***	-0.105***	0.0687***
	(25.44)	(5.44)	(25.37)	(21.01)	(87.32)	(79.61)
lnsize	-0.0376***	0.124***	-0.152***	0.00333***	-0.0498***	0.227***
	(7.097)	(35.09)	(25.44)	(26.39)	(62.09)	(243.1)
lnreer* lntfp(-1)	-1.338***	-3.544***	-3.016***	-0.0539***	-0.152***	-0.548***
	(-6.693)	(-10.11)	(-13.59)	(-11.45)	(3.227)	(15.68)
lnreer*private	0.0321*	0.0366*	0.0351*	0.0381***	0.0180***	0.0389***
	(1.902)	(-1.781)	(-1.692)	(-8.335)	(4.025)	(-114.5)
lnreer*age	-0.0534***	-0.0133***	0.0127***	-3.34e-05***	-0.0103**	-0.0790***
	(-31.65)	(7.887)	(7.229)	(7.492)	(-2.387)	(-23.87)
lnreer*east	-0.0233***	-0.0654***	0.0701***	-0.0588***	-0.0740***	-0.0354***
	(12.87)	(5.346)	(3.369)	(12.47)	(16.21)	(101.2)
Ownership	YES	YES	YES	YES	YES	YES
location	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES	YES
Observations	402,903	402,903	402,903	402,903	402,903	402,903
Log likelihood or R^2	0.098	0.105	476860	649349	-144990	-116699

Note: Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Marginal effects are reported in this table for the results of entry.

6 Concluding Remarks

This study sheds light on the relationship between foreign exchange rate fluctuations and firms' export market dynamics using a firm-level production data from China National Bureau of Statistics and a firm-level trade data from China Customs over the period of 2000–2006. The author adopts a discrete-time survival model in our empirical investigation and further executes several extensions and robustness checks to the baseline results. The main results of the paper can be summarized as follows: First, an exchange rate appreciation increases the likelihood of export market exit, reduces the capability of export market survival and decreases the probability of export market entry. Second, high productivity firms are less likely to exit from export markets and more likely to enter and

survive in export markets in the period of exchange rate appreciation. Third, exchange rate appreciation decreases the likelihood of export market entering and increases the likelihood of export market exiting more for private-owned firms, young firms, ordinary trade firms and non-eastern firms. Finally, other sources of heterogeneity, such as extensive margins, import demand elasticity, different destinations, U.S. dollar peg, and the liberalization of trading rights also matter, but our results are robust to alternative redefinition of dynamics, alternative productivity measures and alternative estimation approaches.

This study gains some policy implications. First, exchange rate appreciation reduces the chance of entering export markets and increases the risk of failure in export markets, thus the government should do their best to avoid large exchange rate movements. Second, the entry and exit of high productivity firms are less affected by the exchange rate appreciation, thus exporters should increase their trade competitiveness by improving productivity. Finally, the effects of exchange rate movement on export market dynamics relate to other firm heterogeneity. The policies implemented by government should take these heterogeneous effects into account in order to improve their adaptability.

Acknowledgement The author thanks the National Nature Science Foundation of China (Grant NO: 71663003) for financial support.

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