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Productivity, Market Penetration and Allocation of Sales

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Productivity, Market Penetration and Allocation of Sales

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Abstract

This paper investigates how firm productivity is associated with the sales allocation of Chinese exporters. We demonstrate that highly productive firms are less export oriented compared with less productive ones. This negative correlation between firm productivity and export intensity among exporters remains robust when we control firm ownership, factor intensity, and rule out impacts of processing trade. In order to rationalize our empirical findings, we extend the Arkolakis (2010) model to allow marketing cost elasticities to be heterogeneous across markets. A higher marketing cost elasticity domestically gives rise to a faster sales expansion in the home market as firm productivity grows. The fact that this negative correlation is more pronounced among firms who belong to advertising intensive industries supports the model predictions. Further evidence helps to rule out alternative explanations such as the effects of variable markup and product quality.

Keywords: Productivity; Marketing Cost; Export Intensity; Market Competition

JEL Classification: F14, F23

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1 Introduction

Trade literature has long been focusing on the difference between exporters and non-exporters. There is an ongoing debate over the causal relationship between firm performance and export status. Previous studies address this issues from a variety of perspectives emphasizing fixed costs of export, factor intensity, ownership, features of processing trade, and with the help of field experiment (see Melitz, 2003; Dai, Maitra and Yu, 2016; Defever and Riaño, 2017; Lu, Lu and Tao, 2010; Lu, 2010; Atkin, Khandelwal and Osman, 2017). However, little has been done regarding the relationship between firm productivity and how much firms export relative to sales in the domestic market. Based on information about Chinese exporters, this paper provides new evidence on how firm productivity is associated with the allocation of sales between foreign and domestic market.

The empirical phenomenon documented in this research is rather surprising: The export to domestic sales ratio of Chinese firms is decreasing in firm productivity. This negative correlation between firm productivity and export intensity remains strong when we control firm ownership, factor intensity, and rule out impacts of processing trade. According to the standard Melitz (2003) model, conditional on market entry, sales are proportional to firm productivity. High productivity firms are associated with high export intensity due to the large number of markets they enter. Arkolakis (2010) and Eaton et al. (2011) build a slightly different model with market penetration technology instead of fixed cost of entry and predicts that firm productivity is positively correlated with relative sales in the foreign market.

To rationalize our empirical findings, we extend the Arkolakis (2010) model to allow for heterogeneous marketing cost elasticities across countries. In this model, firms must incur marketing costs to reach consumers. The returns to marketing is decreasing and the marketing cost elasticity governs the speed of deterioration.[1] The model links firm

[1]This model is a generalization of Melitz (2003) model where the later assumes firms either enter the market and sell to all consumers or stay out completely.

productivity and sales through two margins. The intensive margin, sales to existing consumers, increases proportionally across markets as firm productivity grows. The extensive margin, the number of consumers reached, is governed by the interaction of the marketing elasticity and firm productivity. In markets where the elasticity is small, firms are able to easily approach consumers, making the role of productivity minimal. On the contrary, when the market is difficult to penetrate and the marketing cost elasticity is high, productive firms have an advantage in reaching consumers. When the marketing cost elasticity is higher in China than abroad, productive firms have a relative advantage in selling to domestic consumers resulting in a negative correlation between firm productivity and the foreign-domestic sales ratio.

We conduct an exercise to support our market penetration explanation of the negative relationship between firm productivity and export intensity. Specifically, we hypothesize that if an industry relies more on marketing, the negative correlation between firm productivity and export sales ratio should be more pronounced. We use advertisement expenditures over sales of the industry to capture the relative importance of marketing. The interaction term between firm productivity and advertising intensity is negative and significant in the export sales regressions which supports our marketing story.

Finally, we compile evidence contradicting alternative explanations for a negative relationship between export intensities and firm productivity. The first explanation is based on Melitz and Ottaviano (2008) where markups are determined by the interaction between firm productivity and market size. More efficient firms charge higher markups but this is weakened in large markets due to increased competition. If the Chinese market is larger than the foreign market, the model predicts that export intensities and the ratio of home to foreign prices will decrease with firm productivity. In contrast, our model predicts declining export intensities but constant markups. Using Hong Kong as a close substitute to the Chinese market, we examine export-to-domestic price ratios and find evidence in favor of our model. The other alternative explanation concerns the quality of products. Manova and Zhang

(2012) find that firms vary in terms of the quality of their products across destinations due to different inputs quality levels. They also predict that markups are heterogeneous across firms. If this were true, then the price ratio between two export destinations should be correlated with firm productivity which is not supported by our empirical results.

This paper is related to the growing literature about consumer accumulation. Previous literature studying firm behaviors often assumes that productivity is negatively correlated with marginal cost of production and lower marginal cost allows firms to charge lower prices which lead to larger demand (e.g., Melitz, 2003). Evidence from recent studies about firm dynamics suggests that demand is not deterministic of price (e.g., Berman et al., 2015; Foster et al., 2016). For example, Fitzgerald et al. (2016) finds that sales growth conditional on survival mainly comes from quantity expansions and Berman et al. (2015) shows the importance of demand learning in firm dynamics. However, very few studies examine the non-price effects on cross-sectional comparisons of sales. This paper relates firm productivity to sales variations across markets and supports non-price effects, such as marketing efforts, on sales.

This paper also contributes to the literature about exporting performance of Chinese firms. Lu et al. (2010) find that, among foreign affiliates, exporters are less productive than non-exporters in China. They argue that the fixed cost for foreign affiliates in foreign markets is lower than that in the Chinese market. Dai et al. (2016) argue that the low productivity of exporting firms is entirely driven by firms that engage only in export processing—the activity of assembling tariff-exempted imported inputs into final goods for resale in foreign markets. These firms are less productive than non-exporters and cause a decrease in the average productivity across all exporting firms. Lu (2010) uses factor intensity to explain the productivity difference between exporting firms and non-exporting firms. When countries differ in their factor endowment, sectors that are intensive in the locally abundant factor face higher competition in the domestic market than in foreign markets. Since China has a huge labor supply, domestic rather than foreign markets select the most efficient firms in labor-intensive industries. None of these papers study the sales allocation among exporters and none of the special features of Chinese firms discussed above could explain the puzzling negative correlation between firm productivity and sales ratio illustrated in this paper.

The rest of this paper is organized as follows. In Section 2, we introduce the two main datasets used in this paper, presents the stylized facts as well as the empirical specifications about firm productivity and sales ratio. In Section 3, we develop a theoretical model with heterogeneous marketing cost elasticities to rationalize the empirical findings. In Section 4, we provide evidence based on the importance of marketing across industries and check alternative explanations. The last section concludes this paper.

2 Data and stylized facts of sales allocation

In this section, we first introduce the databases used in this research and describe the distribution of export intensity (i.e., exports over total sales) by ownership for Chinese exporters. Next, we depict the correlation between firm productivity and export intensity with various controls. In order to make the empirical results directly comparable with model predictions, we move from export intensity to export-domestic sales ratio and include destination-specific controls.

2.1 Data and summary statistics

In this paper we combine two databases over the 2000-2006 period: The firm-level production data from Chinese Industrial Enterprises Database (henceforth Firm Survey) and the transaction-level trade data from Chinese Customs Export and Import Database (henceforth Custom Record).

The first database is collected by China's National Bureau of Statistics. It includes all state-owned enterprises (SOEs) and non-SOEs with annual sales above 5 million Chinese Yuan (about 0.6 million US dollars[2]). The Firm Survey contains firm balance sheet

[2]The US Dollar to Chinese Yuan exchange rate during 2000-2006 was around 8.27.

information such as sales, employment, assets, intermediary inputs, export sales, and etc. Only manufacturing firms with positive value-added, capital and sales remain in our sample. We also drop small firms with five or fewer employees or firms without valid postal codes. The number of firms in our sample ranges from 134,775 in 2000 to 258,586 in 2006. Table 1 shows that around 30% of manufacturers included in our sample are exporters. Firms with foreign capital participation (i.e., joint ventures and foreign-owned enterprises) are more likely to export although they account for only 22% of all firms. These patterns are in line with a number of papers (e.g., Dai et al., 2016; Lu et al., 2010).

Table 1: Share of exporters by year or ownership

	Number of Firms	**Share of Exporters**
Panel A: by Year		
2000	134,775	26.52%
2001	143,931	27.10%
2002	155,005	28.05%
2003	173,114	28.67%
2004	231,249	31.18%
2005	231,623	30.87%
2006	258,586	29.19%
Panel B: by Ownership		
State-owned enterprises	523,540	18.21%
Private-owned enterprises	517,403	20.99%
Joint ventures	146,129	56.40%
Foreign-owned enterprises	141,211	71.23%
All Firms	1,328,283	29.13%

Notes: This table summarizes the composition of firms and their export behavior in Firm Survey Database. Only manufacturing firms with positive value-added, capital and sales remain in our sample. We also drop small firms with less than six employees or firms without valid postal codes. Foreign-owned enterprises and joint ventures categories include investors from Hong Kong, Macao, Taiwan and other foreign countries and regions.

In the second database, constructed by the Chinese Customs Office, trade transaction data are collected for each 8-digit harmonized system (HS) product. It provides detailed information on trade status (import or export), product quantity, trade value, origin and destination of each transaction, trade mode (ordinary or processing trade), firm associated with each transaction, firm location, and etc.

While both databases contain firm identification numbers they follow different construction rules. Therefore, we follow the matching algorithm proposed by Wang and Yu (2012) and use firm name, telephone number, name of the manager, and postal code to match firms by orthography. After merging the two databases we obtain $177,396$ firms, which accounts for 45.85% of self-reporting exporters[3], and whose export sales comprise 54.54% of total self-reporting export value.

Export intensity is defined as export divided by total sales. Table 2 shows that the distribution of export intensity is polarized. About 16% of exporters sell less than 10% of their output abroad and over 41% of exporters have an export intensity over 0.9. Over half of the wholly foreign-owned enterprises (WFOEs) and joint ventures (JVs) export 90% of their output. Domestic firms export less intensively compared with WFOEs and JVs. But there are still more than 30% of them shipping the majority of their products to foreign markets. This phenomenon is in stark contrast to the observation in Bernard et al. (2003), who find that around two-thirds of US exporters sell less than 10% of their output abroad.

2.2 Firm productivity and export intensity

We use two ways to measure firm productivity: value-added per worker and TFP constructed following the method in Levinsohn and Petrin (2003).[4]

In order to show the correlation between firm productivity and export intensity, we first rank exporters by their productivity and divide them into 100 percentiles. Then, we calculate the average export intensity for each productivity percentile with 95% confidence intervals. Figure 1 presents a negative correlation between firm productivity and export intensity.[5] In this paper, we do not examine the relationship between firm productivity and their export

[3] Bai et al. (2017) pointed out that many firms export through trade intermediaries and that is why we observe positive export values from Firm Survey but could not trace them in the Custom Record.

[4] In Appendix B, we discuss these two measurements of productivity and Figure A1 shows that these two measurements are correlated with a coefficient of 0.76.

[5] In Appendix C we discuss the slightly hump-shaped correlation more carefully.

Table 2: Distribution of export intensity by ownership

Export Intensity	Full Sample	Domestic	WFOE/JV
(0, 0.1]	16.34%	21.92%	10.13%
(0.1, 0.2]	7.48%	9.29%	5.46%
(0.2, 0.3]	5.26%	6.02%	4.42%
(0.3, 0.4]	4.63%	5.23%	3.96%
(0.4, 0.5]	4.38%	4.76%	3.95%
(0.5, 0.6]	4.29%	4.49%	4.08%
(0.6, 0.7]	4.48%	4.50%	4.46%
(0.7, 0.8]	5.14%	4.95%	5.36%
(0.8, 0.9]	6.55%	6.10%	7.04%
(0.9, 1]	41.44%	32.75%	51.13%

Notes: This table shows the distribution of export intensity by ownership for Chinese exporters. Only manufacturing firms with positive value-added, capital and sales remain in our sample. We also drop small firms with less than six employees or firms without valid postal codes. Foreign-owned enterprises and joint ventures categories include investors from Hong Kong, Macao, Taiwan and other foreign countries and regions.

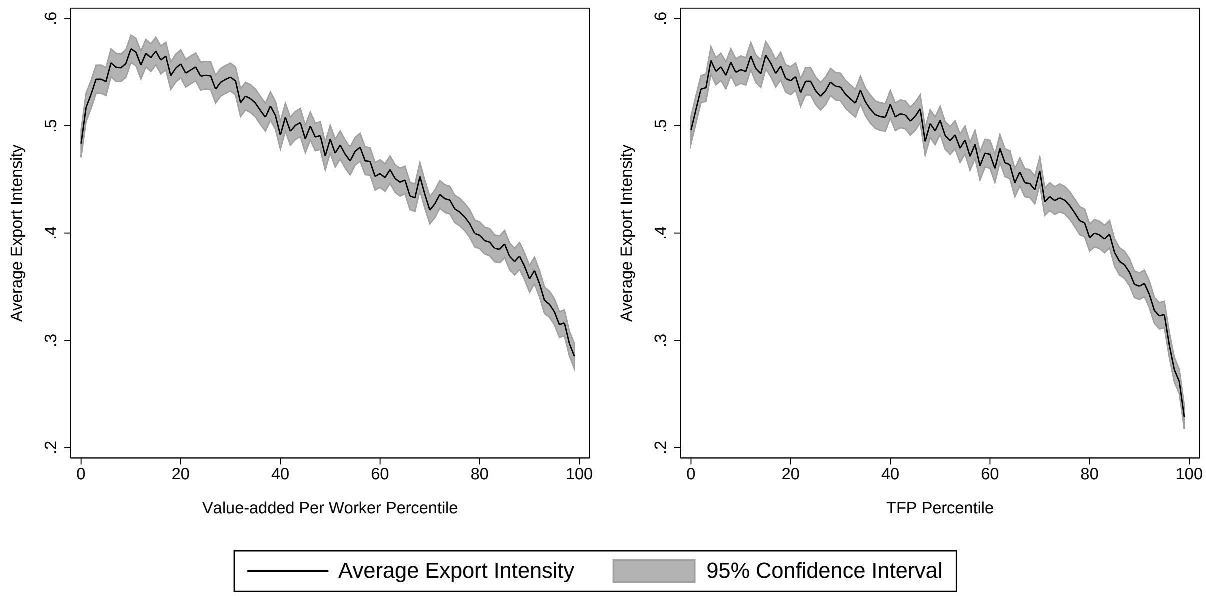
status. Instead, we emphasize the effect of firm productivity on sales allocation between domestic and foreign markets given that a firm has already entered the foreign market(s). Thus, we drop all non-exporting firms and pure exporters (i.e., firms that export all of their output)[6].

The correlation between firm productivity and export intensity is further examined with industry, ownership, and export mode controls respectively in order to check the robustness of the pattern and rule out confounding factors.

First, we investigate the correlation industry by industry to control the effect of factor intensity as a lurking variable. It is well known that China's exports mainly come from labor intensive industries such as the manufacture of textile and electric machines. These labor intensive industries take advantage of China's cheap labor forces without much upgrade in production technology and usually consists of low productivity firms. Lu (2010) argues

[6]There are 111,052 firms that are pure exporters. 14% of them are SOEs, 26% are private-owned, 21% are JVs and 39% are WFOEs. Defever and Riaño (2017) argue that the exporting behavior of pure exporters is different from that of regular exporting firms due to tax subsidies.

Figure 1: Average export intensity and productivity percentile



Notes: This figure shows the correlation between firm productivity and export intensity. We exclude non-exporters and pure exporters (i.e., firms that export all of their outputs). We first rank firms by their productivity and divide them into 100 percentiles. Then, we calculate the average export intensity with 95% CIs for each productivity percentile. The x-axis is the productivity percentile and the y-axis is the average export intensity within the corresponding percentile.

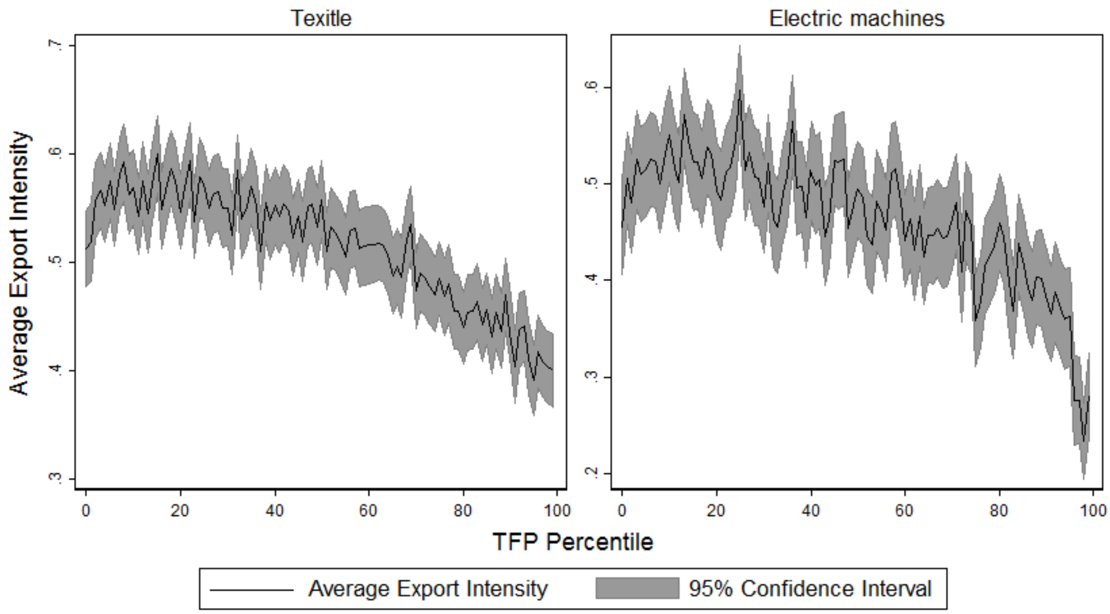
that capital-labor intensity differences across industries affect the correlation between firm productivity and export status. Figure 2 demonstrates that even within the Manufacture of textile, higher productive firms have on average lower export intensity.[7]

Second, processing trade might be another lurking variable that dominates the negative correlation between productivity and export intensity. Table 3 reveals that over half of the Chinese exporters are engaged in processing trade and they export the majority of their output[8]. Firms participating in processing trade are even less productive than non-exporters (Dai et al., 2016). Therefore, the large number of low productivity firms with assembling activities could potentially drive down the overall productivity of exporters who sell more

[7]Exporters from the Manufacture of textile and Manufacture of electric machines and equipments industries account for about 40% of China's total export values during 2000-2006 period. Figures showing the correlations for a full set of 2-digit industries as well as a list of complete industry names are presented in the Appendix D.

[8]This is one reason why export intensity of Chinese firms are unexpectedly high compared with that of US firms.

Figure 2: Average export intensity and TFP percentile (Textile vs Electric machines)



Notes: This figure shows the correlation between the average export intensity and productivity (TFP) percentile for two industries: The Manufacture of textile and Manufacture of electric machines and equipments. We only include firms that sell both in the domestic market and foreign markets.

abroad. In order to exclude this effect, we drop all firms engaged in processing trade and present the result in Figure 3. The robust negative correlation between firm productivity and export intensity demonstrates that trade mode (or processing trade) does not explain the negative pattern.

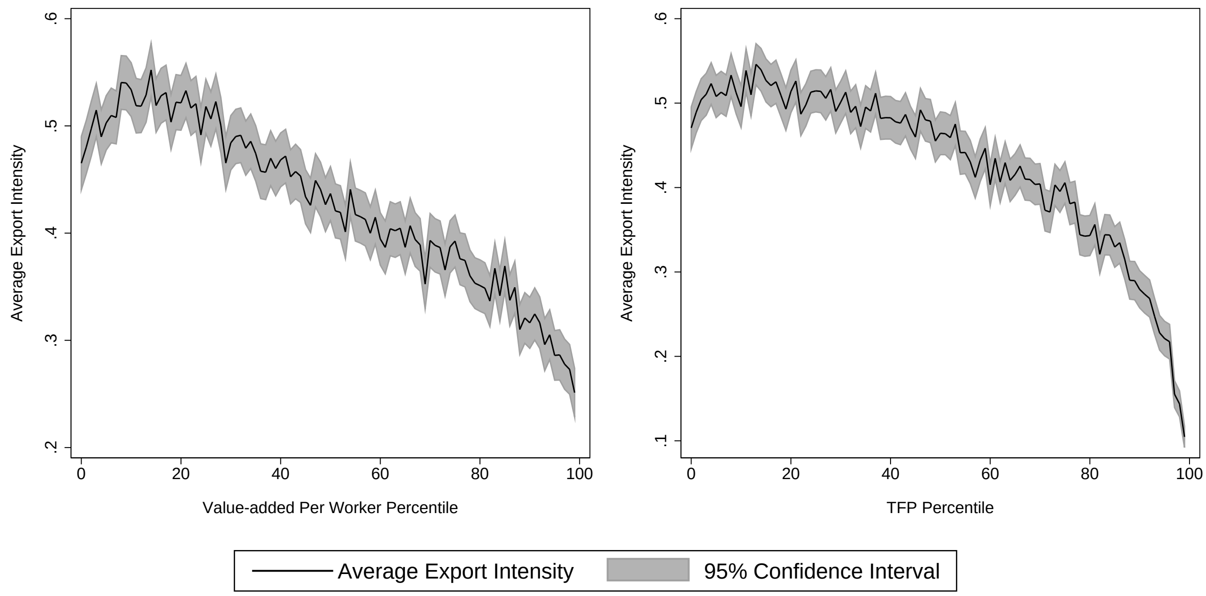
Table 3: Trade mode: ordinary vs processing

	Firm Number	Percent
By Trade Mode:		
Ordinary Trade	85,503	48.20%
Processing Trade	91,893	51.80%
All	177,396	100%

Notes: This table summarizes the merged data. Only manufacturing firms are included. We drop firms whose value-added, capital, sales and export values are negative or zero. We also drop small firms with five or fewer employees or without valid postal codes.

Third, we investigate whether firm ownership has an impact on the relationship between

Figure 3: Export intensity and productivity (excluding processing trade)

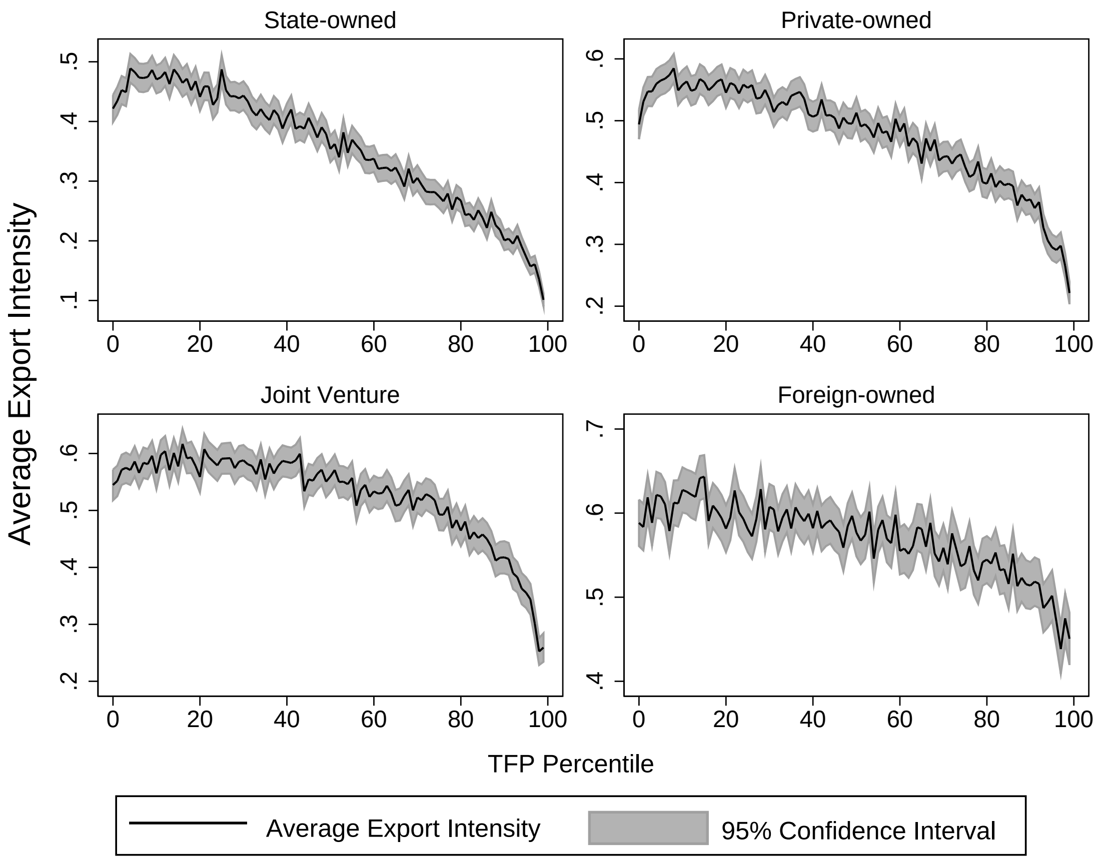


Notes: This figure shows the correlation between the average export intensity and productivity percentile excluding processing trade. We only include firms that sell both in domestic and foreign market.

productivity and export intensity. Table 2 shows that foreign invested firms (i.e., WFOEs and JVs) exhibits higher export intensity than domestic firms probably due to preferential tax credits and export subsidies (Defever and Riaño, 2017). Lu et al. (2010) argue that among foreign affiliates in China exporters are less productive than non-exporters. Whether more intensive exporters are of lower productivity is largely unexamined either within certain ownership or in general. We address the impact of firm ownership by showing the correlation of firm productivity and export intensity by four ownership groups in Figure 4. The negative correlation holds for each ownership type.

Above all, we have demonstrated that export intensity is negatively correlated with firm productivity among exporters from China. This pattern remains robust when we consider factor intensity, exclude processing trade, and control firm ownership.

Figure 4: Average export intensity and TFP percentile by ownership



Notes: This figure shows the correlation between the average export intensity and productivity (TFP) percentile by ownership. We only include firms that sell both in the domestic market and foreign markets. Foreign-owned enterprises or joint ventures include owners from Hong Kong, Macao, Taiwan and other foreign countries and regions.

2.3 Firm productivity and sales ratio (firm level)

We replace export intensity with sales ratio between foreign and domestic market mainly because the sales ratio is directly comparable with our model predictions described in Section 3. Since the total sales of a firm is the sum of export and domestic sales, the two measures (i.e., export over total sales and export over domestic sales) are positively correlated. The negative correlation between firm productivity and sales ratio does not depend on which measure we use. Separating export from total sales in the denominator also allows us to examine the relative sales allocation of firms market by market.[9]

The benchmark regression at the firm level is based on the following specification:

$$\ln(Y_{it}) = \alpha_0 + \alpha_1 \ln(\phi_{it}) + \mathrm{X}_{it} + \mathrm{FE}_{jkt} + \epsilon_{ijkt}, \tag{1}$$

where Y_{it} stands for foreign/domestic sales ratio of firm i in year t. ϕ_{it} indicates firm productivity measured by value added per worker as well as TFP. X_{it} includes a variety of control variables such as firm size, capital/labor ratio, and firm ownership. We add province-industry-year fixed effect FE_{jkt} to capture the unobserved trends of macro economic conditions. ϵ_{ijkt} is the idiosyncratic error.

The regression results are presented in Table 4.[10] Firm productivity, in terms of either value-added per worker (in the upper panel) or TFP (in the bottom panel), is shown to be negatively correlated with the sales allocation between foreign and domestic market. Specifically, a 10% increase in firm TFP leads to a 2.66% decrease in the foreign/domestic sales ratio conditional on total sales. In other words, when the productivity of a firm becomes higher, it sells relatively more in the domestic market. The negative coefficients for capital-labor ratio indicate that labor intensive firms export more than selling in the domestic market. This finding is consistent with the fact that China has comparative advantages in exporting labor-intensive products.

In order to eliminate the effect of low productivity assemblers who mainly engage in exporting, we drop all firms participating in processing trade.[11] The first column of Table 5 shows the regressions results without processing firms. Although slightly smaller in scale,

[9]The issue of measurement error may arise if total sales, which is used to construct revenue TFP and appears in the denominator of export intensity, includes an error term. Using value-add to construct TFP and replace total sales with domestic sales in the denominator of the dependent variable help alleviate the problem. The sample of firms does not change when we replace export intensity with sales ratio since we only take firms who enter both the domestic and foreign market into consideration.

[10]In Appendix B, we include Table A1 to show that export sales increase with firm productivity. There is no irrationality with the Chinese firm export data.

[11]Besides firms doing processing trade, another reason for the decreasing number of observations comes from the merging of two databases (i.e., the Firm Survey and Customs Records) which is required in order to identify the assemblers.

Table 4: Firm productivity and sales ratio (export/domestic)

	Dependent Variable: ln(Export/Domestic Sales)			
	(1)	(2)	(3)	(4)
ln(Labor Productivity)	-0.202***	-0.143***	-0.168***	-0.155***
	(0.017)	(0.014)	(0.014)	(0.018)
ln(Capital/Labor Ratio)		-0.133***	-0.173***	-0.169***
		(0.017)	(0.017)	(0.015)
ln(Sale)				-0.024
				(0.027)
Constant	0.612***	0.857***	0.598***	0.799***
	(0.065)	(0.084)	(0.086)	(0.274)
Ownership FE			✓	✓
Province-Industry-Year FE	✓	✓	✓	✓
Cluster By Industry	✓	✓	✓	✓
Observations	275,872	275,872	275,872	275,872
R-squared	0.348	0.351	0.368	0.369
	Dependent Variable: ln(Export/Domestic Sales)			
	(1)	(2)	(3)	(4)
ln(TFP)	-0.170***	-0.143***	-0.146***	**-0.266*****
	(0.021)	(0.019)	(0.018)	(0.023)
ln(Capital/Labor Ratio)		-0.153***	-0.201***	-0.222***
		(0.016)	(0.017)	(0.016)
ln(Sale)				0.130***
				(0.037)
Constant	1.002***	1.359***	1.086***	0.609**
	(0.142)	(0.161)	(0.163)	(0.279)
Ownership FE			✓	✓
Province-Industry-Year FE	✓	✓	✓	✓
Cluster By Industry	✓	✓	✓	✓
Observations	275,872	275,872	275,872	275,872
R-squared	0.348	0.351	0.369	0.369

Notes: This table shows the correlation between export/domestic sales ratio and productivity at the firm level.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

the coefficient of firm productivity remain to be negative. Next, we examine the impact of firm ownership on the negative correlation between productivity and sales allocation. Firm ownership dummy, *Domestic* equals to 1 if the firm is state-owned or private-owned and 0 otherwise, as well as its interaction with productivity are included in the regression. The second column of Table 5 shows that high productivity firms are associated with lower exports relative to sales in the domestic market, and this effect is more pronounced among domestically owned firms. Coefficients presented in Table 5 are based on the TFP productivity measure. Regression results with value-added per worker are similar and can be found in Appendix B.

Table 5: Firm productivity and sales ratio (robustness)

	Dependent Var.: ln(Foreign/Domestic)		
	(1)	(2)	(3)
ln(TFP)	-0.235***	-0.191***	-0.354***
	(0.032)	(0.025)	(0.040)
ln(TFP)× Domestic		-0.160***	
		(0.038)	
ln(TFP)× Homogeneous			0.018
			(0.032)
Homogeneous Dummy			-0.031
			(0.234)
ln(Capital/Labor Ratio)	-0.260***	-0.225***	-0.229***
	(0.023)	(0.015)	(0.030)
ln(Sale)	-0.049	0.140***	0.254***
	(0.038)	(0.037)	(0.049)
Constant	2.440***	1.100***	0.242
	(0.300)	(0.239)	(0.401)
Ownership FE	✓	✓	✓
Province-Industry-Year FE	✓	✓	✓
Cluster By Industry	✓	✓	✓
Exclude Processing Trade	✓		
Observations	69,691	275,872	80,147
R-squared	0.474	0.370	0.420

Notes: This table shows the correlation between foreign/domestic sales ratio and productivity (TFP) at the firm level.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

We suspect that the sales allocation across markets may be associated with features of product variety offered by different firms.[12] A natural candidate of product feature is the elasticity of substitution. We borrow the elasticity of substitution estimates from Soderbery (2015) to construct the elasticities at the firm level.[13] Specifically, the firm level elasticity of substitution σ_i is defined as the average of σ_{in} weighted by the export share of each product n.

$$\sigma_i = \sum_n \frac{\text{Export value of product } n}{\text{Total export value of firm } i} \times \sigma_{in}$$

The higher the weighted elasticity, the lower the degree of differentiation. Firms are divided into two groups based on σ_i: homogeneous and differentiated goods exporters. We created a dummy variable *homogeneous* which equals 1 if σ_i is larger than the median. We include *homogeneous* and its interaction with firm productivity into Equation 1.

The results are shown in the last column of Table 5. The coefficient on firm productivity becomes smaller when product differentiation variables are included. The interaction term is positive but not significant to suggest any differential effect of homogeneous products.

2.4 Firm productivity and sales ratio (firm-destination level)

We further investigate the negative correlation between firm productivity and sales ratio within each destination country. Firms of different productivity may export to different markets. High productivity firms might be more prone to enter high income countries with fewer sales while low productivity firms export a lot in low income markets. The composition of destination countries may contribute to the negative relationship based on the total export of firms.

To control the influence of destination variations, we construct the sales ratio, Y_{ibt}, for

[12]Note that domestic sales at the product level is not available and only products being exported can be observed.

[13]Soderbery (2015) uses the US trade data and estimates the elasticity of substitution for import goods at the HS8 level.

each destination market b as follows

$$Y_{ibt} = \frac{\text{sales in country } b}{\text{domestic sales}},$$

and include the province-industry-country-year fixed effect, FE_{jkbt}, into the specification.

$$\ln(Y_{ibt}) = \alpha_0 + \alpha_1 \ln(\phi_{it}) + \text{X}_{it} + \text{FE}_{jkbt} + \epsilon_{ijkbt} \tag{2}$$

The number of destination markets at the firm level is also added as a control variable.

The first column of Table 6 shows that the correlation between firm productivity and foreign-domestic sales ratio remains to be negative when destination country fixed effects are taken into consideration. In particular, a 10% increase in firm TFP leads to a 1.15% drop in the relative sales between foreign and domestic market. The number of countries firms enter does not affect the relative sales.

To check the robustness of the result, we further divide destinations into high income (OECD) countries and Less Developed Countries (LDCs). The last two columns of Table 6 show that coefficients on firm TFP only change slightly at the third decimal with different country groups. In addition, we run regressions for the top ten export destinations separately and present the results in Table A10 of Appendix E.[14]

3 A model with heterogeneous marketing cost elasticities

In this section, we extend the Arkolakis (2010) model and allow marketing cost elasticity, how much the marginal cost of marketing increases with the number of consumers reached, to

[14] Crinò and Epifani (2012), using data of Italian exporters, examine the relationship between firm productivity and export share to high-income countries from a different perspective. The dependent variable in their paper is the share of export to OECD countries at the firm level and it captures the relative importance (or attractiveness) of high-income countries. They focus on the export sales allocation among different type of countries while we focus on the sales allocation between foreign and domestic market controlling the type of destination countries.

Table 6: Firm productivity and sales ratio: firm-destination level

	Dept Var.: ln(Foreign $_b$/Domestic)		
	All	OECD	LDC
ln(TFP)	-0.115**	-0.117***	-0.112*
	(0.045)	(0.0438)	(0.0594)
ln(Capital/Labor Ratio)	-0.205***	-0.211***	-0.194***
	(0.032)	(0.0317)	(0.0379)
ln(Sale)	-0.430***	-0.397***	-0.484***
	(0.048)	(0.0437)	(0.0669)
ln(No. of markets)	-0.033	-0.0860	0.0656
	(0.054)	(0.0538)	(0.0590)
Constant	2.587***	2.593***	2.624***
	(0.385)	(0.357)	(0.512)
Ownership FE	✓	✓	✓
Country-Province-Industry-Year FE	✓	✓	✓
Cluster By Industry	✓	✓	✓
Exclude Processing Trade	✓	✓	✓
Observations	560,850	305,163	255,687
R-squared	0.650	0.610	0.694

Notes: This table shows the correlation between foreign/domestic sales ratio and productivity at the firm-destination level.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

be heterogeneous across destination countries. The model links firm productivity and sales by two margins. The intensive margin, sales to existing consumers, grows proportionally across markets as firm productivity increases. The impact of productivity on the difference in extensive margins, number of consumers reached, is small when the market is easy to penetrate while large if it is difficult to expand the consumer base. We begin with a description of the marketing cost and model setup. Then we derive how marketing cost elasticities enter the sales ratio and how the ratio relates to firm productivity.

3.1 Marketing cost

Following Arkolakis (2010), firms must incur marketing costs (e.g., sending out advertisements) to reach consumers in country b. $n_b \in [0,1]$ captures the the fraction of consumers (in a market of size L_b) a firm aims to reach. The amount of labor required to reach these consumers becomes

$$f(n_b, L_b) = \begin{cases} L_b^{\lambda} \cdot \frac{1-(1-n_b)^{1-\kappa_b}}{1-\kappa_b}, & if \quad \kappa_b \in [0,1) \cup (1,+\infty) \\ -L_b^{\lambda} \cdot \ln(1-n_b), & if \quad \kappa_b = 1 \end{cases} \tag{3}$$

There are two parameters governing the cost of marketing. First, $\lambda \in [0,1]$ captures the coverage of the marketing technology. When the coverage is narrow ($\lambda = 1$), each advertisement only reaches one consumer, total marketing cost $f(n_b, L_b)$ increases with the market size L_b. When the coverage is wide enough to include all consumers in a country ($\lambda = 0$), total marketing cost becomes independent of market size.

The other parameter $\kappa_b \in [0, +\infty)$, the marketing cost elasticity, measures the degree of decreasing returns to marketing. That is, within a market, the cost per consumer increases as the number of consumers already reached grows. A larger κ_b corresponds to a faster cost increase with respect to the size of consumer base. When $\kappa_b > 0$, no firm can saturate the market due to the surge of marketing cost for every additional consumer. When $\kappa_b = 0$, the marketing cost structure degenerates to the case in Melitz (2003) where firm either enters the market and sell to all consumers there ($n_b = 1$) or stays out ($n_b = 0$). Arkolakis (2010) assumes κ_b to be homogeneous while we allow it to vary across countries.[15]

3.2 Consumer demand

A representative consumer in country b consumes a set of differentiated goods combined by CES utility with elasticity $\sigma > 1$ from country a. The goods are offered by a continuum of firms with heterogeneous productivity ϕ. Each firm is small and cannot affect the price index. The fraction of consumers in country b reached by a firm of type ϕ from country a is

[15] We assume κ_b to be country-specific meaning that firms face the same level of difficulty in terms of market penetration in country b no matter where they come from. This parameter can be further relaxed to be pair-specific if US firms find it easier to accumulate consumers in Canada than exporters from China. Since we only have data on Chinese exporters, we make κ_b country-specific for notation simplicity.

$n_{ab}(\phi)$. Then, the demand in b for commodity provided by firm ϕ in country a becomes

$$q_{ab}(\phi) = n_{ab}(\phi) L_b \frac{p_{ab}(\phi)^{-\sigma}}{P_b^{1-\sigma}} y_b \ , \qquad \sigma > 1 \tag{4}$$

where $p_{ab}(\phi)$ is the price charged by the firm, P_b indicates the price index, and y_b is the total income in country b which consists of wage level w_b and aggregate profit of domestic firms π_b.

3.3 Firm problem

The production technology used by firms is constant returns to scale and labor is the only factor of input. In order to produce q units of products, a firm has to hire $\frac{q}{\phi}$ units of domestic labor. Suppose the wage in country a is w_a. The production cost for a firm with productivity ϕ in country a to produce q units of a product is

$$C(\phi, q) = \frac{w_a q}{\phi} \tag{5}$$

We assume the iceberg transportation cost between country a and country b is $\tau_{ab} > 1$ and $\tau_{aa} = 1$.

Given the structure of marketing cost (3), consumer demand (4), and production technology (5), the profit of a country a firm selling in country b, is

$$\pi(p_{ab}, n_{ab}; \phi) = n_{ab} L_b y_b \frac{p_{ab}^{1-\sigma}}{P_b^{1-\sigma}} - n_{ab} L_b y_b \frac{p_{ab}^{-\sigma} \tau_{ab} w_a}{P_b^{1-\sigma} \phi} - L_b^{\lambda} \frac{1 - (1 - n_{ab})^{1-\kappa_b}}{1 - \kappa_b} \tag{6}$$

Given productivity ϕ, firms choose the optimal price p_{ab} and advertising intensity n_{ab} that maximize their profits (6). Then, we we have

$$p_{ab}(\phi) = \tilde{\sigma} \frac{\tau_{ab} w_a}{\phi} \ , \quad \text{where} \ \ \tilde{\sigma} = \frac{\sigma}{\sigma - 1} \tag{7}$$

$$n_{ab}(\phi) = \max\{1 - (\frac{\phi^*_{ab}}{\phi})^{\frac{\sigma-1}{\kappa_b}}, 0\} \ , \quad \text{where} \quad (\phi^*_{ab})^{\sigma-1} = \frac{L_b^{\lambda-1}}{\frac{y_b}{\sigma}\frac{(\tilde{\sigma}\tau_{ab}w_a)^{1-\sigma}}{P_b^{1-\sigma}}} \tag{8}$$

ϕ^*_{ab} is the threshold productivity for firms in country a export to country b, which is not affected by the elasticity of marketing cost κ_b. Equation 8 indicates that firms of higher productivity reach more consumers than less efficient ones (i.e., the extensive margin effect), especially in difficult markets and when consumer base is already sizable.

Simulation results shown in Figure 5 provides a simple illustration for the effect of κ_b. The marketing cost elasticity is assumed to be higher in the domestic country c, $\kappa_c > \kappa_b$.[16] When κ is relatively low, as in foreign country b, firms selling there could quickly reach the majority of consumers even with relatively low productivity. The more efficient firms do not exhibit any advantage along this margin. On the contrary, when κ is high, as in the domestic market c, the consumer accumulation process becomes steady and the extensive margin growth is reliant on firm productivity.

Suppose the distribution of firm productivity is Pareto, with probability density function $g(\phi)$ and cumulative density function $G(\phi)$, as follows:

$$g(\phi) = \theta\frac{(\phi^*)^\theta}{\phi^{\theta+1}} \ , \qquad \theta > \sigma - 1$$

$$G(\phi) = 1 - \frac{(\phi^*)^\theta}{\phi^\theta} \ , \qquad \phi \in [\phi^*, +\infty)$$

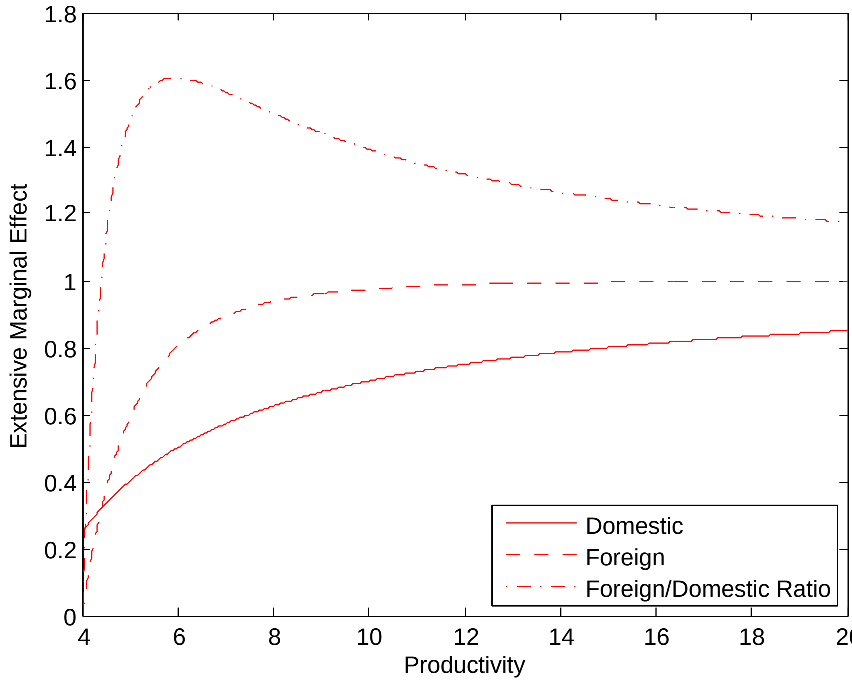
where θ is the scale parameter of Pareto distribution and satisfies $\theta > \sigma - 1$. Thus, the conditional distribution of the productivity of firms from country a exporting to country b is

$$\mu(\phi) = \begin{cases} \theta\frac{(\phi^*_{ab})^\theta}{\phi^{\theta+1}} \ , & \textit{if} \quad \phi \geq \phi^*_{ab} \\ 0 \ , & \textit{otherwise} \end{cases} \tag{9}$$

Based on (4), (7) and (8), the export sales of a country a firm (with productivity ϕ) in

[16] The parameters used in this simulation are the following: $\phi^*_{cc} = 3$, $\phi^*_{cb} = 4$, $\frac{\sigma-1}{\kappa_c} = 1$ and $\frac{\sigma-1}{\kappa_b} = 4$.

Figure 5: Productivity and extensive margin effect $n(\phi)$



Notes: This figure shows the simulation results under some given parameters. The extensive margin effects are $1-(\frac{\phi^*_{cb}}{\phi})^{\frac{\sigma-1}{\kappa_b}}$ and $1-(\frac{\phi^*_{cc}}{\phi})^{\frac{\sigma-1}{\kappa_c}}$ as shown in (8). In this simulation, we assume $\phi^*_{cc}=3$, $\phi^*_{cb}=4$, $\frac{\sigma-1}{\kappa_c}=1$ and $\frac{\sigma-1}{\kappa_b}=4$.

country b can be derived as

$$r(\phi)=n(\phi)p(\phi)q(\phi)=\begin{cases}\sigma L_b^{\lambda}(\frac{\phi}{\phi^*_{ab}})^{\sigma-1}[1-(\frac{\phi^*_{ab}}{\phi})^{\frac{\sigma-1}{\kappa_b}}]\ , & \text{if } \phi\geq\phi^*_{ab}\\ 0, & \text{if } \phi<\phi^*_{ab}\end{cases}\tag{10}$$

Firm sales in Equation 10 can be decomposed into the intensive and extensive margins. The extensive margin, $[1-(\frac{\phi^*_{ab}}{\phi})^{\frac{\sigma-1}{\kappa_b}}]$, captures the fraction of consumers each firm could reach while the intensive margin, $\sigma L_b^{\lambda}(\frac{\phi}{\phi^*_{ab}})^{\sigma-1}$, characterizes the average sales to each consumer reached by the firm. As discussed above, the marketing cost elasticity κ only affects the extensive margin. It governs the speed of consumer accumulation as productivity rises.

Integrating expression (10) across the pdf (9), we can obtain the average sales of firms exporting from country a to country b as the following:

$$\bar{r}_{ab} = \sigma L_b^{\lambda}[\frac{1}{1-1/\tilde{\theta}} - \frac{1}{1-1/(\tilde{\theta}\tilde{\kappa}_b)}] \tag{11}$$

where

$$\tilde{\theta} = \frac{\theta}{\sigma - 1}, \qquad \tilde{\kappa}_b = \frac{\kappa_b}{\kappa_b - 1}$$

Pareto distribution implies that marketing costs are a constant share of a firm sales:

$$m = \frac{\theta - (\sigma - 1)}{\theta\sigma}$$

Profits and wages can also be expressed as constant shares of income:

$$\pi_a = \eta y_a, \qquad w_a = (1-\eta) y_a$$

where $\eta = (\sigma - 1)/(\theta\sigma)$.

3.4 Sales ratio between foreign and domestic market

The sales ratio between destination country b and the domestic market c of Chinese exporters, $\gamma_b(\phi)$, is defined as:

$$\gamma_b(\phi) \equiv \frac{r_{cb}(\phi)}{r_{cc}(\phi)} = \begin{cases} \frac{\sigma L_b^{\lambda}\left(\frac{\phi}{\phi_{cb}^*}\right)^{\sigma-1}\left[1-(\frac{\phi_{cb}^*}{\phi})^{\frac{\sigma-1}{\kappa_b}}\right]}{\sigma L_c^{\lambda}\left(\frac{\phi}{\phi_{cc}^*}\right)^{\sigma-1}\left[1-(\frac{\phi_{cc}^*}{\phi})^{\frac{\sigma-1}{\kappa_c}}\right]}, & \text{if } \phi \geq \phi_{cb}^* \\ 0, & \text{if } \phi < \phi_{cb}^* \end{cases} \tag{12}$$

Other than the relative market size, the foreign/domestic sales ratio of a firm depends on the productivity threshold of exporting to country b (ϕ_{cb}^*) and that for selling in the domestic market (ϕ_{cc}^*). It also depends on the elasticity of marketing cost in both countries.

If we examine the sales ratio along two margins, intensive and extensive, Equation 12 indicates that the intensive margins change proportionally to firm productivity while the extensive margins (in square parentheses) respond non-proportionally due to the impact of κ. In other words, conditional on market entry, the sales ratio to existing consumers does not change with firm productivity since ϕ can be canceled out and only market size and productivity cutoffs play a role in determining the relative sales along the intensive margin. Due to the existence of κ and the functional form of extensive margin effect, how changes in firm productivity are linked to the relative number of consumers obtained is not readily obvious. Proposition 1 below describes the conditions under which high productivity is associated with low foreign/domestic sales ratio.[17]

Proposition 1:[18]

(a) If $\kappa_b \geq \kappa_c$, then $\frac{\partial \ln \gamma_b(\phi)}{\partial \ln \phi} > 0$.

(b) If $\kappa_b < \kappa_c$, then there exists a $\phi^*(> \phi^*_{cb})$ which satisfies $\frac{1}{\kappa_b} \frac{\left(\frac{\phi^*_{cb}}{\phi^*}\right)^{\frac{\sigma-1}{\kappa_b}}}{1-\left(\frac{\phi^*_{cb}}{\phi^*}\right)^{\frac{\sigma-1}{\kappa_b}}} = \frac{1}{\kappa_c} \frac{\left(\frac{\phi^*_{cc}}{\phi^*}\right)^{\frac{\sigma-1}{\kappa_c}}}{1-\left(\frac{\phi^*_{cc}}{\phi^*}\right)^{\frac{\sigma-1}{\kappa_c}}}$. We have $\frac{\partial \ln \gamma_b(\phi)}{\partial \ln \phi} \geq 0$ for $\phi \in (\phi^*_{cb}, \phi^*]$, and $\frac{\partial \ln \gamma_b(\phi)}{\partial \ln \phi} < 0$ for $\phi \in (\phi^*, +\infty)$.

Thus, when $\kappa_b \geq \kappa_c$, there is always a positive correlation between firm productivity and foreign/domestic sales ratio. When κ are homogeneous across markets, as assumed in Arkolakis (2010) and Eaton et al. (2011), higher productive firms sell more in foreign markets. The intuition is that the initial consumer base in the domestic market is larger, the decreasing returns in marketing makes it even harder to gain consumers at home than abroad as productivity increases.

In Proposition 1 we show that when $\kappa_b < \kappa_c$, the correlation between firm productivity and sales ratio is a hump-shaped curve with ϕ^* being the turning point. Figure 5 presents the relationship between sales along the extensive margin and firm productivity based on the simulation parameters introduced before. We ignore the component from intensive margin

[17] To simplify the illustration, we assume that the threshold of productivity for selling in the Chinese market is lower than that for selling in foreign markets, which means $\phi^*_{cc} < \phi^*_{cb}$. This assumption is reasonable since most Chinese firms first sell in the domestic market and then enter foreign markets.

[18] The proof of Proposition 1 is in the Appendix F.

because it does not change with firm productivity. The extensive margin effect in the foreign market increases very quickly initially but stays almost constant later while the extensive margin effect in the domestic market is more steady paced. As a result, when $\phi \in (\phi^*_{cb}, \phi^*]$, the extensive margin effect in foreign markets is larger than that in the domestic market; when $\phi \in (\phi^*, +\infty]$, the extensive margin effect in foreign markets becomes smaller.

The hump-shaped relationship predicted by the model corresponds to the stylized pattern we show in Figure 1 with Chinese exporters. However, the squared productivity is not statistically significant in regressions indicating that ϕ^* and ϕ^*_{cb} are close to each other in our sample.

4 Evidence on the effect of marketing cost

In this section, we provide empirical evidence on the impact of marketing cost. Advertisement expenditure is used to shed light on the relative importance of marketing activities across industries. Then, we investigate alternative theories that may provide the same empirical predictions and use the differential effects on price ratios to distinguish marketing cost channels from other alternative mechanisms.

4.1 Advertisement expenditure

Different industries feature different marketing strategies. For instance, firms in Manufacture of wearing apparel may spend more on advertising in order to distinguish with other brands while firms manufacturing special equipment emphasize more on product innovation since their consumer base is relatively stable and less responsive to advertisements. In light of the model proposed in Section 3, firm productivity affects the sales ratio by the difference in number of consumers reached (i.e., extensive margin). Therefore, if firms in an industry relies more on consumer accumulation, the negative correlation between firm productivity and sales ratio should be more pronounced.

In order to capture the relative importance of marketing strategy, we use firm level information to calculate the average advertisement expenditure of the industry. It is divided by the average sales to control industry size effects. The interaction of advertisement over sales and firm productivity is included in the specifications (1 and 2).[19]

Table 7 presents the regression results at both firm and firm-destination levels. Firm productivity, measured by TFP, is reaffirmed to be negatively correlated with sales ratio between foreign and domestic market. This negative correlation is more prominent in industries with higher advertisement expenditures.[20] Neither the sign nor the scale of the coefficients change much when processing trade is excluded. Results from Table 7 supports the marketing cost channel that we proposed for the linkage between firm productivity and sales ratio.

4.2 Alternative explanations

In this paper, we approach the puzzling negative correlation between firm productivity and foreign-domestic sales ratio from the production side through market penetration technology. However, the disproportionate sales allocation across markets may also arise from the demand side. For example, Melitz and Ottaviano (2008) allows firms to charge variable markups and the degree of market power depends on market size. Firms of higher productivity have larger sales than lower productive ones especially when the market is big. If Chinese market is larger than foreign market, more efficient firms would expand non-proportionally more at home.

We construct a relative market size measure using the relative consumption[21] in foreign over domestic market. It varies across destination countries and different industries over

[19] The advertisement over sales variable is captured by the province-industry-year fixed effects in the firm level regressions and absorbed by the country-province-industry-year fixed effects in the firm-destination level regressions.

[20] Similar results can be found in Appendix C with value-added per worker being the productivity measure.

[21] The consumption data come from the "Industrial Demand-Supply Balance Database (IDSB)," which is collected by UNIDO. This database contains datasets based on the four-digit level of ISIC Revision 3 for each country and each year. The apparent consumption in this database is calculated as the summation of domestic output and net import. Since there are some missing values for domestic output, total imports or total exports, only half of the observations can be used.

Table 7: Effect of advertisement expenditure

	Dependent Variable: ln(Export/Domestic Sales)			
	Firm level		Firm-destination level	
ln(TFP)	-0.240***	-0.207***	-0.212***	-0.101**
	(0.0224)	(0.0325)	(0.0352)	(0.0458)
ln(TFP)× Advertisement/Sales Ratio	-11.28***	-12.27***	-8.402***	-8.036***
	(2.378)	(4.092)	(2.005)	(2.828)
ln(Capital/Labor Ratio)	-0.222***	-0.260***	-0.184***	-0.205***
	(0.0157)	(0.0229)	(0.0225)	(0.0319)
ln(Sale)	0.130***	-0.0483	-0.188***	-0.429***
	(0.0366)	(0.0377)	(0.0517)	(0.0479)
ln(No. of markets)			-0.0792	-0.0341
			(0.0495)	(0.0541)
Constant	0.588**	2.416***	0.849**	2.597***
	(0.276)	(0.299)	(0.394)	(0.385)
Ownership FE	✓	✓	✓	✓
Province-Industry-Year FE	✓	✓		
Country-Province-Industry-Year FE			✓	✓
Cluster By Industry	✓	✓	✓	✓
Exclude Processing Trade		✓		✓
Observations	275,872	69,691	1,098,287	560,850
R-squared	0.370	0.474	0.586	0.650

Notes: This table shows the impact of advertising spending on the correlation between firm productivity and foreign/domestic sales ratio.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

time. The interaction term between firm productivity and relative market size is included in the regressions. It is expected to be positive if market size has an impact on the negative correlation. In other words, as the foreign market is relatively small than Chinese market, firm productivity is negatively correlated with sales ratio. As the foreign market becomes comparable with the Chinese market, a positive interaction term would cancel out the negative effect, making productivity uncorrelated with relative sales ratio. If the foreign market is large enough to surpass the domestic market, the positive coefficient for the interaction term could overwhelm the negative correlation and make higher productive firms export more.

The first column of Table 8 presents a positive coefficient on the interaction suggesting an impact of market size. However, it becomes insignificant when we get rid of processing trade or control firm-industry fixed effects (shown in the last two columns of Table 8).

Table 8: Effect of relative market size

	Y=ln(Export/Domestic Sales)		
	(1)	(2)	(3)
ln(TFP)	-0.244***	-0.100**	
	(0.0388)	(0.0504)	
ln(TFP)× Relative Market Size	0.0157**	0.00176	0.00639
	(0.00759)	(0.00444)	(0.00540)
ln(Capital/Labor Ratio)	-0.201***	-0.204***	-0.197***
	(0.0222)	(0.0290)	(0.0289)
ln(Sale)	-0.192***	-0.439***	-0.407***
	(0.0470)	(0.0501)	(0.0505)
ln(No. of markets)	-0.0341	-0.00499	-0.0219
	(0.0539)	(0.0591)	(0.0588)
Constant	1.032***	2.589***	2.810***
	(0.342)	(0.379)	(0.243)
Country-Province-Industry-Year FE	✓	✓	✓
Ownership FE	✓	✓	✓
Cluster By Industry	✓	✓	✓
Excluding Processing Trade		✓	✓
Industry Dummy × ln(TFP)			✓
Observations	391,677	212,825	212,825
R-squared	0.515	0.586	0.592

Notes: This table shows the impact of market size on the correlation between export/domestic sales ratio and productivity on the firm-destination level. Relative market size varies at the industry-country-year level.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

In addition, Melitz and Ottaviano (2008) also predicts a correlation between firm productivity and relative price ratio between foreign and domestic market. When domestic market is relatively large (and thus more competitive), more efficient firms would have weaker market power and therefore charge a lower markup. As a result, firm productivity is positively correlated with the relative price ratio. In our model, as well as in Arkolakis (2010), firms enter monopolistic competition with CES demand and charge constant markup. All the variations in relative sales come from differences in quantity instead of price. Therefore, whether the negative correlation results from demand or production side can be resolved if we could compare the reactions of price and quantity ratios respectively.

One difficulty is that price information for products sold in the domestic market is not observed. As an alternative, we turn to Hong Kong (HK) which is close to mainland China both geographically and culturally. Hong Kong is treated as if it were a foreign country in the Customs records and we assume selling to Hong Kong is comparable to selling in mainland China. In order to check the validity of this assumption, we replace domestic sales with sales to Hong Kong and replicate the benchmark regressions with various controls. Trade data allows us to include additional controls at the HS 8-digit product level.

Table 9: Firm productivity and sales ratio: Hong Kong

	Dependent Var.: ln(foreign/HK Sales)			
	value-added per worker		TFP	
ln(Productivity)	-0.0463	-0.0934**	-0.0519**	**-0.0837****
	(0.0307)	(0.0475)	(0.0238)	(0.0338)
ln(Capital/Labor Ratio)	-0.0825***	-0.0668*	-0.0886***	-0.0853**
	(0.0263)	(0.0348)	(0.0261)	(0.0335)
Constant	-1.756	-4.027	-1.501	-3.764
	(1.390)	(2.612)	(1.379)	(2.601)
Product(HS 2-digit) FE	✓	✓	✓	✓
Country-Province-Industry-Year FE	✓	✓	✓	✓
Ownership fixed effect	✓	✓	✓	✓
Exclude Processing Trade		✓		✓
Cluster By Industry	✓	✓	✓	✓
Observations	441,946	110,086	441,946	110,086
R-squared	0.360	0.516	0.360	0.516

Notes: This table shows the correlation between sales ratio and productivity on the firm-destination level. We calculate the export value on HS8 level for the same firm.
The sales ratio is $\frac{Export\ \ Value\ \ to\ \ Country\ \ b}{Export\ \ Value\ \ to\ \ Hong\ \ Kong}$ at firm-product level. We include US, Japan, South Korea, Germany, UK, Canada, Italy, Australia and Taiwan. These markets are the top 10 destinations of Chinese exporting firms.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

Table 9 shows that firm productivity remains negatively correlated with sales ratio between foreign and HK market. This pattern does not depend on the measurement of firm productivity nor the exclusion of processing trade. The scale of the effect becomes slightly smaller than that in Table 6 (probably due to the additional product dimension) but still at a comparable level.[22] Given that Hong Kong provides a reasonably good substitute to the Chinese domestic market, we construct relative price ratios between selling in foreign country b and in Hong Kong as well as relative quantity ratios.

Table 10 shows the regression results. Price ratio turns out to be positively correlated with productivity as predicted by the demand theory. However, the correlation is not statistically significant. The coefficient on quantity ratio, on the other hand, is strongly negative suggesting the relationship between firm productivity and sales ratio mainly comes from the differences in quantities rather than prices. These results lend support to the marketing cost theory proposed in this paper and identifies production side effects from demand side mechanisms.

Another potential explanation for our empirical findings relates to the quality of the products. Manova and Zhang (2012) find that more successful exporters use higher quality inputs to produce higher quality goods. Firms vary in terms of the quality of their products across destinations by using inputs of different quality levels. Thus, firm sales will vary across markets due to the differing quality of its products. Manova and Zhang (2012) also argue that the markups are heterogeneous across firms. Therefore, the price ratio between two export destinations should be correlated with a firm productivity. However, we find no such evidence in the Chinese data.

5 Conclusion

This paper examines the relationship between firm productivity and allocation of sales across markets. Using data on Chinese exporters, we establish the stylized fact that firm productivity is negatively correlated with sales ratio between foreign and domestic market. This empirical pattern remains robust when we control firm ownership, capital intensity, and rule out the impact of processing trade at both firm and firm-destination level.

[22] There is a 0.84% decrease in sales ratio with respect to 10% TFP growth compared with a 1.1% drop previously with domestic sales.

Table 10: Price ratio vs quantity ratio: Hong Kong

	Dependent Var.: ln(foreign/HK Sales)	
	ln(Price Ratio)	ln(Quantity Ratio)
ln(TFP)	0.00706	-0.0921**
	(0.00845)	(0.0369)
ln(Capital/Labor Ratio)	-0.00761	-0.0774**
	(0.00556)	(0.0340)
Constant	0.654**	-4.398*
	(0.289)	(2.660)
Country-Province-Industry-Year FE	✓	✓
Ownership FE	✓	✓
Product(HS 2-digit) FE	✓	✓
Exclude Processing Trade	✓	✓
Cluster By Industry	✓	✓
Observations	109,743	109,743
R-squared	0.431	0.516

Notes: This table shows the correlation between price ratio, quantity ratio and productivity on the firm-destination level. We calculate the export prices (quantities) on HS 8-digit level for the same firm.
The price (quantity) ratio is $\frac{Export\ \ Price\ (Quantity)\ \ to\ \ Country\ \ b}{Export\ \ Price\ (Quantity)\ \ to\ \ Hong\ \ Kong}$ at firm-product level. Here other countries (regions) include US, Japan, South Korea, Germany, UK, Canada, Italy, Australia and Taiwan. These countries (regions) are the top 10 destinations of Chinese exporting firms.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

This finding is in stark contrast with Melitz (2003) predictions where sales ratio across markets are independent of firm productivity and high productivity firms are associated with high export intensity due to the large number of markets they enter. The empirical pattern we observe is the opposite to predictions by Arkolakis (2010) and Eaton et al. (2011) where market penetration technology replaces the fixed cost of entry and firm productivity is positively correlated with relative sales in the foreign market.

To rationalize our empirical findings, we extend the Arkolakis (2010) model to allow for heterogeneous marketing cost elasticities across countries. The returns to marketing is decreasing and the marketing cost elasticity governs the speed of deterioration. The model links firm productivity and non-proportional distribution of sales across markets through the extensive margin—number of consumer reached. When the marketing cost elasticity is higher in China than abroad, productive firms have a relative advantage in selling to domestic consumers resulting in a negative correlation between firm productivity and the foreign-domestic sales ratio.

Our market penetration explanation of the negative relationship between firm productivity and export intensity is supported by evidence on industry level reliance on marketing strategies measured by advertisement expenditures. The model prediction on constant rather than variable price ratio helps to distinguish our marketing theory with alternative explanations.

Yet, more work is needed to investigate which factors determine local marketing cost elasticities. Future research aims to find a direct measure of marketing cost, estimate the marketing elasticity across countries, and carry out counterfactuals for policies that help ease barriers to reaching local consumers.

References

Arkolakis, Costas, "Market penetration costs and the new consumers margin in international trade," *Journal of Political Economy*, 2010, *118* (6), 1151–1199.

Atkin, David, Amit K Khandelwal, and Adam Osman, "Exporting and firm performance: Evidence from a randomized experiment," *The Quarterly Journal of Economics*, 2017, *132* (2), 551–615.

Bai, Xue, Kala Krishna, and Hong Ma, "How you export matters: Export mode, learning and productivity in China," *Journal of International Economics*, 2017, *104*, 122–137.

Berman, Nicolas, Vincent Rebeyrol, and Vincent Vicard, "Demand learning and firm dynamics: evidence from exporters," *Review of Economics and Statistics*, 2015, (0).

Bernard, Andrew B., Jonathan Eaton, J. Bradford Jensen, and Samuel Kortum, "Plants and productivity in international trade," *The American Economic Review*, 2003, *93* (4), 1268–1290.

Crinò, Rosario and Paolo Epifani, "Productivity, quality and export behaviour," *The Economic Journal*, 2012, *122* (565), 1206–1243.

Dai, Mi, Madhura Maitra, and Miaojie Yu, "Unexceptional exporter performance in China? The role of processing trade," *Journal of Development Economics*, 2016, *121*, 177–189.

Defever, Fabrice and Alejandro Riaño, "Subsidies with export share requirements in China," *Journal of Development Economics*, 2017, *126*, 33–51.

Eaton, Jonathan, Samuel Kortum, and Francis Kramarz, "An anatomy of international trade: Evidence from French firms," *Econometrica*, 2011, *79* (5), 1453–1498.

Fitzgerald, Doireann, Stefanie Haller, and Yaniv Yedid-Levi, "How exporters grow," Technical Report, National Bureau of Economic Research 2016.

Foster, Lucia, John Haltiwanger, and Chad Syverson, "The slow growth of new plants: Learning about demand?," *Economica*, 2016, *83* (329), 91–129.

Levinsohn, James and Amil Petrin, "Estimating production functions using inputs to control for unobservables," *The Review of Economic Studies*, 2003, *70* (2), 317–341.

Lu, Dan, "Exceptional exporter performance? Evidence from Chinese manufacturing firms," *manuscript, University of Chicago*, 2010.

Lu, Jiangyong, Yi Lu, and Zhigang Tao, "Exporting behavior of foreign affiliates: Theory and evidence," *Journal of International Economics*, 2010, *81* (2), 197–205.

Manova, Kalina and Zhiwei Zhang, "Export prices aross firms and destinations," *The Quarterly Journal of Economics*, 2012, *127*, 379–436.

Melitz, Marc J., "The impact of trade on intra-industry reallocations and aggregate industry productivity," *Econometrica*, 2003, *71* (6), 1695–1725.

_ **and Giancarlo I. P. Ottaviano**, "Market size, trade, and productivity," *The Review of Economic Studies*, 2008, *75* (1), 295–316.

Soderbery, Anson, "Estimating import supply and demand elasticities: Analysis and implications," *Journal of International Economics*, 2015, *96* (1), 1–17.

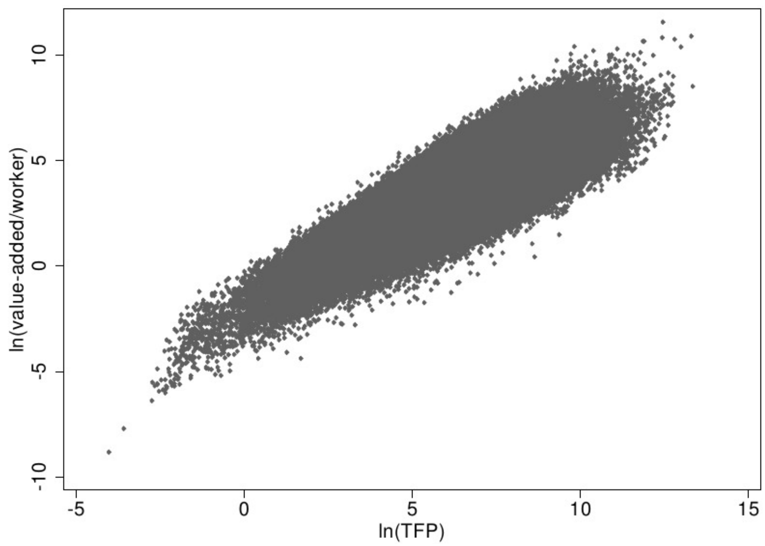
Wang, Zheng and Zhihong Yu, "Trading partners, traded products and firm performances of Chinas exporter-importers: Does processing trade make a difference?," *The World Economy*, 2012, *35* (12), 1795–1824.

A Appendix

B Correlation between value-added per worker and TFP

Figure A1 shows the correlation between two productivity measurements. The x-axis is ln(TFP) and the y-axis is ln(value-added per worker). The correlation between two measurements is 0.76.

Figure A1: The Correlation between Value-added Per Worker and TFP



Notes: This figure shows the correlation between two productivity measurements. The x-axis is ln(TFP) and the y-axis is ln(value-added per worker). The correlation between two measurements is 0.76.

The following tables provide regression results with value-adder per worker as the measure of firm productivity.

C Productivity and sales ratio: quadratic regression

Figure 1 shows that the correlation between firm productivity and export intensity is an hump-shaped curve. However, the positive correlation before the turning point is not significant. Thus, we use a linear regression model to describe the correlation. In this section we use a quadratic regression to address the hump-shaped correlation. The regression can

Table A1: Firm productivity and export sales

	(1) LaborProd	(2) K/L	(3) Ownership	(4) TFP	(5) K/L	(6) Ownership
ln(LabProd)	0.426a	0.397a	0.401a			
	(0.011)	(0.010)	(0.010)			
TFP				0.809a	0.796a	0.791a
				(0.013)	(0.012)	(0.012)
KL		0.065a	0.032a		0.085a	0.060a
		(0.010)	(0.010)		(0.008)	(0.009)
Ownership FE			✓			✓
Province-Industry-Year FE	✓	✓	✓	✓	✓	✓
Cluster By Industry	✓	✓	✓	✓	✓	✓
N	386924	386924	386924	386924	386924	386924
R^2	0.307	0.309	0.325	0.474	0.477	0.489

Notes: ln(LabProd) stands for labor productivity measured by value-added per worker. Standard errors in parentheses. c p<0.1, b p<0.05, a p<0.01.

be written as follows:

$$\begin{aligned} \ln(Export/Domestic\ Sales\ \ Ratio_{ijkt}) = \ & \eta_0 + \eta_1\ \ln(P_{ijkt}) + \eta_2\ \ln(P_{ijkt})^2 \\ & + other\ controls + \mu_{jkt} + \epsilon_{ijkt} \end{aligned} \tag{13}$$

The results are shown in Tables A7 and A8. We find that the coefficient of $\ln(Productivity)^2$ is always negative and significant. But the coefficient of $\ln(Productivity)$ is only significant when we use a firm's TFP as our measurement and the regression is at the firm level. Thus, a linear regression is a better way to address the correlation between the firms' export/domestic sales ratio and their productivity.

D Industry list and firm share

There are 30 manufacturing industries at two-digit level. The name list of these industries is as follows and the number in the bracket is the proportion of firms in that industry.

Figures A2 and A3 show the correlation between the average export intensity and productivity percentile by industries. The industries are on 2-digits level. From the first

Table A2: Firm productivity and sales ratio

	Dependent Variable: ln(Export/Domestic Sales)		
	(1)	(2)	(3)
ln(Value-added per worker)	-0.065**	-0.146***	-0.272***
	(0.030)	(0.026)	(0.033)
ln(Value-added per worker)× Domestic		-0.019	
		(0.032)	
ln(Value-added per worker)× Homogeneous			0.080**
			(0.033)
Homogeneous Dummy			-0.221
			(0.152)
ln(Capital/Labor Ratio)	-0.228***	-0.170***	-0.150***
	(0.021)	(0.015)	(0.028)
ln(Sale)	-0.211***	-0.024	0.063*
	(0.028)	0.027)	(0.036)
Constant	2.659***	0.833***	0.575
	(0.298)	(0.269)	(0.396)
Ownership FE	✓	✓	✓
Province-Industry-Year FE	✓	✓	✓
Cluster By Industry	✓	✓	✓
Exclude Processing Trade	✓		
Observations	69,691	275,872	80,147
R-squared	0.472	0.369	0.419

Notes: This table shows the correlation between export/domestic sales ratio and productivity (value-added per worker) on the firm level.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

Table A3: Firm productivity and sales ratio (value-added/worker): firm-destination level

	Dependent Variable: ln(Export/Domestic Sales)		
	All	OECD	LDC
ln(Productivity)	0.027	0.00133	0.0686
	(0.045)	(0.0399)	(0.0606)
ln(Capital/Labor Ratio)	-0.202***	-0.202***	-0.201***
	(0.031)	(0.0290)	(0.0396)
ln(Sale)	-0.527***	-0.488***	-0.589***
	(0.037)	(0.0337)	(0.0470)
ln(No. of markets)	-0.029	-0.0826	0.0720
	(0.055)	(0.0539)	(0.0597)
Constant	2.697***	2.708***	2.712***
	(0.386)	(0.362)	(0.504)
Ownership FE	✓	✓	✓
Country-Province-Industry-Year FE	✓	✓	✓
Cluster By Industry	✓	✓	✓
Exclude Processing Trade	✓	✓	✓
Observations	560,850	305,163	255,687
R-squared	0.649	0.610	0.694

Notes: This table shows the correlation between export/domestic sales ratio and productivity on the firm-destination level.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

Table A4: Effect of advertisement expenditure: value-add/worker

	Dependent Variable: ln(Export/Domestic Sales)			
	(1)	(2)	(3)	(4)
ln(Productivity)	-0.141***	-0.0438	-0.0688**	0.0420
	(0.0181)	(0.0312)	(0.0313)	(0.0462)
ln(Productivity)× Advertisement/Sales Ratio	-7.037***	-10.72***	-7.241***	-9.202***
	(1.759)	(3.353)	(1.986)	(3.141)
ln(Capital/Labor Ratio)	-0.170***	-0.229***	-0.149***	-0.202***
	(0.0154)	(0.0209)	(0.0230)	(0.0307)
ln(Sale)	-0.0231	-0.208***	-0.338***	-0.526***
	(0.0268)	(0.0277)	(0.0384)	(0.0366)
ln(No. of markets)			-0.0773	-0.0297
			(0.0496)	(0.0544)
Constant	0.789***	2.645***	1.039***	2.701***
	(0.272)	(0.297)	(0.390)	(0.385)
Ownership FE	✓	✓	✓	✓
Province-Industry-Year FE	✓	✓		
Country-Province-Industry-Year FE			✓	✓
Cluster By Industry	✓	✓	✓	✓
Exclude Processing Trade		✓		✓
Observations	275,872	69,691	1,098,287	560,850
R-squared	0.369	0.473	0.585	0.649

Notes: This table shows the impact of advertising spending on the correlation between export/domestic sales ratio and productivity.
The first two columns are at the firm level. The last two columns are at the firm-destination level.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

Table A5: Effect of relative market size (value-added per worker)

	Dependent Variable: ln(Export/Domestic Sales)		
	(1)	(2)	(3)
ln(Productivity)	-0.100***	0.0215	
	(0.0303)	(0.0451)	
ln(Productivity)× Relative Market Size	-0.00702*	-0.00939**	-0.00348
	(0.00388)	(0.00430)	(0.00438)
ln(Capital/Labor Ratio)	-0.160***	-0.199***	-0.183***
	(0.0222)	(0.0278)	(0.0280)
ln(Sale)	-0.337***	-0.519***	-0.505***
	(0.0337)	(0.0390)	(0.0392)
ln(No. of markets)	-0.0346	-0.00168	-0.0132
	(0.0538)	(0.0592)	(0.0587)
Constant	1.220***	2.677***	2.562***
	(0.331)	(0.384)	(0.322)
Country-Province-Industry-Year FE	✓	✓	✓
Ownership FE	✓	✓	✓
Cluster By Industry	✓	✓	✓
Excluding Processing Trade		✓	✓
Industry Dummy × ln(Productivity)			✓
Observations	391,677	212,825	212,825
R-squared	0.515	0.586	0.591

Notes: This table shows the impact of market size on the correlation between export/domestic sales ratio and productivity on the firm-destination level.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

Table A6: Firm productivity and sales ratio: value-added/worker (HK)

	ln(Price Ratio)	ln(Quantity Ratio)
	(1)	(2)
ln(Productivity)	-0.00731	-0.0867*
	(0.0104)	(0.0514)
ln(Capital/Labor Ratio)	-0.00483	-0.0616*
	(0.00608)	(0.0360)
Constant	0.720**	-4.735*
	(0.288)	(2.669)
Country-Province-Industry-Year FE	✓	✓
Ownership FE	✓	✓
Product(HS 2-digit) FE	✓	✓
Exclude Processing Trade	✓	✓
Cluster By Industry	✓	✓
Observations	109,743	109,743
R-squared	0.431	0.515

Notes: This table shows the correlation between price ratio, quantity ratio and productivity on the firm-destination level. We calculate the export prices (quantities) on HS08 level for the same firm.
The price (quantity) ratio is $\frac{Export\ \ Price\ (Quantity)\ \ to\ \ Country\ \ b}{Export\ \ Price\ (Quantity)\ \ to\ \ Hong\ \ Kong}$ at firm-product level. Here other countries (regions) include US, Japan, South Korea, Germany, UK, Canada, Italy, Australia and Taiwan. These countries (regions) are the top 10 destinations of Chinese exporting firms.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

Table A7: Quadratic productivity: firm level

	Dependent Variable: ln(Export/Domestic Sales)			
	(1)	(2)	(3)	(4)
ln(Productivity)	0.0114	0.0225	0.189***	0.459***
	(0.0301)	(0.0650)	(0.0700)	(0.121)
ln(Productivity)^2	-0.0220***	-0.0117	-0.0359***	-0.0547***
	(0.00427)	(0.00972)	(0.00579)	(0.00999)
ln(Capital/Labor Ratio)	-0.165***	-0.223***	-0.221***	-0.255***
	(0.0154)	(0.0211)	(0.0157)	(0.0226)
ln(Sale)	-0.0218	-0.208***	0.172***	0.0141
	(0.0269)	(0.0281)	(0.0380)	(0.0422)
Constant	0.467*	2.456***	-1.218***	-0.367
	(0.271)	(0.325)	(0.376)	(0.608)
Ownership FE	✓	✓	✓	✓
Province-Industry-Year FE	✓	✓	✓	✓
Cluster By Industry	✓	✓	✓	✓
Exclude Processing Trade		✓		✓
Observations	275,872	69,907	275,872	69,907
R-squared	0.369	0.472	0.370	0.474

Notes: This table shows the correlation between export/domestic sales ratio and productivity at the firm level.
We use value-added per worker to measure a firm's productivity in the first two and use TFP in last two columns.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

Table A8: Quadratic productivity: firm-destination level

	Dependent Variable: ln(Export/Domestic Sale)			
	(1)	(2)	(3)	(4)
ln(Productivity)	0.0440	-0.0137	0.225	0.318
	(0.0672)	(0.117)	(0.138)	(0.223)
ln(Productivity)^2	-0.0160*	0.00519	-0.0336***	-0.0325*
	(0.00962)	(0.0172)	(0.0103)	(0.0179)
ln(Capital/Labor Ratio)	-0.145***	-0.202***	-0.183***	-0.203***
	(0.0233)	(0.0311)	(0.0226)	(0.0320)
ln(Sale)	-0.338***	-0.528***	-0.153***	-0.400***
	(0.0386)	(0.0368)	(0.0528)	(0.0523)
ln(No. of markets)	-0.0780	-0.0283	-0.0829*	-0.0375
	(0.0496)	(0.0548)	(0.0496)	(0.0546)
Constant	0.782**	2.781***	-1.016*	0.864
	(0.393)	(0.437)	(0.578)	(0.887)
Ownership FE	✓	✓	✓	✓
Destination-Province-Industry-Year FE	✓	✓	✓	✓
Cluster By Industry	✓	✓	✓	✓
Exclude Processing Trade		✓		✓
Observations	1,098,287	560,850	1,098,287	560,850
R-squared	0.585	0.649	0.586	0.650

Notes: This table shows the correlation between export/domestic sales ratio and productivity at the firm-destination level.
We use value-added per worker to measure a firm's productivity in the first two and use TFP in last two columns.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.

Table A9: List of industries

CIC	Industry name (share of firms)
17	Manufacture of Textile (12.22%)
18	Manufacture of Wearing Apparel, Footwear and Headwear (8.01%)
35	Universal Equipments Manufacturing (7.67%)
39	Manufacture of Electric Machines and Equipments (6.82%)
26	Chemical Raw Materials and Manufacture of Other Basic Chemical Raw Materials (6.50%)
40	Manufacture of Telecommunication Equipments, Computers and Other Electric Equipments (5.94%)
34	Manufacture of Metal Products (5.62%)
31	Manufacture of Non-metal Products (4.54%)
30	Manufacture of Plastic Products (4.53%)
37	Manufacture of Transportation Equipments (4.31%)
36	Manufacture of Special Equipments (4.03%)
19	Manufacture of Leather, Fur Apparel, Feather and Products (3.40%)
42	Manufacture of Arts and Crafts and Other Manufacturing (2.91%)
24	Manufacture of Cultural, Educational and Sporting Products (2.38%)
14	Manufacture of Food Products (2.09%)
41	Manufacture of Instruments and Appliances, Culture-related and Office Machinery (2.02%)
27	Manufacture of Pharmaceuticals (2.02%)
20	Manufacture of Wood and Articles of Wood, Bamboo, Bine, Palm Fibre, Straw and Grass (1.74%)
22	Manufacture of Pulp, Paper, Paperboard and Articles of Paper and Paperboard (1.47%)
21	Furniture Manufacturing (1.38%)
29	Manufacture of Rubber Products (1.35%)
13	Processing Industry of Agricultural and Subsidiary Food (1.30%)
33	Manufacture and Casting of Non-ferrous Metals (1.19%)
32	Manufacture and Casting of Ferrous Metals (1.02%)
15	Manufacture of Drinking Products (0.87%)
23	Printing and Reproduction of Recorded Media (0.76%)
25	Processing of Crude Oil, Coking and Nuclear Fuel (0.42%)
28	Manufacture of Chemical Fibres (0.41%)
16	Manufacture of Tobacco Products (0.11%)
43	Recycling of Waste and Scrap (0.02%)

Manufacture of Textile has the most firms and is among the top 3 industries in terms of export value. Manufacture of Electric Machines and Equipments follows Textile and Wearing Apparel to be the third largest industry in terms of number of firms. It is among the top 5 in export value and its ranking is rising in recent years.

industry to the last one, the capital/Labor ratio of industry increases. The only two industries, which are abnormal, are "Recycling of Waste and Scrap "(industry 9) and "Manufacture of Tobacco Products" (industry 29).

E Firm productivity and sales ratio: top 10 destinations

In Regression 2 we only control the export destination fixed effect. Next, we run regressions for each export destination. We rank the destinations according to the number of Chinese exporting firms that sell products in that country. We choose the top ten export destinations: the US, Hong Kong, Japan, South Korea, Germany, the UK, Canada, Australia, Taiwan, and Italy. The results are given in Table A10. We find that the negative correlation remains robust for the top ten most significant destinations.

F Proof of Proposition 1

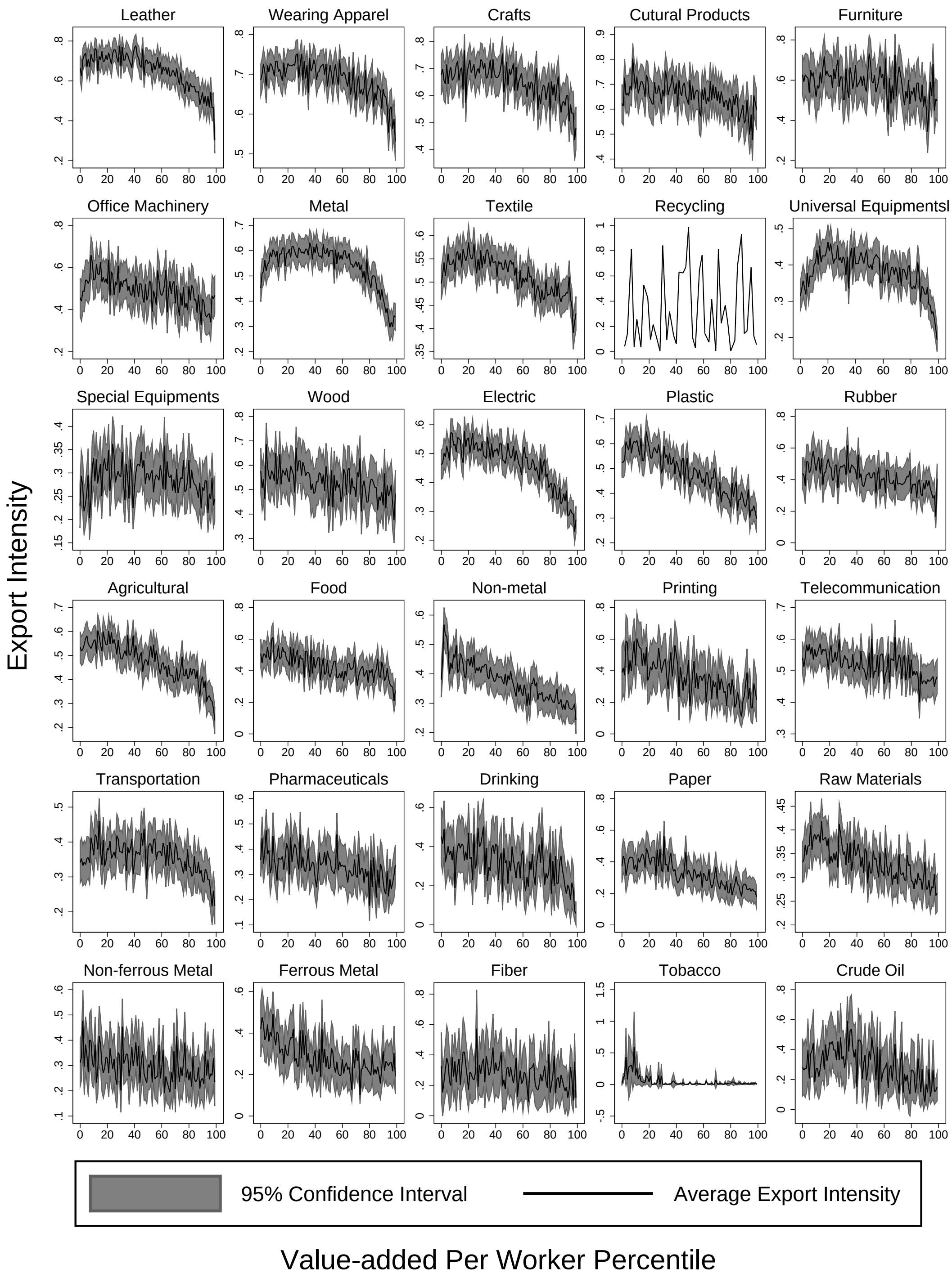
Proof: By (12), we have

$$\begin{aligned}\ln\gamma(\phi) &= \lambda[\ln(L_b)-\ln(L_c)]+(\sigma-1)[\ln(\phi_{cc}^*)-\ln(\phi_{cb}^*)]\\ &+ \ln\left[1-(\frac{\phi_{cb}^*}{\phi})^{\frac{\sigma-1}{\kappa_{cb}}}\right]-\ln\left[1-(\frac{\phi_{cc}^*}{\phi})^{\frac{\sigma-1}{\kappa_{cc}}}\right].\end{aligned}$$

Therefore,

$$\begin{aligned}\frac{\partial\ln\gamma(\phi)}{\partial\ln\phi} &= \phi\left[\frac{\frac{\sigma-1}{\kappa_{cb}}\frac{1}{\phi}(\frac{\phi_{cb}^*}{\phi})^{\frac{\sigma-1}{\kappa_{cb}}}}{1-(\frac{\phi_{cb}^*}{\phi})^{\frac{\sigma-1}{\kappa_{cb}}}}-\frac{\frac{\sigma-1}{\kappa_{cc}}\frac{1}{\phi}(\frac{\phi_{cc}^*}{\phi})^{\frac{\sigma-1}{\kappa_{cc}}}}{1-(\frac{\phi_{cc}^*}{\phi})^{\frac{\sigma-1}{\kappa_{cc}}}}\right]\\ &= (\sigma-1)\left[\frac{1}{\kappa_{cb}}\frac{(\frac{\phi_{cb}^*}{\phi})^{\frac{\sigma-1}{\kappa_{cb}}}}{1-(\frac{\phi_{cb}^*}{\phi})^{\frac{\sigma-1}{\kappa_{cb}}}}-\frac{1}{\kappa_{cc}}\frac{(\frac{\phi_{cc}^*}{\phi})^{\frac{\sigma-1}{\kappa_{cc}}}}{1-(\frac{\phi_{cc}^*}{\phi})^{\frac{\sigma-1}{\kappa_{cc}}}}\right].\end{aligned}$$

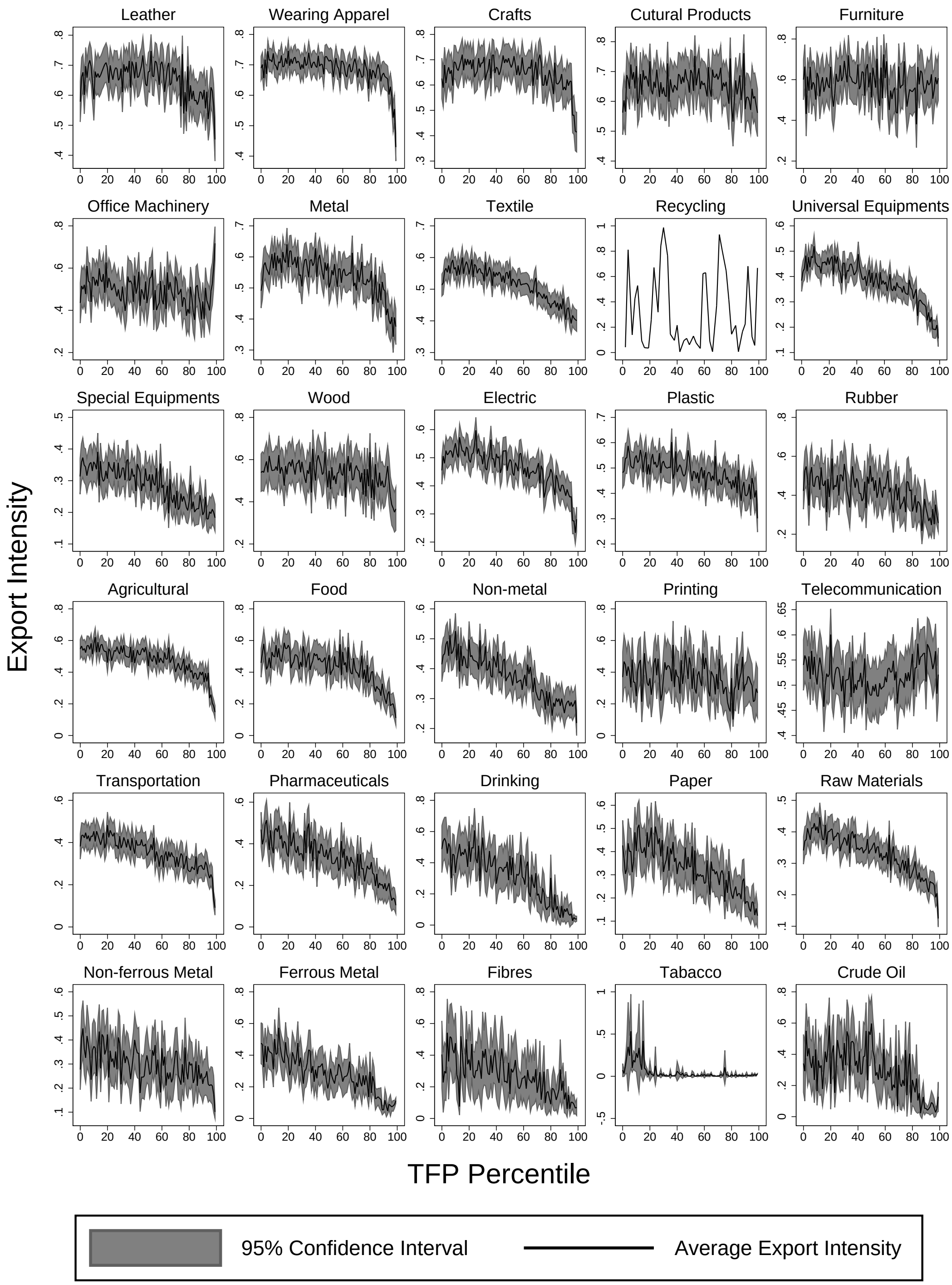
Figure A2: Average export intensity and productivity (value-added per worker)



Data Sources: The "Chinese Industrial Enterprises Database" (2000-2006).

Notes: This figure shows the correlation between the average export intensity and productivity (value-added per worker) percentile by industries. We only include firms that sell both in the domestic market and foreign markets. The industries are on 2-digits level. From the first industry to the last one, the capital/Labor ratio of industry increases. The only two industries, which are abnormal, are "Recycling of Waste and Scrap "(industry 9) and "Manufacture of Tobacco Products" (industry 29).

Figure A3: Average export intensity and productivity (TFP)



Data Sources: The "Chinese Industrial Enterprises Database" (2000-2006).

Notes: This figure shows the correlation between the average export intensity and productivity (TFP) percentile by industries. We only include firms that sell both in the domestic market and foreign markets. The industries are on 2-digits level. From the first industry to the last one, the capital/Labor ratio of industry increases. The only two industries, which are abnormal, are "Recycling of Waste and Scrap "(industry 9) and "Manufacture of Tobacco Products" (industry 29).

Table A10: Firm productivity and sales ratio: top 10

	Dependent Variable: Ln(Export/Domestic Sales)			
	(1)	(2)	(3)	(4)
USA	-0.262***	-0.0705	-0.372***	-0.242***
	(0.0369)	(0.0595)	(0.0406)	(0.0739)
HKG	-0.222***	-0.058	-0.247***	-0.0789
	(0.0367)	(0.0539)	(0.0396)	(0.0598)
JPN	-0.224***	0.0111	-0.305***	-0.130**
	(0.0357)	(0.0433)	(0.0474)	(0.0615)
KOR	-0.0736	0.0449	-0.196***	-0.0516
	(0.0474)	(0.0574)	(0.0559)	(0.062)
GER	-0.0934**	-0.00168	-0.202***	-0.127
	(0.038)	(0.0559)	(0.0548)	(0.0788)
GBR	-0.0648	0.0861	-0.177***	-0.0368
	(0.0419)	(0.0673)	(0.0511)	(0.0854)
AUS	-0.0875**	-0.048	-0.245***	-0.179**
	(0.0439)	(0.0723)	(0.0549)	(0.0853)
CAN	-0.146***	-0.0369	-0.232***	-0.147
	(0.0463)	(0.0893)	(0.0574)	(0.109)
TWN	-0.204***	-0.0917	-0.279***	-0.188**
	(0.0493)	(0.0756)	(0.0575)	(0.0815)
ITA	-0.0919**	0.00554	-0.218***	-0.0958
	(0.0445)	(0.0587)	(0.054)	(0.0746)
Ownership FE	✓	✓	✓	✓
Province-Industry-Year FE	✓	✓	✓	✓
Cluster By Industry	✓	✓	✓	✓
Exclude Processing Trade		✓		✓

Notes: This table shows the correlation between export/domestic sales ratio and productivity for the top ten destinations.
The productivity in the first two columns is value-added per worker. The productivity in last two columns is TFP.
Standard errors in parentheses. **Significant at 5%; ***significant at 1%.
USA United States; HKG Hong Kong; JPN Japan; KOR South Korea; GER Germany; GBR: United Kingdom; AUS Australia; CAN Canada; TWN Taiwan; ITA Italy.

In the following, we denote

$$\Omega \equiv \frac{1}{\kappa_{cb}} \frac{\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cb}}}}{1-\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cb}}}} - \frac{1}{\kappa_{cc}} \frac{\left(\frac{\phi^*_{cc}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cc}}}}{1-\left(\frac{\phi^*_{cc}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cc}}}},$$

and consider the three cases as below.

Case 1: $\kappa_{cb} = \kappa_{cc} = \kappa$. In this case,

$$\Omega = \frac{1}{\kappa} \left[\frac{\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa}}}{1-\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa}}} - \frac{\left(\frac{\phi^*_{cc}}{\phi}\right)^{\frac{\sigma-1}{\kappa}}}{1-\left(\frac{\phi^*_{cc}}{\phi}\right)^{\frac{\sigma-1}{\kappa}}} \right].$$

By $\phi \geq \phi^*_{cb} > \phi^*_{cc}$, we have $1 \geq \frac{\phi^*_{cb}}{\phi} > \frac{\phi^*_{cc}}{\phi}$. Therefore,

$$\frac{\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa}}}{1-\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa}}} > \frac{\left(\frac{\phi^*_{cc}}{\phi}\right)^{\frac{\sigma-1}{\kappa}}}{1-\left(\frac{\phi^*_{cc}}{\phi}\right)^{\frac{\sigma-1}{\kappa}}},$$

which implies that $\Omega > 0$. Thus, we obtain $\frac{\partial \ln \gamma(\phi)}{\partial \ln(\phi)} > 0$.

Case 2: $\kappa_{cb} > \kappa_{cc}$. We first show the following two inequalities (14) and (15).

$$\frac{1}{\kappa_{cb}} \frac{\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cb}}}}{1-\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cb}}}} > \frac{1}{\kappa_{cc}} \frac{\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cc}}}}{1-\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cc}}}}, \tag{14}$$

and

$$\frac{1}{\kappa_{cc}} \frac{\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cc}}}}{1-\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cc}}}} > \frac{1}{\kappa_{cc}} \frac{\left(\frac{\phi^*_{cc}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cc}}}}{1-\left(\frac{\phi^*_{cc}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cc}}}}. \tag{15}$$

Then using (14) and (15), we obtain $\Omega > 0$, and thus $\frac{\partial \ln \gamma(\phi)}{\partial \ln(\phi)} > 0$.

To show (15), note that $\phi \geq \phi^*_{cb} > \phi^*_{cc}$, and thus $1 \geq \frac{\phi^*_{cb}}{\phi} > \frac{\phi^*_{cc}}{\phi}$. Therefore

$$\frac{1}{\kappa_{cc}} \frac{\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cc}}}}{1-\left(\frac{\phi^*_{cb}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cc}}}} > \frac{1}{\kappa_{cc}} \frac{\left(\frac{\phi^*_{cc}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cc}}}}{1-\left(\frac{\phi^*_{cc}}{\phi}\right)^{\frac{\sigma-1}{\kappa_{cc}}}}.$$

This implies (15). To show (14), note that $\frac{1}{\kappa} \frac{x^{\frac{\sigma-1}{\kappa}}}{1-x^{\frac{\sigma-1}{\kappa}}}$ is an increasing function of κ for any given $x \in (0, 1)$. Then (14) holds because $\kappa_{cb} > \kappa_{cc}$ and $1 \geq \frac{\phi^*_{cb}}{\phi} > 0$.

Combing Case 1 and Case 2, we obtain the desired result of part (a).

Case 3: $\kappa_{cb} < \kappa_{cc}$. In this case, notice that when $\phi \to \phi^*_{cb}$,

$$\frac{(\frac{\phi^*_{cb}}{\phi})^{\frac{\sigma-1}{\kappa_{cb}}}}{1-(\frac{\phi^*_{cb}}{\phi})^{\frac{\sigma-1}{\kappa_{cb}}}} \to \infty, \text{and } 0 < \frac{(\frac{\phi^*_{cc}}{\phi})^{\frac{\sigma-1}{\kappa_{cc}}}}{1-(\frac{\phi^*_{cc}}{\phi})^{\frac{\sigma-1}{\kappa_{cc}}}} < +\infty.$$

Thus $\Omega > 0$. In addition, we know that both $\frac{(\frac{\phi^*_{cb}}{\phi})^{\frac{\sigma-1}{\kappa_{cb}}}}{1-(\frac{\phi^*_{cb}}{\phi})^{\frac{\sigma-1}{\kappa_{cb}}}}$ and $\frac{(\frac{\phi^*_{cc}}{\phi})^{\frac{\sigma-1}{\kappa_{cc}}}}{1-(\frac{\phi^*_{cc}}{\phi})^{\frac{\sigma-1}{\kappa_{cc}}}}$ are decreasing with respect to ϕ. We can prove that there is an unique ϕ^*, such that $\frac{1}{\kappa_{cb}}\frac{(\frac{\phi^*_{cb}}{\phi^*})^{\frac{\sigma-1}{\kappa_{cb}}}}{1-(\frac{\phi^*_{cb}}{\phi^*})^{\frac{\sigma-1}{\kappa_{cb}}}} = \frac{1}{\kappa_{cc}}\frac{(\frac{\phi^*_{cc}}{\phi^*})^{\frac{\sigma-1}{\kappa_{cc}}}}{1-(\frac{\phi^*_{cc}}{\phi^*})^{\frac{\sigma-1}{\kappa_{cc}}}}$, $\Omega > 0$ for $\phi \in (\phi^*_{cb}, \phi^*)$, and $\Omega < 0$ for $\phi \in (\phi^*, +\infty)$. Thus we obtain desired result of part (b). ■