Exceptional Exporter Performance? Evidence from Chinese Manufacturing Firms[*]

Dan Lu

University of Chicago

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Abstract

This paper uses Chinese firm-level data to document facts that run counter to the accumulated evidence about exporting firms and provides a model that reconciles these contrasting patterns. The new facts are: (1) China's exporters are typically less productive and sell less in the domestic market than non-exporters, and (2) the distribution of export intensity exhibits a U-shape, with more than half of China's exporters exporting most of their output. Previous studies of firms in more developed countries have found that exporters are more productive, sell more in the domestic market, and export only a small fraction of their output. The new facts call into question the generality of recent trade theory, which has been extremely successful in explaining the behavior of exporters in developed countries. However, I show that the economic forces described by Melitz (2003), when properly interpreted, are exactly the ones needed to explain the observed patterns among Chinese 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. Hence domestic rather than export markets select the most efficient firms. In the Chinese data, both the productivity differences between exporters and non-exporters as well as the distribution of export intensity are systematically related to the labor intensity of the firm or its industry. This relationship is exactly what is predicted by a Melitz model augmented to allow for factor intensity to vary by industry. Lastly, I show that the model correctly predicts the effects of trade liberalization in China following China's integration into the WTO in 2001.

1   Introduction

This paper documents stylized facts about exporting firms in China that contrast with the accumulated evidence in the literature. First, China's exporters are typically less productive and sell less in the domestic market than non-exporters. Second, the distribution of export intensity in China exhibits a U-shape, i.e., while many exporters only export a very small fraction of their output, another large set of exporters export the majority of their output. However, previous studies of firms in developed countries have found that exporters are more productive, sell more in the domestic market than their non-exporting counterparts, and export only a small fraction of their output.[1]

These facts seem to be inconsistent with existing trade theories as well. Existing theories (e.g. Melitz (2003), Chaney (2008), Eaton, Kortum, and Kramarz (2009)) postulate that firms differ in production efficiency. With fixed costs and trade costs of selling to foreign markets, only the more productive firms will be able to export. These models seem to be a poor match for the behavior of Chinese firms, which raises the question: How can we explain the very different firms' exporting behavior?

A useful clue comes from the fact that export patterns of Chinese firms are systematically related to the factor intensity of firms/sectors. In labor-intensive sectors, exporters are actually the majority, are less productive than non-exporters, and export a large fraction of their output. On the other hand, in capital-intensive sectors, exporters are the minority, are more productive than non-exporters, and export a small fraction of their output.

This brings us to an explanation based on factor intensity. Indeed, Melitz's (2003) insight is that only the more productive firms are able to enter tougher markets, which we have always assumed to be the foreign markets. This is not necessarily the case, especially if countries differ in factor endowments, and sectors differ in factor intensities. In particular, for a labor-abundant country like China, wages in its main export destinations are likely to be higher than its domestic wage. For labor-intensive goods, prices are higher in the foreign market than in the domestic market. Thus the exporting markets are less competitive than the domestic market for Chinese firms in the labor-intensive sectors. As a result, less productive firms sell only to foreign markets while the survivors in the more competitive domestic market are the more productive firms. For example, for a Chinese producer of apparel (a labor-intensive sector), the Chinese market, populated by firms with access to cheap labor, is much tougher than the US market, populated mostly by firms with access to more expensive labor. The opposite is true for capital-intensive sectors. For a Chinese

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[1]For example, Bernard and Jensen (1995, 1999), Aw, Chung, and Roberts (1998), and Bernard and Wagner (1996) show that across a wide range of countries and industries, employment, shipments, wages, productivity, and capital intensity are all higher at exporters than non-exporters at any given moment.

producer of pharmaceuticals (a capital-intensive sector), it is much harder to enter the US market than the domestic market.

The relative competitiveness of markets also explains firms' export intensity. By adopting Arkolakis's (2008) market access costs, we expect that the more productive firms in markets will access more consumers and sell more. For Chinese firms in labor-intensive sectors, the foreign markets are less competitive than the domestic market. These exporters are relatively more profitable in foreign markets and are thus able to access more consumers there. Hence, a large fraction of their output is sold abroad. Again the opposite is true for exporters in capital-intensive sectors. Exporters sell a small fraction of their output abroad. The model explains the different patterns of trade, productivity, and export intensity in China as well as in developed countries documented in the literature.

When embedded in a general equilibrium framework, the model predicts that if we lower import tariffs in China, labor will shift to labor-intensive sectors because of Heckscher–Ohlin effects. In addition, the productivity advantage of exporters decreases across all sectors as the domestic markets become more competitive due to foreign competition. These predictions are confirmed by the Chinese data when China joined the WTO in 2001 and reduced import tariffs dramatically.

In the literature, the superior performance of exporting firms relative to non-exporters is often explained by self-selection (i.e., good firms become exporters) rather than by learning by exporting. This paper supports the self-selection mechanism precisely because exporters do not necessarily exhibit superior performance.[2]

Introducing factor endowments and different factor intensity across sectors into Melitz (2003) follows the model of Bernard, Redding, and Schott (2007). But in this paper, I show why we need to bring Heckscher-Ohlin theory to the study of firm-level trade. When firms in a labor-abundant country like China export to developed countries, comparative advantage makes it easier to enter foreign markets for labor-intensive goods; hence firms' exporting behavior exhibits patterns opposite to those observed in capital-abundant countries.

The rest of this paper is organized as follows: Section 2 reports the facts. Section 3 explains individual firms' decisions in a partial equilibrium setup, and shows how the model fits the data. Section 4 presents the general equilibrium analysis and the effects of tariff change. Section 5 concludes.

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[2]Clerides, Lach, and Tybout (1998) concludes that the well-known efficiency gap between exporters and non-exporters is due to self-selection of the more efficient firms into the export market, rather than due to learning by exporting. Bernard and Jensen (1999) also finds evidence that good firms become exporters. Both growth rates and levels of success measures are higher ex-ante for exporters, while the benefits of exporting for the firm are less clear. Whether exporting improves Chinese firms' performance is not analyzed in the paper.

2 Empirical Evidence

The data used in this paper comes from a firm-level data set from the Annual Census of Enterprises by the Chinese National Bureau of Statistics from 1998 to 2007.[3] It includes all the State-Owned Enterprise (henceforth SOE) and non-SOEs with sales over 5 million RMB (about 600,000 US dollars), yielding 162,855 firms in the 2000 survey. This number rises to 336,768 in 2007. The data contain all information from the three accounting statements (balance sheet, profit & loss, and cash flow), which include more than 100 financial variables for each firm. The analyses are based on all manufacturing firms, representing 90% of all firms in the sample. Their exports total about 90% of Chinese manufacturing exports from aggregate trade data.

2.1 Export Participation and Productivity

This section describes the overall patterns of Chinese manufacturing firms' exporting behaviors. By comparing the statistics with those from US firms,[4] I demonstrate the systematic differences between Chinese and US firms.

Table 1: Exporting Participation

	Percentage of Manufacturing Firms				
Export Status	China[a]	US[b]	Germany[c]	France[d]	Taiwan[e]
Some Exports	29.6	21	44	17.4	46

Export Value / Gross Production	
China	US
22	14

[a]The statistics are calculated from the Annual Census of Enterprises in China, for all manufacturing firms in 2005.
[b]Bernard, Eaton, Jensen, and Kortum (2003), 1992 US Census of Manufactures.
[c]Bernard and Wagner (1997), 1978 and 1992 Annual Survey of Establishments, Lower Saxony State, Germany.
[d]Eaton, Kortum, and Kramarz (2004), 1986 Customs and BRN-SUSE data source.
[e]Aw and Hwang (1994), 1986 Taiwanese electronics industry.

The first natural question would be: How many firms export? Table 1 reports the overall export participation for manufacturers. The fraction of exporting firms in China is higher than that in the US, but exporters are still in the minority.

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[3]I thank Liutang Gong in Beijing University for providing this data.
[4]Statistics from other countries, if available, are also shown. Note that they are similar to the US figures.

For firms that export, how much do they sell abroad? Table 2 reports the distribution of export intensity – export values as the percentage of total output – for exporters. Notice that the Chinese export intensity distribution is U-shaped: fewer than 20% of exporters sell less than 10% of their output abroad, while about 40% of them export more than 90% of their output.

Table 2: Export Intensity of Exporters

	Percentage of Exporters		
Export Intensity (%)	China[a]	US[b]	Germany[c]
0 to 10	18.15	66	50
10 to 20	8.60	16	
20 to 30	4.98	7.7	
30 to 40	4.52	4.4	
40 to 50	4.26	2.4	
50 to 60	4.13	1.5	12.6
60 to 70	4.35	1.0	
70 to 80	5.08	0.6	
80 to 90	6.46	0.5	
90 to 100	39.49	0.7	

[a]The statistics are calculated from the Annual Census of Enterprises in China, for all manufacturing firms in 2005.
[b]Bernard, Eaton, Jensen, and Kortum (2003).
[c]Bernard and Wagner (1997).

This is significantly different from the US distribution. The second column of Table 2, taken from Bernard et. al. (2003), indicates that two-thirds of US exporters sell less than 10% of their output abroad, and fewer than 5% of them export more than 50% of their output.[5]

Are exporting firms systematically different from non-exporting firms in China? The answer is yes, as demonstrated by Table 3.[6] Chinese exporting firms are larger than non-exporters, though the difference is not as pronounced as for their US counterparts. The more striking finding is that exporting firms have lower labor productivity (about 10%) than non-exporters. Again these patterns are different for US plants. US exporters are more productive than their non-exporting counterparts with higher (more than 30%) sales per worker and value added per worker.[7]

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[5]The third column for Germany should indicate that 50% of exporters export less than 15% of their output; overall, 12.6% of exporters export more than 50% of their output.

[6]In this table, I define exporters relative to non-exporters as the arithmetic mean value of exporters divided by the arithmetic mean of non-exporters to facilitate a direct comparison with the US figures in Bernard and Jensen (1995). However, since the data distributions are close to log-normal, a geometric mean is probably more appropriate and is used in the rest of this paper.

[7]One may argue that, since Chinese exporters use labor more intensively, differences in value added per

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Table 3: Firms Characteristics

	Exporters Relative to Non-Exporters[a]				
	China	US[b]	Germany	France	Taiwan
Total sales	2.92	6.48	5.87	28	15.41
Employment	2.59	4.38	3.84		8.17
Value added	2.74				13.35
Sales per worker	0.91	1.36	1.01		1.56
Value added per worker	0.86	1.39	0.99	1.22	

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[a]Mean value of exporters divided by mean value of non-exporters.
[b]Bernard and Jensen (1995), 1987 US Census of Manufactures.

These findings suggest that firm exporting behavior in China exhibits a pattern different from the United States and other countries. Why is this the case?

2.2 Determinants of Market Selection: Labor-Intensity of Firms or Their Sectors

In this section I consider the explanatory power of the capital-labor ratio. I examine the three questions in Section 2.1 by the labor-intensity of firms or their sectors: How many firms export? How much do they export? What is the productivity difference between exporters and non-exporters?

Export Participation

To do so, I first rank sectors by their capital-labor ratio. Figure 1 plots the share of exporting firms in 2-digit sectors (on the y-axis) against the median capital-labor ratio in the sector. There is a clear negative relationship between export participation and the capital-labor ratio: more firms in the sector export if the sector uses labor more intensively.

Distributions of Export Intensity

I then plot the histogram of export intensity in sectors grouped by their factor intensity. Figures 2, 3, and 4 show the distribution of export intensity of exporters in sectors with low, medium, and high capital-labor ratio, respectively. A common pattern is that exporters in labor-intensive sectors export a large fraction of their output, while exporters in capital-intensive sectors export only a small fraction of their output. The distributions of export intensity shifts to the left as sectors' relative capital usage increases. In general, the distribution of foreign-owned firms (including Hong Kong, Macau, and Taiwan firms,

worker in China cannot be directly compared to the same ratio in US, as it may misrepresent the differences in TFP. However, Chinese exporters on average are still less productive than non-exporters after controlling for factor usage. See Section 2.2 for details.

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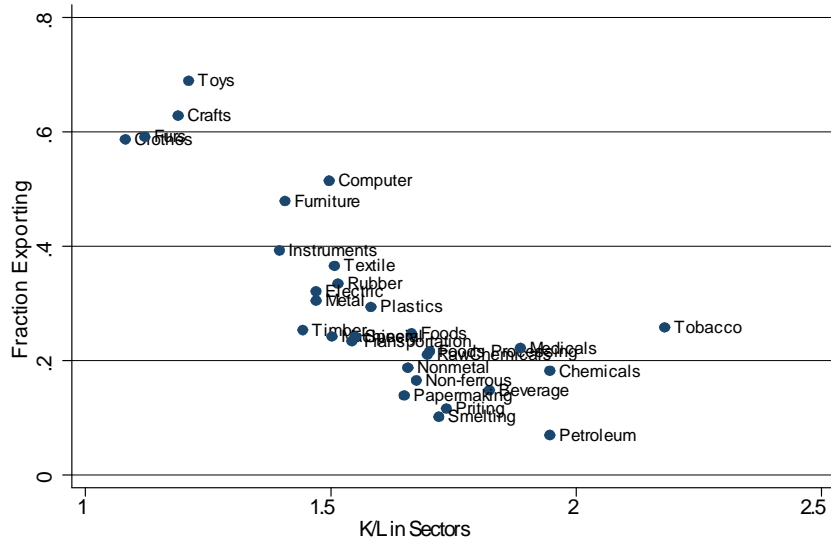Figure 1: Share of Exporters vs K/L Across Sectors.

Figure 2: Histogram of Exporters Export Intensity : Labor-Intensive Sectors
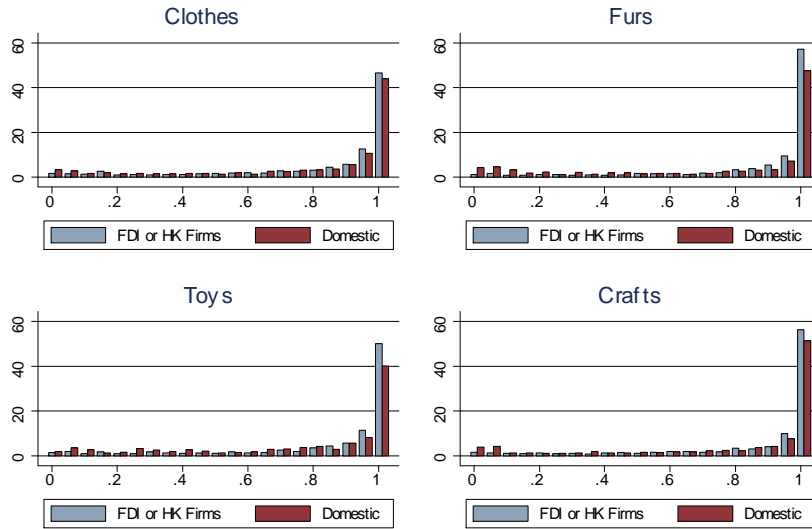
Figure 3: Histogram of Exporters Export Intensity: Medium Capital-Intensity Sectors
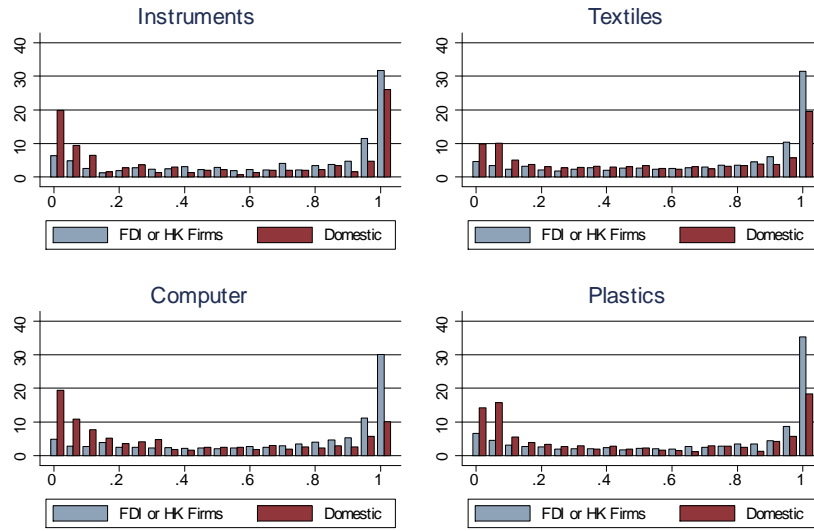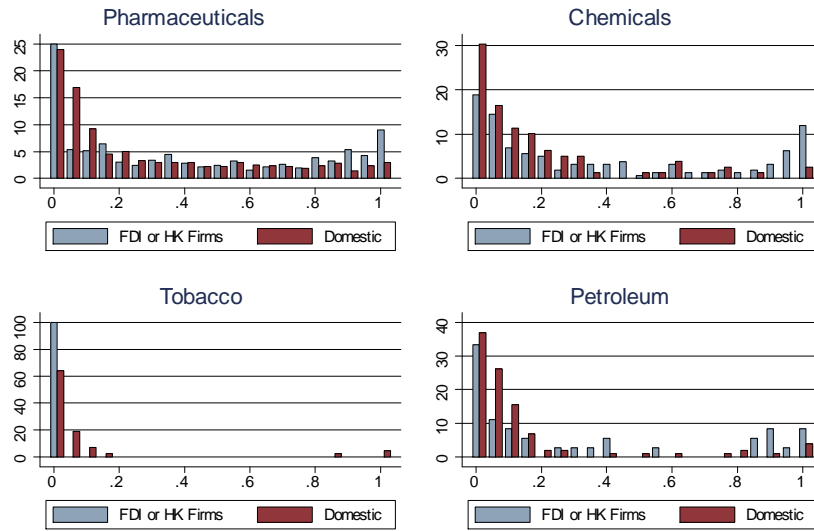

Figure 4: Histogram of Exporters Export Intensity: Capital-Intensive Sectors

and firms in tariff free zones) are more concentrated to the right (which means they sell relatively more abroad than domestic firms). Yet they exhibit a similar left-shifting pattern as we move from labor-intensive to capital-intensive sectors.

Productivity Differences Between Exporters and Non-Exporters

I also examine average labor productivity (in terms of value added per worker) for exporters and non-exporters across different sectors. The x-axes in Figures 5 and 6 are the median capital-labor ratio of sectors. Figure 5 plots the value-added per worker for exporting and non-exporting firms in each sector. Notice that in labor-intensive sectors, non-exporters have higher productivity than exporters, whereas the reverse is true in capital-intensive sectors. Figure 6 plots the differences in value added per worker between exporters and non-exporters for each sector. The difference between exporters and non-exporters increases with capital intensity. The differences are negative for labor-intensive sectors, meaning that exporters have lower labor productivity in these sectors.[8]

Figure 5: Productivity of Exporters and Non-Exporters Across Sectors
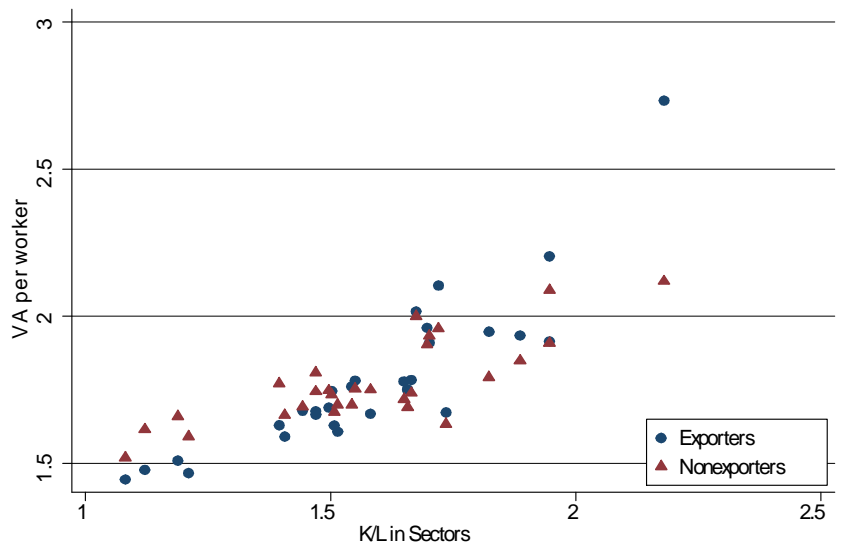
It is possible that a sector median is not a good classification for a firm's technology and capital-labor usage. To further explore the relationship between factor intensity and productivity differences, I rank firms by their capital-labor ratio and group them into 100 bins. Within each group, firms are choosing a very similar capital-labor ratio. In this case, differences in value added per worker represent differences in firm TFP.

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[8]The pattern is similar if we exclude SOEs. Among non-SOEs, exporters are less productive in labor-intensive sectors, and the productivity difference between exporters and non-exporters has a significant positive relation with the capital-labor usage. Therefore, SOEs are not the explanation of this relationship.

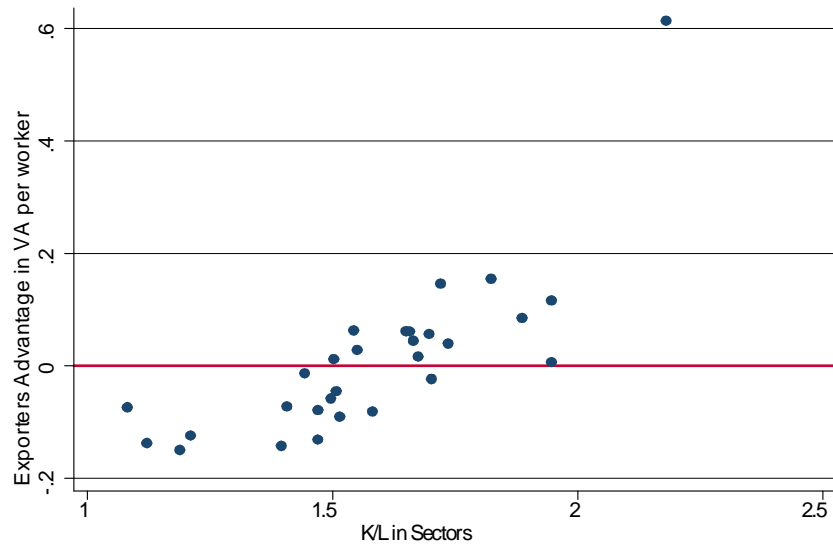Figure 6: Productivity Differences Between Exporters and Non-Exporters Across Sectors

Figure 7: Productivity of Exporters and Non-Exporters Across Different K/L Bins
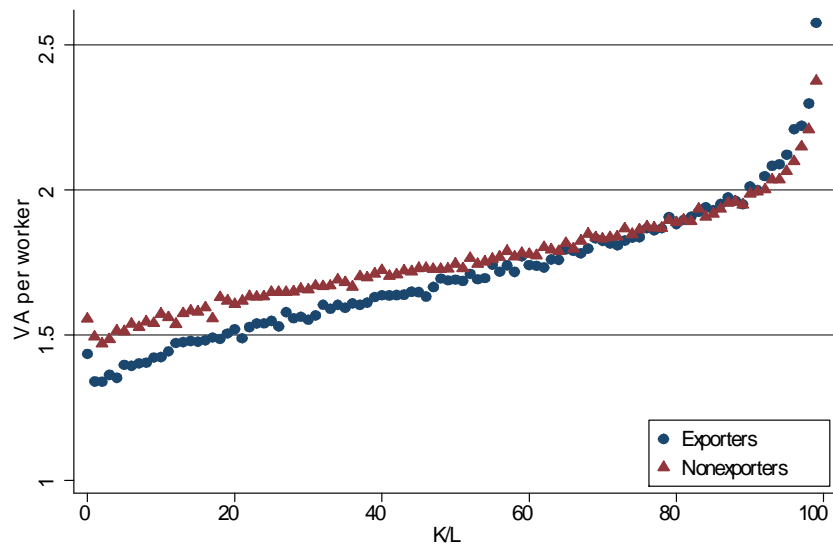
Figure 8: Productivity Differences Between Exporters and Non-Exporters and the 95% confidence intervals Across Different K/L Bins
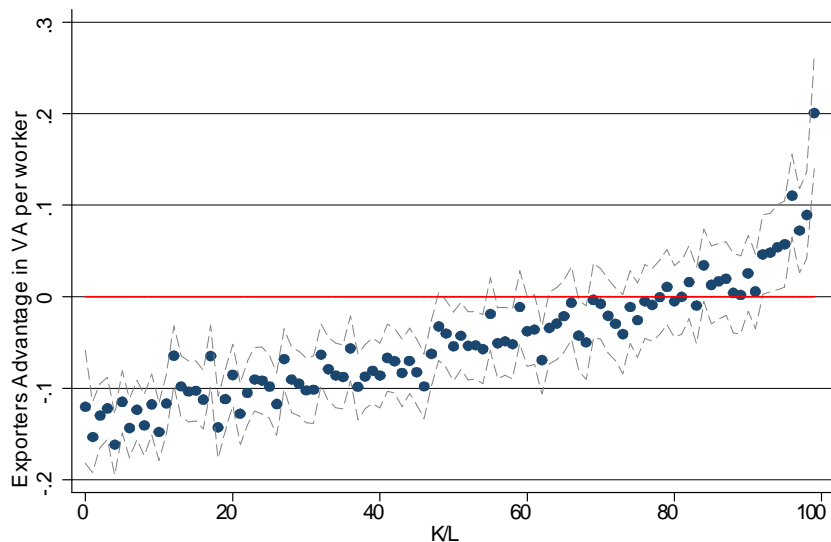

Figure 7 plots the mean level of log value added per worker of exporters and non-exporters across different capital-labor-ratio bins. Figure 8 shows the differences between the value of exporters and non-exporters and the 95% confidence intervals. Again, the productivity difference between exporters and non-exporters has a significant positive relation with the capital-labor ratio. Exporters are more productive among capital-intensive goods, but not among labor-intensive goods. Figure 9 reports the results from the same exercise excluding SOEs. The pattern is similar, suggesting that SOEs are not generating the significant positive relationship observed.

Another possible productivity measure is sales. Under monopolistic competition and CES preferences, more efficient firms have larger sales. Figure 10 plots the total sales of exporters and non-exporters across different capital-labor-ratio bins. It is not surprising that exporters have higher sales than non-exporters, as they enter into more markets. If we consider sales in a single market, the domestic market only, we get Figure 11 (I also plot the percentage of exporter selling in the domestic market for the readers' information). Domestic sales of exporters are smaller than non-exporters for labor-intensive goods, but larger for capital-intensive goods. Both sales and domestic sales figures exhibit a systematic relationship between the exporter-nonexporter difference and capital-labor usage as seen earlier.

The evidence suggests a systematic relationship between the capital-labor ratio and export patterns. Any good explanation of the overall pattern of export behavior should also

Figure 9: Productivity Differences Between Exporters and Non-Exporters and the 95% confidence intervals Across Different K/L Bins, Non-SOE Firms
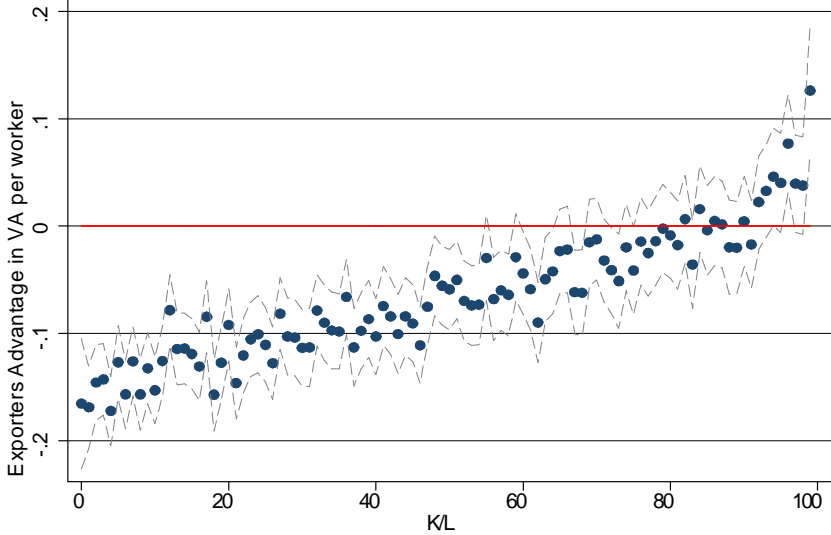

Figure 10: Total Sales of Exporters and Non-Exporters Across Different K/L Bins
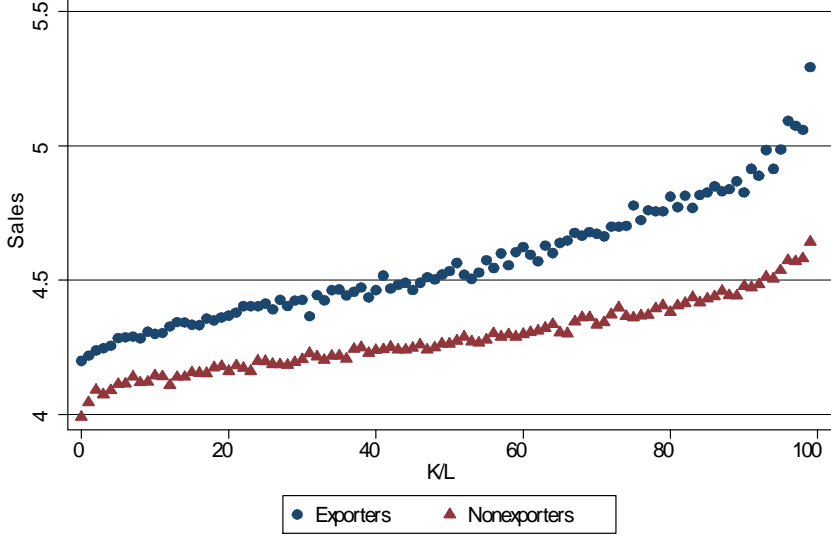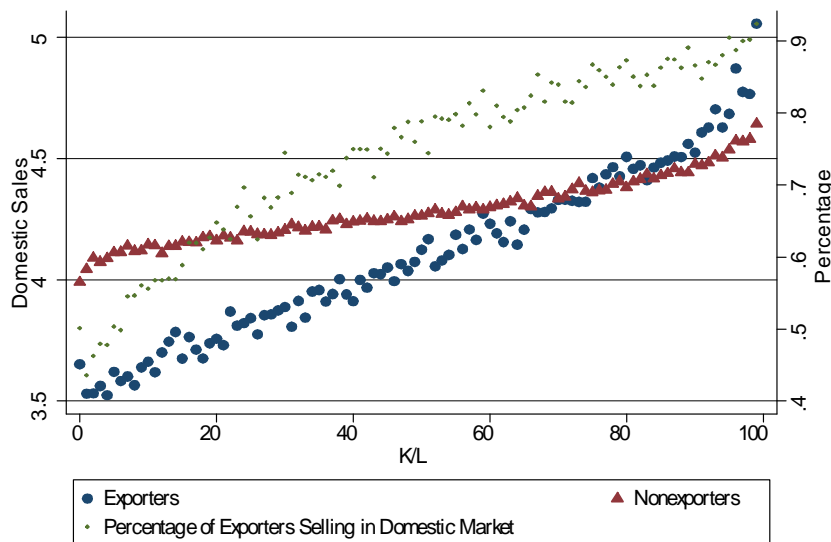
Figure 11: Domestic Sales of Exporters and Non-Exporters Across Different K/L Bins

be consistent with this relationship.[9]

3 Model

To recap, Chinese exporters are less efficient than non-exporters on average. This fact seems to contradict the existing theories of export participation (Melitz (2003)), which predict only the more efficient firms will export to the tougher foreign market. At the same time, the systematic relationship between exporters non-exporters productivity differences and capital-labor ratio hints at an explanation driven by factor intensity, a mechanism which is absent in the existing models. Indeed, when relative factor endowment in the domestic and foreign markets differ, whether the foreign market is "tougher" depends on the factor intensity.

In Section 3.1, I introduce endowment-driven comparative advantage into Melitz (2003) and Chaney (2008) in a manner similar to Bernard, Redding, and Schott (2007). The stripped-down model is used to give the intuition for why such a model can explain the trade patterns in China and in developed countries.

The full model which adds market access costs (Arkolakis, 2008) and firm-specific shocks in entry costs (Eaton, Kortum, and Kramarz, 2009) is presented in Section 3.2. I show that

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[9]In Appendix A, I consider and reject several explanations of differences between US and Chinese exporters. Overall, SOE or foreign-owned firms' behavior, tariff free zones, and processing trade explain little of the opposite patterns observed in China.

the observations documented in Section 2, which seem to contradict the existing models, actually fit the natural hybrid model, both qualitatively and quantitatively.

3.1 A Baseline Model

There are 2 countries, $m, n \in \{CN, US\}$, that produce goods using capital and labor. China is relatively labor abundant: $\frac{K_{CN}}{L_{CN}} < \frac{K_{US}}{L_{US}}$. In this section, I restrict the analysis to a partial equilibrium model by assuming $\frac{w_{CN}}{r_{CN}} < \frac{w_{US}}{r_{US}}$, i.e., China has relatively cheap labor. A general equilibrium analysis consistent with this assumption is deferred to Section 4.

To focus on differences in factor costs, countries are assumed to have the same preferences and technology. There are I sectors in each country.

Preferences

In both countries, utility is a Cobb-Douglas function of the I sector goods, with $\gamma_i \in (0, 1)$ being the share of spending on sector i.

$$U = \prod_{i \in I} \left(C^i \right)^{\gamma_i}.$$

Sector i consumption is a composite of individual varieties sold in the market,

$$C^i = \left[\int_{\Omega^i} q^i(z)^{\frac{\sigma-1}{\sigma}} d\mu(z) \right]^{\frac{\sigma}{\sigma-1}}, \ \ P^i = \left[\int_{\Omega^i} p^i(z)^{1-\sigma} d\mu(z) \right]^{\frac{1}{1-\sigma}},$$

where σ is the elasticity of substitution across varieties. Assume σ is the same across countries and sectors.

Technology

Firms within each sector have heterogeneous productivity. The measure of potential firms in country m and sector i who have productivity at least z is:

$$\mu_m^i(z) = T_m z^{-\theta}.$$

Assume θ is the same across countries and sectors.[10]

The production function for a firm with productivity z in sector i is:

$$y^i(z) = z l^{\beta_i} k^{1-\beta_i},$$

where β_i is the labor intensity of sector i. Sector i is more labor intensive than sector i' if

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[10]Assumption of Pareto distribution makes the model analytically simple. Results hold for general productivity distributions.

$\beta_i > \beta_{i'}$.

Trade Barriers

Selling goods in a foreign country incurs transportation cost $d > 1$ and tariff charge $\tau > 0$. Transportation costs are iceberg costs: for 1 unit of goods to arrive in n, d_{nm} units need to be shipped from m. On the other hand, tariffs distort prices but do not entail a physical loss of goods. Trade barriers can take many forms; here I only consider flat rate tariffs τ_{nm} which are levied by country n on goods imported from m. Tariff revenues are rebated as lump sum payments to households in n.

Firm Decisions

There is a fixed entry cost to sell in each market (country). Each firm in each country decides where to sell its output and what price to set in each market.

Pricing

For simplicity I drop the country index. The variable cost function for a firm in sector i is $c^i(z) = B \frac{w^{\beta_i} r^{1-\beta_i}}{z}$, where $B = \beta^{-\beta} (1-\beta)^{\beta-1}$.

In the home market the firm sets a price that is the usual markup over unit cost: $p^i(z) = \frac{\sigma}{\sigma-1} c^i(z)$. If it sells in a foreign country, it adjusts that price for tariffs and trade costs: $p_x^i(z) = d(1+\tau) \frac{\sigma}{\sigma-1} c^i(z)$. The potential revenue from selling in either market is

$$s_n^i(z) = (\gamma_i X_n) \left(\frac{p^i(z)}{P_n^i} \right)^{1-\sigma}, \quad n = CN, US \tag{1}$$

where X_n is the total spending of the market and P_n^i is the price index of the market.

Market Selection

Let E_d and E_x be the Chinese firms' entry cost to the domestic and foreign market respectively. Note the entry costs here are the fixed costs in Melitz (2003); i.e., E_d is f and E_x is $f + f_x$. Because the model here is static, there is no entry costs f_e on free-entry condition.

The net profits for firm z from selling in the domestic and foreign market are:

$$\pi_d^i(z) = \frac{s_d^i(z)}{\sigma} - E_d$$
$$\pi_x^i(z) = \frac{s_x^i(z)}{\sigma} - E_x.$$

Then the productivity cutoffs of entering domestic and foreign markets are $\bar{z}_d^i$ and $\bar{z}_x^i$,

respectively:

$$s_d^i \left(\bar{z}_d^i \right) = \sigma E_d$$
$$s_x^i \left(\bar{z}_x^i \right) = \sigma E_x. \tag{2}$$

Using the formula for the revenue (1) and combining the expressions of productivity cutoffs (2), we get the relationship between domestic and exporting productivity cutoffs:

$$\frac{\bar{z}_x^i}{\bar{z}_d^i} = d \left(1 + \tau \right) \frac{P_d^i}{P_x^i} \left(\frac{X_d E_x}{X_x E_d} \right)^{\frac{1}{\sigma-1}}. \tag{3}$$

The literature to date assumes that countries are symmetric, in which case $\frac{P_d^i}{P_x^i} = 1$, then $\frac{\bar{z}_x^i}{\bar{z}_d^i} > 1$ due to extra trade costs or higher fixed costs for exporting. Because the existing empirical evidence finds that only the most productive firms export, the productivity cutoff for exporting must be higher. But, in theory, this ratio can be less than 1. In particular, if $\frac{P_d^i}{P_x^i}$ is low enough, then $\frac{\bar{z}_x^i}{\bar{z}_d^i} < 1$ and the domestic market is tougher than the foreign market, so that less productive firms sell to the foreign market. $\frac{P_d^i}{P_x^i} = \frac{P_{CN}^i}{P_{US}^i}$ is decreasing in the labor intensity of the sector i (Proof is provided in Section 3.2). Therefore, it is more likely that the price ratio is low enough in labor-intensive sectors in China to make $\frac{\bar{z}_x^i}{\bar{z}_d^i} < 1$.

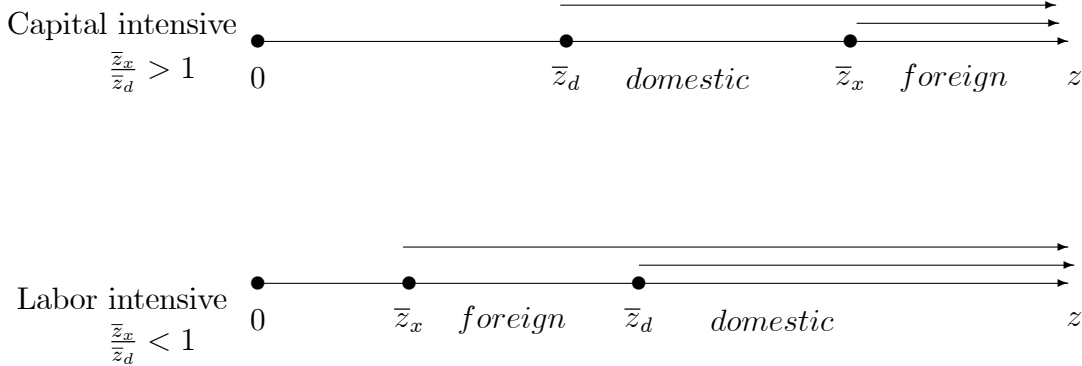Figure 12: Productivity Cutoffs for Market Entry

Figure 12 summarizes Chinese firms' decisions for the domestic and foreign markets and for different sectors. For the labor-intensive sector, $\frac{P_d}{P_x}$ is very small and $\frac{\bar{z}_x}{\bar{z}_d} < 1$.

Intuitively, since wages are generally higher in the main export destinations of Chinese products than in China, labor-intensive goods are more expensive in those markets. With frictional trade, the price indices of those goods in foreign markets decrease but are still higher than that in the Chinese market. Hence, for labor-intensive goods, foreign markets are less competitive than the domestic (Chinese) market. As a result, less productive firms

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sell only to the foreign market, while survivors in the more competitive domestic market are more productive. The opposite is true for capital-intensive sectors: Capital is abundant abroad, so foreign firms have lower costs. Since the foreign market is more competitive, only the most productive Chinese firms can export. Less productive Chinese firms in those sectors can sell domestically, but they cannot export.

At the same time, it can happen that for US firms, the foreign market is tougher in both the capital and labor-intensive sectors. Therefore, productive US firms export in both capital and labor-intensive sectors.[11] For Chinese firms, more productive firms export in capital-intensive sectors and less productive firms export in labor-intensive sectors. Relative market competitiveness, hence the productivity cutoffs in (3) also depend on markets size and entry costs. When the US market is larger or the entry cost is lower, the above case is more likely to happen.

3.2 Full Model

The baseline model shows that augmenting the Melitz model to allow for factor intensity that varies by industry can explain the very different exporting patterns in China and the US. In this section, I follow Eaton, Kortum, and Kramarz (2009) to introduce firm-by-market specific shocks in entry costs or/and demand and incorporate Arkolakis's (2008) formulation of market access costs. The former helps explain market entry decisions, and the latter helps explain export intensity. The extended model fits the data quantitatively.

In the basic model, firms enter markets according to a perfect hierarchy. Any firm selling to a tougher market necessarily sells to the softer market as well. Therefore, when the domestic market is tougher, any firm selling in the domestic market should also export. On the other hand, when the foreign market is tougher, every exporter should sell in the domestic market as well. Neither the French nor the Chinese data display this rigid pattern, so in this section I incorporate firm-by-market specific shocks to break the deterministic ranking of markets.

In the Melitz model, the distribution of export intensity is degenerate. For a n-country model, the distribution is a step function depending on the number of countries firms sell to. Introducing an endogenous marketing costs adds an intensive margin and shows how relative toughness of the markets affects firms' sales in different markets.

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[11]Note even with symmetric market sizes and entry costs, Chinese firms cutoff ratio is $d\left(1+\tau\right)\frac{P_{cn}^{i}}{P_{us}^{i}}$ and US firms cutoff ratio is $d\left(1+\tau\right)\frac{P_{us}^{i}}{P_{cn}^{i}}$ with $d\left(1+\tau\right) > 1$. Hence it can happen that $\frac{\bar{z}_x^i}{\bar{z}_d^i} < 1$ and $\frac{\bar{z}_x^{i'}}{\bar{z}_d^{i'}} > 1$ for Chinese labor-intensive and capital-intensive goods, respectively, while $\frac{\bar{z}_x^i}{\bar{z}_d^i} > 1$ for both US labor and capital-intensive goods.

Entry Costs

Consider a firm in country m. In addition to its idiosyncratic productivity shock z, it has an idiosyncratic shock ε_n to its marketing cost in country n. I assume firm $(z, \vec{\varepsilon})$ pays a cost $E_n(\varepsilon_n)$ to sell goods in country n:

$$E_n(\varepsilon_n) = \varepsilon_n E_n M(f), \tag{4}$$

where E_n is the component of the cost common to all the firms. ε_n is the firm-specific fixed-cost shock in market n. $M(f)$ is the cost for a firm that choose to access a fraction f of consumers in the market, and the function $M(f)$ is the same across destinations. I use the specification for marketing costs derived by Arkolakis (2008):

$$M(f) = \frac{1 - (1-f)^{1-\frac{1}{\lambda}}}{1 - \frac{1}{\lambda}}. \tag{5}$$

The cost of reaching zero consumers in a market is zero. Total cost is increasing and marginal cost is weakly increasing. Since it is harder to access a higher fraction of consumers, we can expect more productive firms to choose a larger fraction of consumers. Export intensity depends on a firm's relative performance in domestic and foreign markets.

Results

I drop the country index for simplicity. The firm's optimization problem is:

$$\max_f \pi(z, \varepsilon) = f \frac{s(z)}{\sigma} - \varepsilon E M(f). \tag{6}$$

The FOC is:

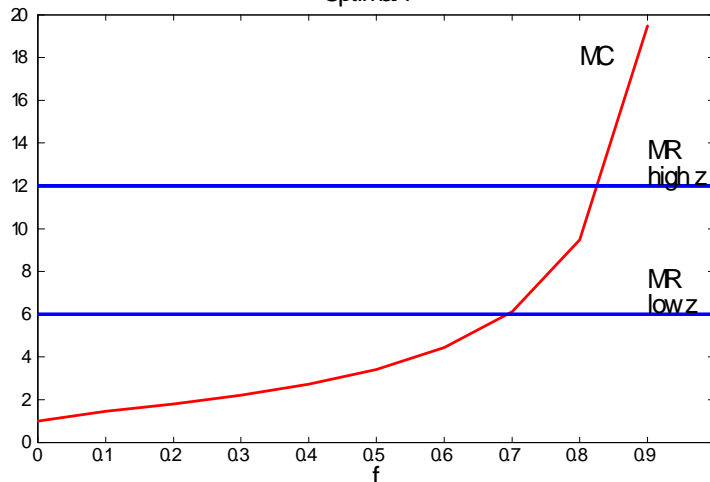$$\frac{s(z)}{\sigma} = \frac{\varepsilon E}{(1-f)^{\frac{1}{\lambda}}} \tag{7}$$

Figure 13 shows the marginal cost (right-hand side of the FOC (7)) and marginal revenue (left-hand side of the FOC (7)) of accessing f fraction of consumers, given εE. Firms with higher z have higher optimal f, which means more productive firms choose to access more consumers.

Optimal f

Using the formula for revenues (1) and the FOC (7), we get the optimal f

$$f(c, \varepsilon) = \max \left\{ 1 - \left[\frac{\sigma \varepsilon E}{\gamma^i X} \left(\frac{\sigma}{\sigma - 1} \frac{c^i(z)}{P^i} \right)^{\sigma - 1} \right]^{\lambda}, 0 \right\}.$$

Figure 13: Optimal f

Define

$$\bar{c}^i\left(\varepsilon\right) = \left(\frac{\gamma^i X}{\sigma \varepsilon E}\right)^{\frac{1}{\sigma-1}} \frac{\sigma-1}{\sigma} P^i = M \left(\frac{\gamma^i X}{\varepsilon E}\right)^{\frac{1}{\sigma-1}} P^i, \tag{8}$$

which summarizes all the parameters of the market; $M = \frac{\sigma-1}{\sigma^{\frac{\sigma}{\sigma-1}}}$.

A firm with cost c and shock ε enters the market if

$$c \leq \bar{c}^i\left(\varepsilon\right), \tag{9}$$

and chooses to reach f fraction of consumers

$$f\left(c, \varepsilon\right) = 1 - \left(\frac{c}{\bar{c}^i\left(\varepsilon\right)}\right)^{(\sigma-1)\lambda}. \tag{10}$$

Both the entry and access decisions depend on the market's profitability $\bar{c}^i\left(\varepsilon\right)$ in (8): if the price index P^i is higher, the market size $\gamma^i X$ is larger, or the fixed cost εE is lower, then $\bar{c}^i\left(\varepsilon\right)$ is larger, and it is more profitable and easier for firms to sell in the market. Equation (10) shows that, conditional on entering a market, lower cost firms sell more not only because they have lower prices, but also because they choose to spend more on marketing to access a larger fraction of consumers.

Price Index

The price index for sector i in country n depends on prices of varieties from both countries

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and weighted by market penetration f of the varieties. Specifically,

$$P_n^i = \frac{\sigma}{\sigma - 1} \left[\int \left(\sum_m \int_0^{\bar{c}_{nm}^i(\varepsilon)} f(\varepsilon, c) c^{1-\sigma} d\mu_{nm}(c) \right) g(\varepsilon) d\varepsilon \right]^{\frac{1}{1-\sigma}}, \qquad (11)$$

where

$$\mu_{nm}(c) = \Phi_{nm}^i c^{\theta},$$

$$\Phi_{nm}^i = T_m \left(w_m^{\beta_i} r_m^{1-\beta_i} d_{nm} (1 + \tau_{nm}) \right)^{-\theta}. \qquad (12)$$

It can be shown (see EKK (2009)) that the price index in sector i country n is

$$P_n^i \propto \left(\Phi_n^i \right)^{-\frac{1}{\theta}} \left(\frac{X_n^i}{E_n} \right)^{\frac{1}{\theta} - \frac{1}{\sigma - 1}}, \qquad (13)$$

$$\text{where } \Phi_n^i = T_n \left(w_n^{\beta_i} r_n^{1-\beta_i} \right)^{-\theta} + T_m \left(w_m^{\beta_i} r_m^{1-\beta_i} d_{nm} (1 + \tau_{nm}) \right)^{-\theta} \qquad (14)$$

is a weighted average of inputs costs at home and abroad for industry i.

The following proposition establishes the relationship between relative factor costs and relative price indices.

Proposition 1 *With frictional trade $(d(1+\tau) > 1)$, if CN is more labor abundant than the US $\left(\frac{w_{CN}}{r_{CN}} < \frac{w_{US}}{r_{US}} \right)$, and sector i is more labor intensive than sector i' $(\beta_i > \beta_{i'})$, then*

$$\frac{P_{US}^i}{P_{CN}^i} > \frac{P_{US}^{i'}}{P_{CN}^{i'}}.$$

That is, more labor-intensive goods have a higher relative price index in the US.

Proof. First note that

$$P_n^i \left(\Phi_n^i \right) \propto \left(\Phi_n^i \right)^{-\frac{1}{\theta}} \left(\frac{X_n^i}{E_n} \right)^{\frac{1}{\theta} - \frac{1}{\sigma - 1}},$$

where

$$\Phi_n^i = T_n \left(w_n^{\beta_i} r_n^{1-\beta_i} \right)^{-\theta} + T_m \left(w_m^{\beta_i} r_m^{1-\beta_i} d_{nm} (1 + \tau_{nm}) \right)^{-\theta}.$$

Let $d_1 = d_{us,cn} (1 + \tau_{us,cn}) > 1$ and $d_2 = d_{cn,us} (1 + \tau_{cn,us}) > 1$, then

$$\frac{P_{US}^i}{P_{CN}^i} > \frac{P_{US}^{i'}}{P_{CN}^{i'}}$$

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is equivalent to

$$\frac{T_{cn}\left(w_{cn}^{\beta_i}r_{cn}^{1-\beta_i}\right)^{-\theta} + T_{us}\left(w_{us}^{\beta_i}r_{us}^{1-\beta_i}d_2\right)^{-\theta}}{T_{cn}\left(w_{cn}^{\beta_i}r_{cn}^{1-\beta_i}d_1\right)^{-\theta} + T_{us}\left(w_{us}^{\beta_i}r_{us}^{1-\beta_i}\right)^{-\theta}} > \frac{T_{cn}\left(w_{cn}^{\beta_{i'}}r_{cn}^{1-\beta_{i'}}\right)^{-\theta} + T_{us}\left(w_{us}^{\beta_{i'}}r_{us}^{1-\beta_{i'}}d_2\right)^{-\theta}}{T_{cn}\left(w_{cn}^{\beta_{i'}}r_{cn}^{1-\beta_{i'}}d_1\right)^{-\theta} + T_{us}\left(w_{us}^{\beta_{i'}}r_{us}^{1-\beta_{i'}}\right)^{-\theta}}.$$

Letting $v_i = \left(\frac{w_{us}r_{cn}}{w_{cn}r_{us}}\right)^{-\theta\beta_i}$, it follows that

$$\frac{T_{us}}{T_{cn}}\left(\frac{r_{us}}{r_{cn}}\right)^{-\theta}\left(1 - d_1^{-\theta}d_2^{-\theta}\right)(v_{i'} - v_i) > 0.$$

Since $d > 1$, this is equivalent to

$$v_{i'} > v_i.$$

Hence $\frac{w_{us}r_{cn}}{w_{cn}r_{us}} > 1$, i.e., $\frac{w_{us}}{r_{us}} > \frac{w_{cn}}{r_{cn}}$. Therefore, if $d = 1$, (i.e., without trade frictions), $\frac{P_{US}^i}{P_{CN}^i} = \frac{P_{US}^{i'}}{P_{CN}^{i'}} = 1$. With trade frictions, if $\frac{w_{us}}{r_{us}} > \frac{w_{cn}}{r_{cn}}$, $\frac{P_{US}^i}{P_{CN}^i} > \frac{P_{US}^{i'}}{P_{CN}^{i'}}$. ∎

Corollary 2 *The competitiveness of the US market in sector i, relative to the Chinese market, is decreasing in the labor intensity β_i.*

Proof.

$$\bar{c}^i(\varepsilon) = \Gamma\left(\frac{\gamma^i X}{\varepsilon E}\right)^{\frac{1}{\sigma-1}} P^i$$

Proposition 1 implies $\frac{\bar{c}_{US}^i}{\bar{c}_{CN}^i} > \frac{\bar{c}_{US}^{i'}}{\bar{c}_{CN}^{i'}}$ for $\beta_i > \beta_{i'}$. Thus the US market for labor-intensive goods is relatively (w.r.t. the CN market) less competitive than for capital-intensive goods. ∎

Market Selection

Market selection is the same as in the simple model in Section 3.1. Tougher markets select more efficient firms. Market toughness depends not only on fixed costs and transportation costs, but also depends on market size and the competition in the market. For labor-intensive goods, the foreign market is less competitive than the Chinese market in the sense that the price index is higher in the foreign market. As a result, less productive firms sell only to the foreign market while survivors in the more competitive domestic market are the more productive firms. The opposite is true for capital-intensive sectors.

Export Intensity

The model also explains the distribution of export intensity among Chinese exporters. Note that the expression for sales in the domestic market is:

$$s_d^i = f(\varepsilon, c)(\gamma_i X)\left(\frac{\sigma}{\sigma-1}\frac{c}{P^i}\right)^{1-\sigma}. \tag{15}$$

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Then the export intensity for exporters is:

$$\frac{s_x^i}{s_x^i + s_d^i} = \frac{f_x \left(\frac{P_x^i}{\tau}\right)^{\sigma-1} X_{ex}}{f_x \left(\frac{P_x^i}{\tau}\right)^{\sigma-1} X_{ex} + f_d (P_d^i)^{\sigma-1} X_d}$$

$$= \frac{\left[1 - \left(\frac{c_x}{\bar{c}_x^i}\right)^{(\sigma-1)\lambda}\right]\left(\frac{P_x^i}{\tau}\right)^{\sigma-1} X_{ex}}{\left[1 - \left(\frac{c_x}{\bar{c}_x^i}\right)^{(\sigma-1)\lambda}\right]\left(\frac{P_x^i}{\tau}\right)^{\sigma-1} X_{ex} + \left[1 - \left(\frac{c}{\bar{c}_d^i}\right)^{(\sigma-1)\lambda}\right](P_d^i)^{\sigma-1} X_d}. \quad (16)$$

Without marketing costs, conditional on selling in the market, $f_d = 1$, $f_x = 1$, and the export intensity is a constant for all firms. With marketing costs, $f \in (0, 1)$. For labor-intensive sectors, $\bar{c}_d^i < \bar{c}_x^i$; $f_d < f_x$, and exporters' export intensity $\frac{r_x^i}{r_x^i + r_d^i}$ is more likely to be close to 1. In capital-intensive sectors, $\bar{c}_x^i < \bar{c}_d^i$; $f_d > f_x$ and exporters' export intensity $\frac{r_x^i}{r_x^i + r_d^i}$ is more likely to be close to 0.

Intuitively, as the foreign market is less competitive than the domestic market for labor-intensive sectors, the exporters are relatively more profitable in the foreign market and choose to access more consumers. A relatively larger fraction of output is sold in the foreign market. Again the opposite is true for exporters in capital-intensive sectors.

Figures 14, 15, and 16 show a simulated example of productivity by market and the distributions of export intensity, respectively. For Chinese firms, non-exporters are more productive in labor-intensive sectors while exporters are more productive in capital-intensive sectors. Figure 15 shows the histograms of Chinese exporters' export intensity, in labor-intensive and capital-intensive sectors, respectively. They are consistent with the distributions in the Chinese data. Figure 16 plots the histograms of US exporters' export intensity, where in this example US exporters always sell mainly in the domestic market.

If foreign-owned firms have lower entry costs to foreign markets (the distribution of the entry shock has a lower mean) than domestic firms, then the export intensity of foreign firms are always more concentrated to 1. Nonetheless, their export intensity distribution is still bimodal (see the following Figure), which is again consistent with the observations in Section 2.2.

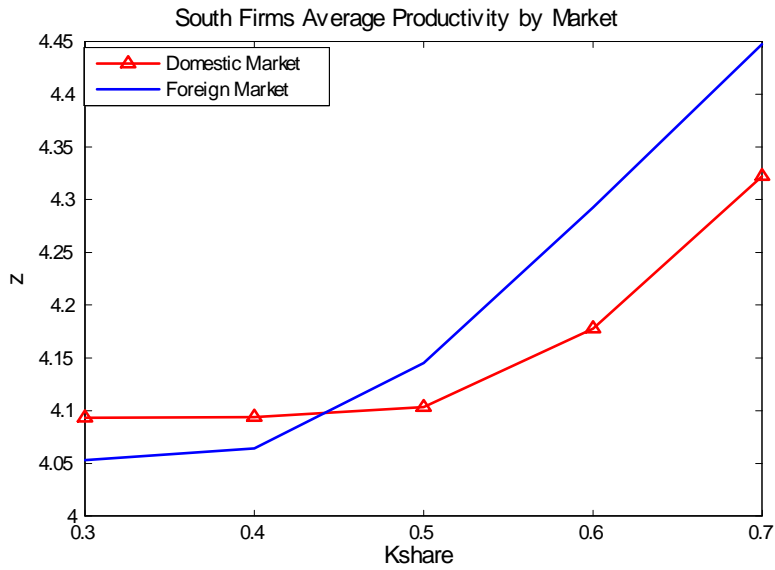Figure 14: Productivity of Firms Entering Different Markets (Model)

Figure 15: Distribution of Chinese Firms Export Intensity, Labor-Intensive and Capital-Intensive Sectors (Model)
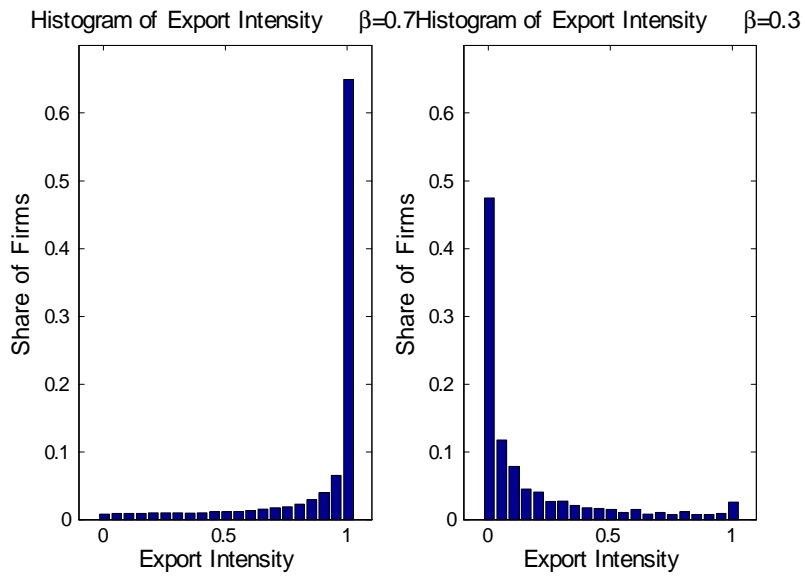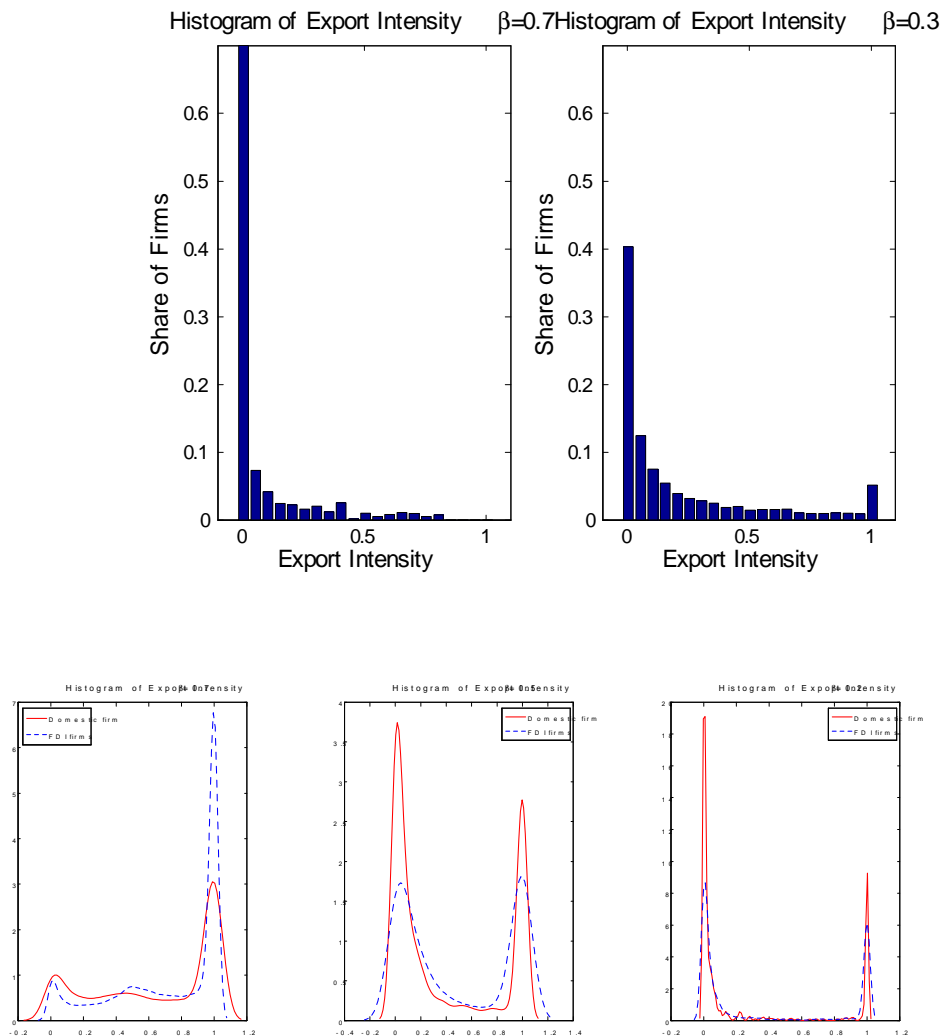
Figure 16: Distribution of US Firms Export Intensity, Labor-Intensive and Capital-Intensive Sectors (Model)

3.3 Estimation

In this section, I estimate the model to fit three moments for each sector: (1) the productivity difference between exporters and non-exporters, (2) the fraction of exporters that only export, (3) the mean export intensity.

Because I focus on sector variations, I use parameter values from EKK (2009) for $\frac{\theta}{\sigma-1}$, λ, and the shock distributions. I assume for sector i that the cost threshold for selling in the foreign market relative to the domestic market is $\left(\frac{\bar{c}_x}{\bar{c}_d}\right)^i = a - bi$, which means the relative cost threshold decreases with the sector's capital intensity. Figure 17, 18, and 19 shows how the model fits the three sets of moments taken from the data with only 2 parameters (a, b).

Figure 17: Data Versus Model: Differences Between Exporters and Non-Exporters in Value Added per Worker Across Sectors
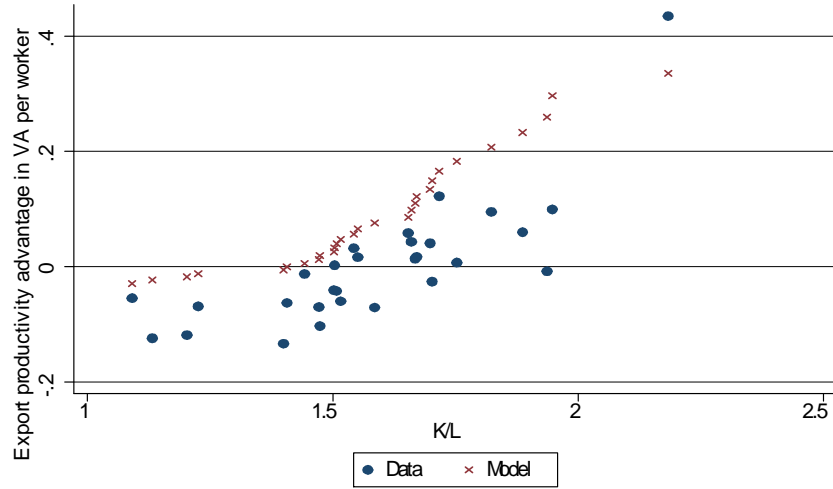

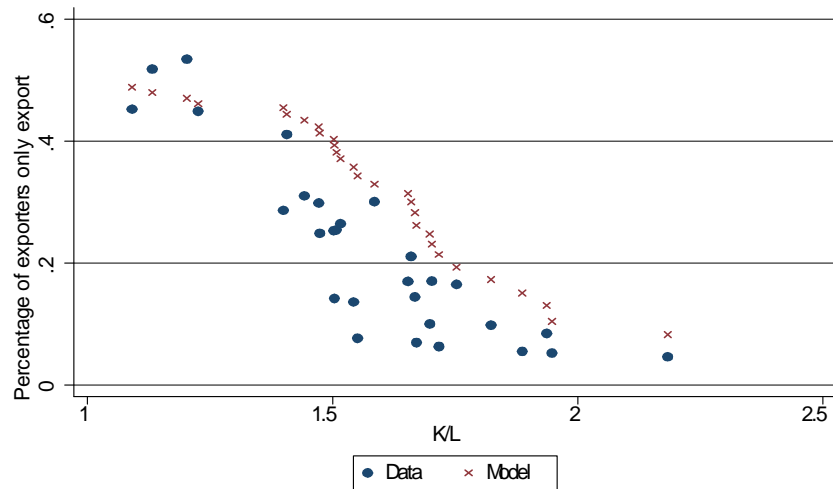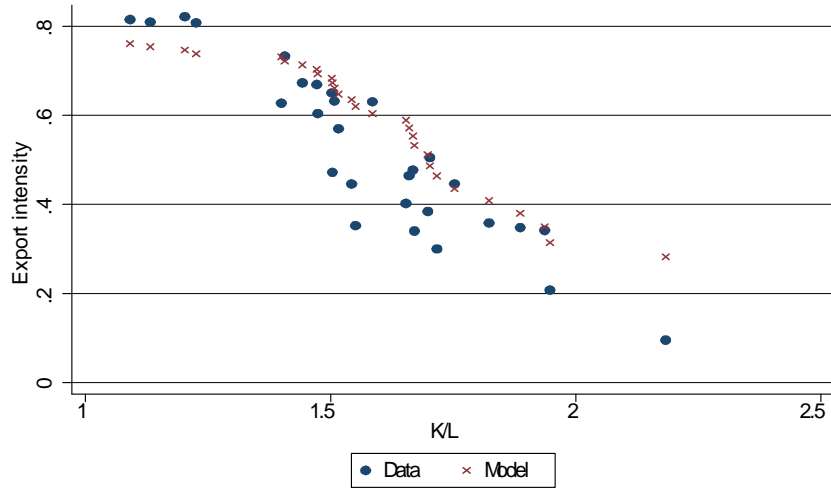Figure 18: Data Versus Model: Percentage of Exporters That Only Export Across Sectors

Figure 19: Data Versus Model: Average Export Intensity Across Sectors

4 General Equilibrium and Trade Liberalization

4.1 General Equilibrium

I now close the model by making factor returns endogenous, and use it to examine the aggregate effects of a tariff reduction on the decisions of individual firms. To do so we need to consider how such changes would affect factor returns and prices through market clearing conditions.

The factor allocation in sector i and country m satisfies[12]:

$$r_m k_m^i = \frac{1 - \beta_i}{\beta_i} w_m l_m^i. \tag{17}$$

Factor market clearing conditions are:

$$\begin{aligned} \sum_i k_m^i &= K_m, \\ \sum_i l_m^i &= L_m. \end{aligned} \tag{18}$$

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[12]Results in Section 3 can be generalized to a model with N countries.

Given factor prices, trade shares are:

$$\pi_{nm}^i = \frac{T_m \left(w_m^{\beta_i} r_m^{1-\beta_i} d_{nm} \left(1 + \tau_{nm}^i\right)\right)^{-\theta}}{\sum_{k=1}^{N} T_k \left(w_k^{\beta_i} r_k^{1-\beta_i} d_{nk} \left(1 + \tau_{nk}^i\right)\right)^{-\theta}}, \tag{19}$$

where d_{nm} is the iceberg costs for shipping goods from country m to country n, and τ_{nm}^i is the tariff applied by country n to goods imported from country m in sector i.

The goods market clearing condition for sector i is:

$$Y_m^i = \sum_{n=1}^{N} \pi_{nm}^i X_n^i \frac{1}{1 + \tau_{nm}^i},$$

where

$$X_n^i = \gamma^i X_n$$

$$\underbrace{X_n}_{\text{Total spending}} = \underbrace{w_n L_n + r_n K_n}_{\text{factor returns}} + \underbrace{\Pi_n}_{\text{firms' net profits}} + \underbrace{\sum_{i=1}^{I} \gamma^i X_n \left(1 - \sum_{k=1}^{N} \frac{\pi_{nk}^i}{1 + \tau_{nk}^i}\right)}_{\text{Tariff rebate to consumers}},$$

$$Y_m^i = w_m l_m^i + r_m k_m^i + \underbrace{\Pi_m^i}_{\text{net profit}}.$$

It can be shown that, for $m = 1, ..., N$ and $i = 1, ..., I$, goods market clearing conditions can be re-expressed as:

$$\frac{1}{\beta_i} w_m l_m^i = \sum_{n=1}^{N} \pi_{nm}^i \gamma_i \frac{(w_n L_n + r_n K_n)}{\sum_{i=1}^{I} \gamma^i \sum_{k=1}^{N} \frac{\pi_{nk}^i}{1+\tau_{nk}^i}} \frac{1}{1 + \tau_{nm}^i} \tag{20}$$

I normalize world GDP $= \sum_m \sum_i Y_m^i$ to 1 (or we can normalize wage or rental in one country to be 1). Define an equilibrium as follows:

Definition 3 *Given* $\left\{K_m, L_m, \tau_{nm}^i, \pi_{nm}^i, \beta^i, \gamma_i\right\}$, *an equilibrium is a set of factor prices and factor allocations* $\{w_m, r_m, k_m^i, l_m^i\}$ *that satisfy the factor allocation conditions* (17), *factor market clearing conditions* (18), *and goods market clearing conditions* (20).

Remark 4 *There are* $I \times N$ *factor allocation conditions* (17), $2N$ *factor market clearing conditions* (18), *and* $I \times N$ *goods market clearing conditions* (20). *Since the goods market clearing conditions sum to an accounting identity, this is a system of* $N(2 + 2I) - 1$ *equations in the same number of unknowns.*

4.2 Effects of Import Tariff Reduction

Proposition 5 *If China reduces its import tariffs, then:*

1. *Both Chinese and US trade volumes increase;*

2. *In China, labor moves to labor-intensive sectors;*

3. *Price indices in all sectors in China decrease relative to the US. Chinese markets become more competitive, and exporters' productivity relative to non-exporters decreases;*

4. *Real returns increase for both factors in the US.*

As a direct effect of import tariff reduction, Chinese imports increase. Chinese exports also increase through two indirect effects: factor prices adjust to the deterioration of terms of trade, and demand increases as foreigners have more profits.

A reduction of trade frictions leads to an increase in the relative demand for a country's comparative advantage goods. Thus labor moves to labor-intensive sectors in China. The relative nominal reward of the abundant factor also rises.

Relative price indices in both sectors in China decrease as it becomes easier for foreign firms to enter, which increases competition and drives prices down. Less productive firms cannot survive and the average productivity of domestic firms increase. As a result, exporters' productivity advantage falls.

We can test these predictions using the observations when China joins the WTO in 2001. As shown by Figure 20, China reduced the average tariff it applied on its imports by 30% upon joining the WTO in 2001. On the other hand, the export tariff applied by the rest of the world to China did not change much.

Figure 21 plots the changes in labor employment share by sector in China from 2000 to 2007. On the x-axis is the median capital labor ratio of the sector and on the y-axis is the percentage change of labor employment share over the time period. Observe that labor-intensive sectors have employment share gains while capital-intensive sectors have employment share losses. This is consistent with prediction (2) in Proposition 5 that trade liberalization moves labor to the sectors with comparative advantage.

Figure 22 reports the average productivity (in terms of value added per worker) for Chinese exporters and non-exporters across different capital-labor-ratio bins for the years 2000, 2005, and 2007. The stylized relationships between capital-labor ratio and productivity as well as exporters (dis)advantage remain similar over time: average productivity (both exporters and non-exporters) increases with capital-labor ratio, but the slope for exporters is steeper than that of non-exporters. Therefore exporters have lower productivity than

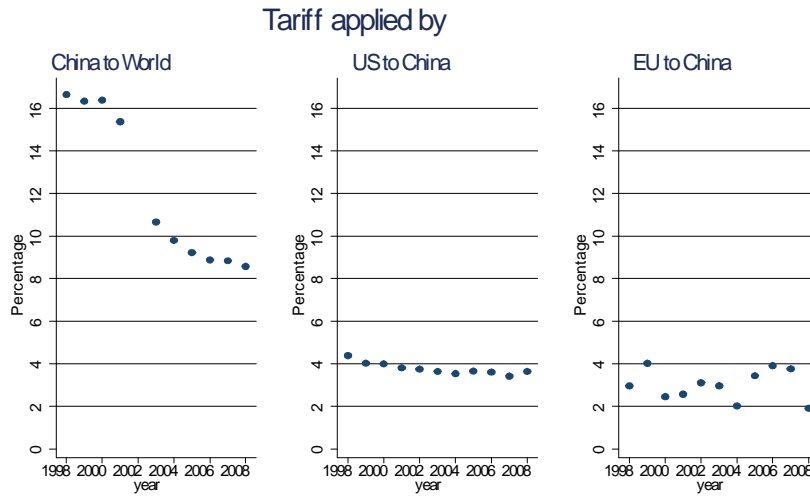29

Figure 20: Tariff Rate from 1998 to 2007

Figure 21: Percentage Change of Sectors' Employment Share from 2000 to 2007.
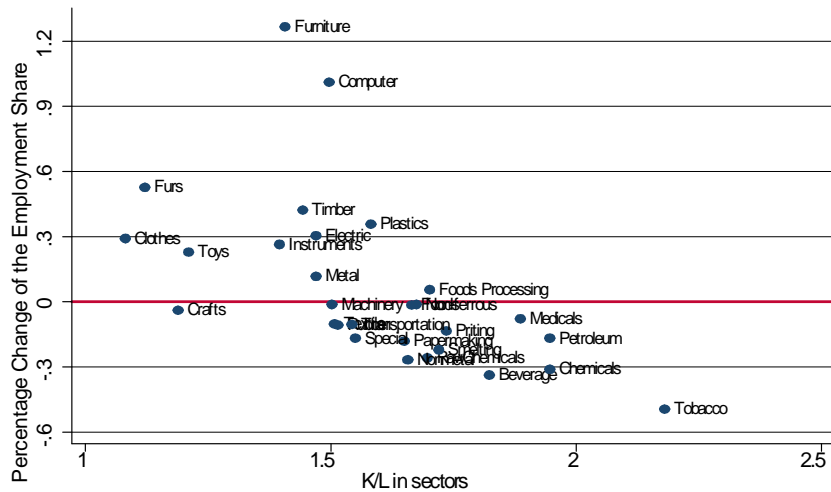
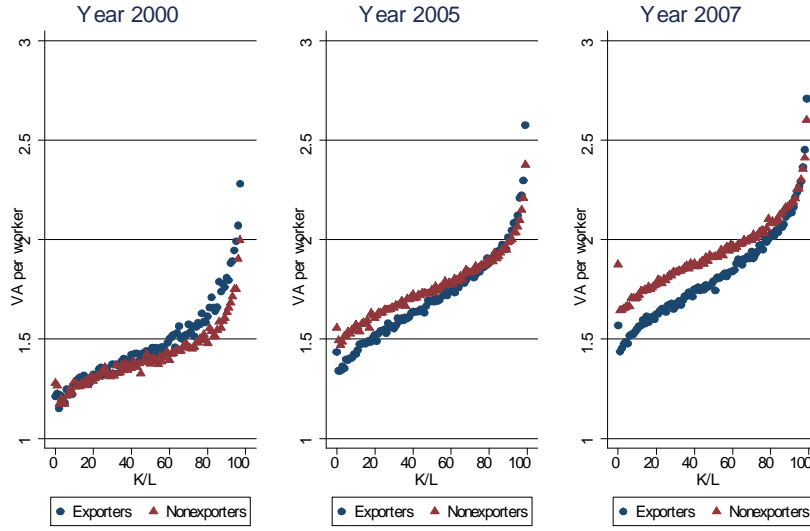Figure 22: Productivity of Exporters and Non-Exporters Over Time

Figure 23: Productivity Differences Between Exporters and Non-Exporters Over Time
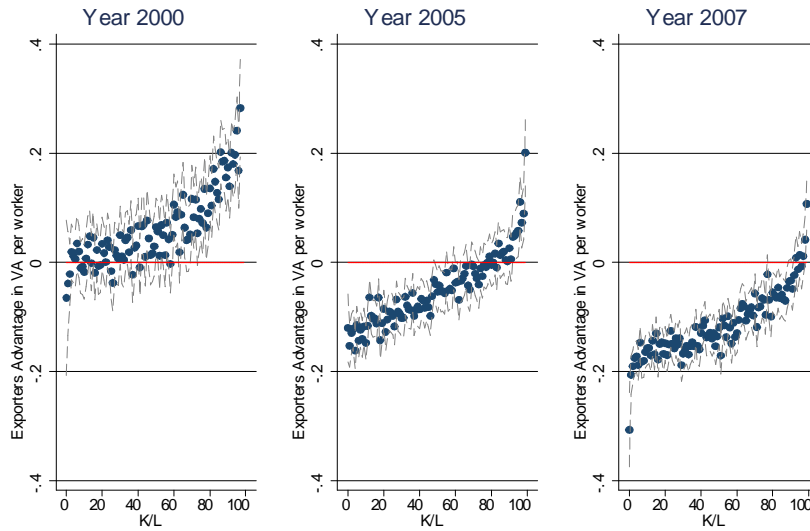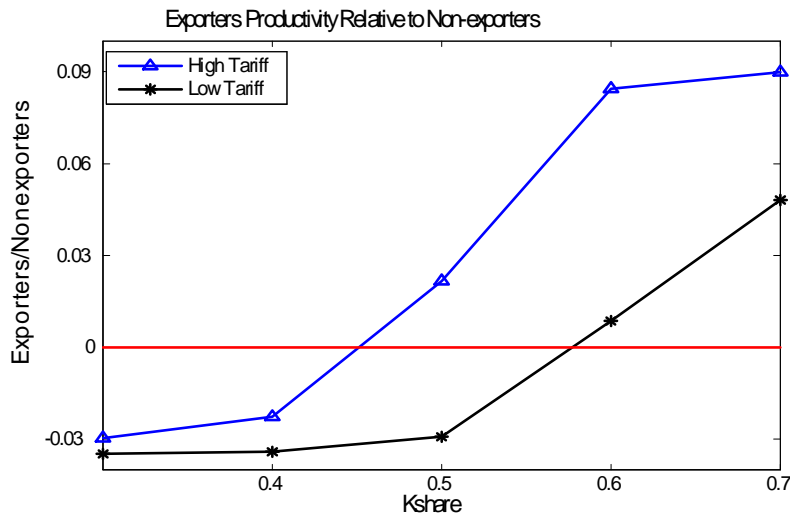
Figure 24: Productivity Differences Between Exporters and Non-Exporters Over Time (Model)

non-exporters for low capital intensity goods, but higher productivity for high capital intensity goods. However, over the time period studied, non-exporters become more productive relative to exporters.

Figure 23 displays the productivity of exporters relative to non-exporters across different capital labor ratio bins. The productivity advantage of exporters clearly declines from 2000 to 2007, as predicted by part (3) in Proposition 5. I also simulated the model and plot the simulated exporter advantage over time in Figure 24. By comparing it to Figure 23, we can see that the overall pattern of the predicted exporters' advantage matches the empirical observations as China enters the WTO.

4.3 Quantify the Effects of Tariff Reduction

In this section, I use Chinese and US data on capital labor endowments K_m, L_m, bilateral trade π_{nm}^i, and tariff τ_{nm}^i to calculate the effects of import tariff reduction in China. I apply the method used in Dekle, Eaton, and Kortum (2008). To get the baseline w_m, r_m, I solve the factor prices and factor allocations $\{w_m, r_m, k_m^i, l_m^i\}$ from (17), (18), and (20), given K_m, L_m and τ_{nm}^i, π_{nm}^i in 2001.

Denote the value after import tariff reduction as x' and the change of any variable as

$\hat{x} = \frac{x'}{x}$. We can rewrite the equilibrium conditions:

$$\hat{r}_m r_m k_m'^i = \frac{1-\beta_i}{\beta_i}\hat{w}_m l_m'^i$$

$$\sum_i k_m'^i = K_m$$

$$\sum_i l_m'^i = L_m$$

$$\pi_{nm}'^i = \frac{\pi_{nm}^i\left(\hat{w}_m^{\beta_i}\hat{r}_m^{1-\beta_i}(\widehat{1+\tau_{nm}^i})\right)^{-\theta}}{\sum_{k=1}^{N}\pi_{nk}^i\left(\hat{w}_k^{\beta_i}\hat{r}_k^{1-\beta_i}(\widehat{1+\tau_{nk}^i})\right)^{-\theta}}$$

$$\frac{1}{\beta_i}\hat{w}_m w_m l_m'^i = \sum_{n=1}^{N}\pi_{nm}'^i\gamma_i\frac{(\hat{w}_n w_n L_n + \hat{r}_n r_n K_n)}{\sum_{i=1}^{I}\gamma^i\sum_{k=1}^{N}\frac{\pi_{nk}'^i}{1+\tau_{nk}'^i}}\frac{1}{1+\tau_{nm}'^i}$$

Given $\left\{w_m, r_m, K_m, L_m, \pi_{nm}^i, (\widehat{1+\tau_{nm}^i})\right\}$, solve $\left\{\hat{w}_m, \hat{r}_m, k_m'^i, l_m'^i\right\}$. Table 4 shows the results.[13]

Table 4: Model Simulation for Tariff Reduction

| | Country | |
Changes	China	US
$\frac{r}{w}$	0.96	1.05
Relative Wage	1	1.02
Relative Rental	1	1.11
Price Index (Most Labor-Intensive Industry)	0.98	0.98
Price Index (Least Labor-Intensive Industry)	0.95	1.03
Real Wage	1.02	1.00
Real Rental	0.98	1.05

5   Conclusion

Firm-level trade patterns in China are different from those in the US and France, and they may seem to be at odds with existing theoretical models. They can be explained, however, by a hybrid model that considers relative factor abundance. This model encompasses the existing trade model as a special case and explains the data from Chinese and developed countries simultaneously. Tougher markets – either foreign or domestic markets – select the

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[13]In this exercise, I leave out the trade deficit, which is an important issue for future work.

most efficient firms. Relative toughness of markets depends on the comparative advantage as well as trade costs. Foreign market can be the main market for some firms and exporters can be less productive than non-exporters. This is more likely to happen in a country's comparative advantage sectors. The model's predictions on the effects of a tariff change are also consistent with observations before and after China joined the WTO in 2001.

By looking at foreign-owned, private firms and SOE separately, at firms in tariff free zones and other areas, as well as at share of processing trade across sectors, I provide some reassuring evidence on concerns about Chinese government policies, but future work can try to investigate this issue more fully. In addition, further quantitative analysis of the effect of trade liberalization on wages and welfare in both China and other countries would be interesting, as it could aid trade policy formulation.

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Appendix

A   Firm Ownership and Processing Trade

This section considers and rejects several explanations of the difference between US and Chinese exporters.

Firm Ownership

A possible explanation for the difference in export patterns between China and the United States is the difference in firms' ownership structure: some manufacturing firms in China are state-owned. If state-owned enterprises behave differently, this might cause the differences in overall export patterns.

Table 5 shows the ownership patterns and the export participation of different kinds of firms in China in 2000 and 2005.[14] Note that the percentage of SOEs and collective firms falls from 2000 to 2005. However, export participation remains stable over the same period.

Table 5: Composition of Firms

	2000		2005	
	Fraction(%)	Exporters(%)	Fraction(%)	Exporters(%)
SOE	24	12	5	15
Collective	42	19	26	20
Private	15	20	47	21
Foreign	8	61	11	63
HK/Macau/Taiwan	11	60	11	62
Total	100		100	

A closer look at the SOEs reveals that they have smaller sales, are more capital intensive, but are less productive in terms of value added per worker. Most SOEs are non-exporters and are less productive, which implies that among non-SOEs the patterns described above are even stronger. Among non-SOEs, exporters are still less productive than non-exporters (see Figure 9 for details). Thus the presence of SOEs cannot explain the low relative productivity of exporters in China.

SOEs are also not the explanation for the U-shaped distribution of export intensity in China. Figure 25 plots the export intensity for both SOEs and non-SOEs. While SOEs typically export a smaller fraction of their output than non-SOE exporters, both distributions are still bimodal.

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[14]Using the ownership classification code in the data, I group firms into five categories. The SOE in this table includes those with ownership codes 110, 141, 143, 149, 151. Results for non-SOE in this section are similar if I include all the firms with positive state asset as SOE. Hong Kong, Macau, and Taiwan firms are 200, 210, 220, 230, 240. Foreign-owned firms are 300, 310, 320, 330, 340.

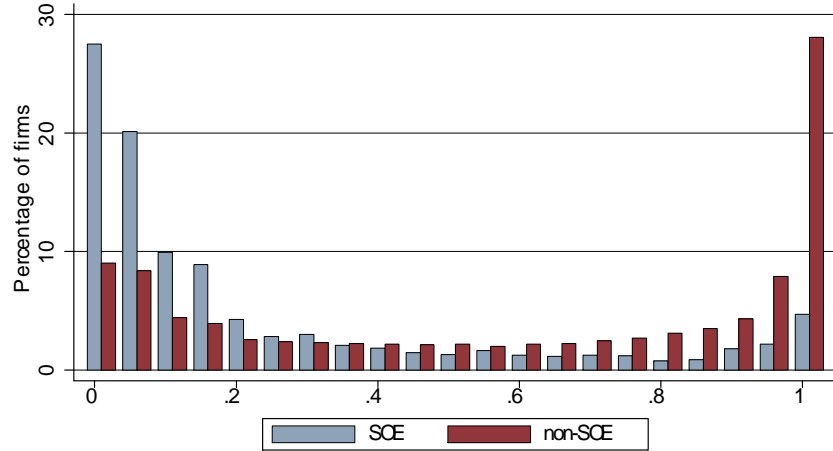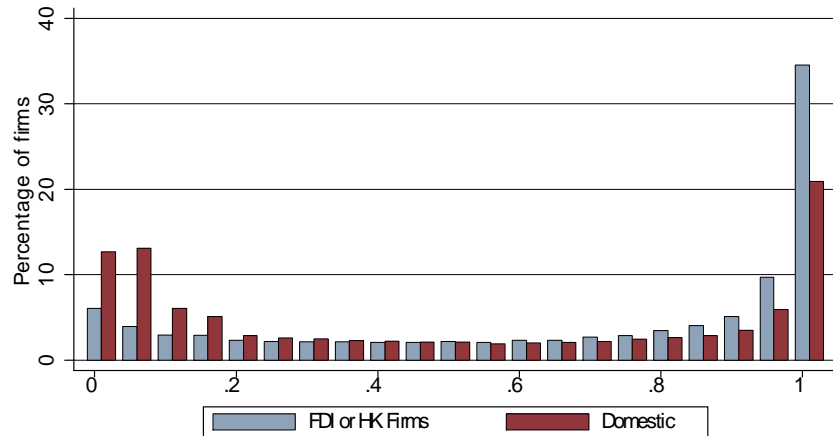Figure 25: Histogram of Export Intensity: SOE vs. Non-SOE

Figure 26: Histogram of Exporter Export Intensity: Foreign-owned vs. Domestic Firms

Another possible explanation for the difference in exporting patterns: many manufacturers are foreign-owned firms that serve as an exporting platform for foreign countries. Indeed, Table 5 indicates that most of these firms export. To see if this fact can explain the pattern, I group firms into domestic and foreign-owned firms (for our purpose, Hong Kong, Macau, and Taiwan firms are considered as foreign-owned firms since they receive the same treatment as foreign investors) and plot the distribution of export intensity for both groups.[15] The histogram is given in Figure 26. Foreign owned firms do sell a larger fraction abroad than domestic exporters. But among domestic firms the distribution of export intensity is still U-shaped, with a large fraction of firms selling most of their output abroad. We lack

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[15]Including all the firms with positive foreign asset as foreign-owned firms does not change the result.

explanation for the group of firms that export most of their output.

Tariff Free Zones

To further investigate the impact of processing trade, I also classify exporters by their locations: in tariff free zones or other regions. Firms in tariff free zones can import intermediate materials without a tariff and usually work on assembling or processing trade, with their main markets being the foreign markets. Figure 27 plots the export intensity of firms in the two groups. Again, while exporters in tariff free zones do sell a higher fraction abroad than exporters in other regions, the export intensity distributions are still bimodal. There are still many firms in other regions that export most of their output.

Figure 27: Histogram of Exporters Export Intensity: Tariff Free Zones vs. Other Regions
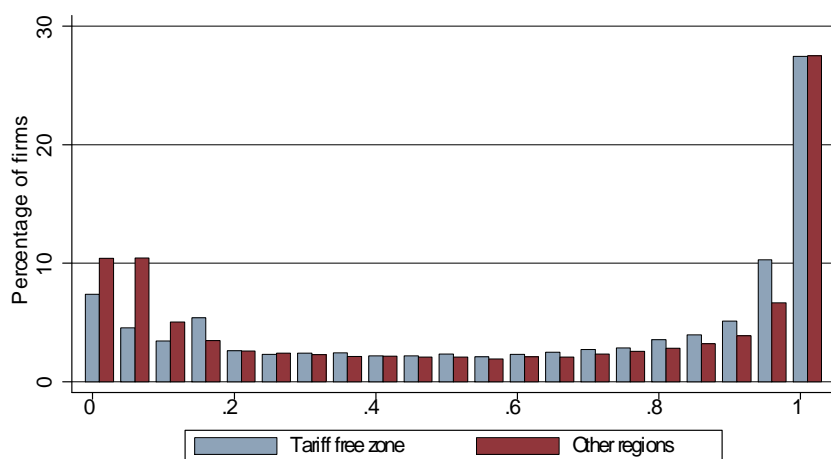
Overall, firms ownership and location explain little of the difference between US and Chinese exporters.[16]

Processing Trade by Sectors

This section looks at Chinese processing trade by sector. Processing trade has been an important part of China's export. It accounted for more than half of its exports in recent years. However, more than 70 percent of processing trade is handled by foreign-owned firms. I have shown that foreign-owned firms and firms in tariff free zones explain little for the difference in pattern between China and the US.[17] This section examines processing trade by sector and shows that the share of processing trade is not correlated with the variation (of export intensity and productivity differences between exporters and non-exporters) across sectors.

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[16]Taking both foreign firms and firms in tariff free zones into account still explains little.

[17]Ideally we can further investigate the impact of processing trade by analyzing well-matched firm-level data and custom data.

Processing trade data are aggregated from Chinese custom monthly transaction data for the year 2005.[18] The custom data categorize trade into many types, and here "processing trade" indicates the summed value of two classifications: "processing and assembly" and "processed with imported materials". The share of processing trade in total trade for all HS 2-digit industries are given in Figure 28.

Figure 28: Share of Processing Trade in Total Trade (HS 2-digit)
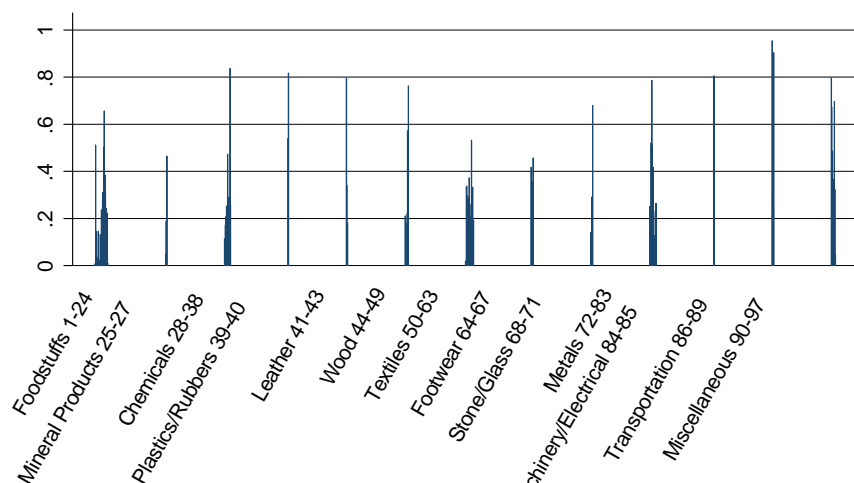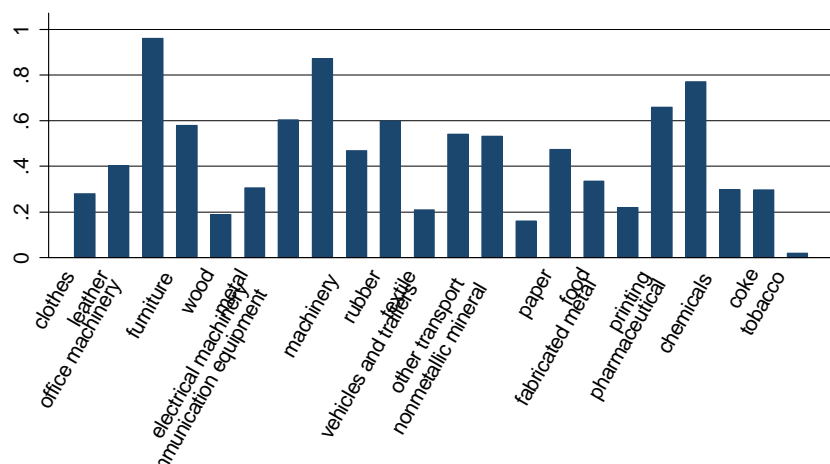

Figure 29: Share of Processing Trade in Total Trade (ISIC 2-digit, sectors ranked by their capital intensity)

By using the correspondence between HS1996 and ISIC Rev.3, I match the HS 6-digit products to ISIC 4-digit sectors, then calculate the share of processing trade in total trade

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[18]I thank Anna Wang for providing this data.

for ISIC 2-digit sectors. Figure 29 ranks the 2-digit sectors (on the y-axis) by their capital-labor ratio (from the firm-level data) and plots the shares. The share of processing trade in total trade is not correlated with sectors' capital-labor ratio, hence the variation of export intensity and exporter productivity (dis)advantage across sectors.

B   Robustness to Productivity Measures

This section shows that the patterns observed are robust to using alternative measures of productivity.

Labor Quality

Labor quality may differ across firms. A concern is that productivity will be mismeasured if labor quality varies in a systematic way across firms. We can use a firm's wage bill to correct this source of variation in our productivity measure.[19] Define the number of quality adjusted workers for firm j as

$$l(j)^* = \frac{w(j)\, l(j)}{w},$$

where $w(j)l(j)$ is the total wage bill of firm j, and $w = \frac{\sum_j w(j)l(j)}{\sum_j l(j)}$ is the average wage markets paid. Quality adjusted workers satisfy $\sum_j l(j)^* = \sum_j l(j)$.

Value added per quality adjusted worker is defined as $\frac{VA}{l(j)^*}$. Figure 30 shows the distributions of value added per worker and value added per quality adjusted worker. The distribution of value added per quality adjusted worker is slightly more concentrated, but not much. This finding is consistent with that of Lentz and Mortensen (2005) and Fox and Smeets (2009) for Danish firms.[20]

For Chinese firms, value added per quality adjusted worker is highly correlated with value added per worker. Figures 31 and 32 plot the productivity of exporters and non-exporters, and differences between exporters and non-exporters in the different capital-labor-ratio bins using value added per quality adjusted worker. They are similar to Figures 7 and 8.

The patterns observed are robust to various productivity measures (domestic sales, TFP, value added per worker, and value added per quality adjusted worker). As van Biesebroeck

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[19]Fox and Smeets (2009) suggests that including the wage bill alone as a measure of labor inputs does almost as well as including the full array of their human capital measures in their data.

[20]Lentz and Mortensen (2005) suggests that differences in the labor quality do not seem to be the essential explanation for cross-firm productivity differentials. Correcting for wage differences across firms does reduce the spread and skew of the productivity distribution somewhat, but both distributions have high variance and skew, and are essentially the same shape.

Fox and Smeets (2009) uses Danish matched employer-employee data to control for workers education, gender, experience, and industry tenure in the production function estimation. While these labor-quality measures have significant coefficients in the production function, accounting for their influence only decreases the average within-industry 90-10 percentile productivity ratio from 3.74 to 3.36.

Figure 30: Distribution of VA per Worker and Quality Adjusted VA per Worker
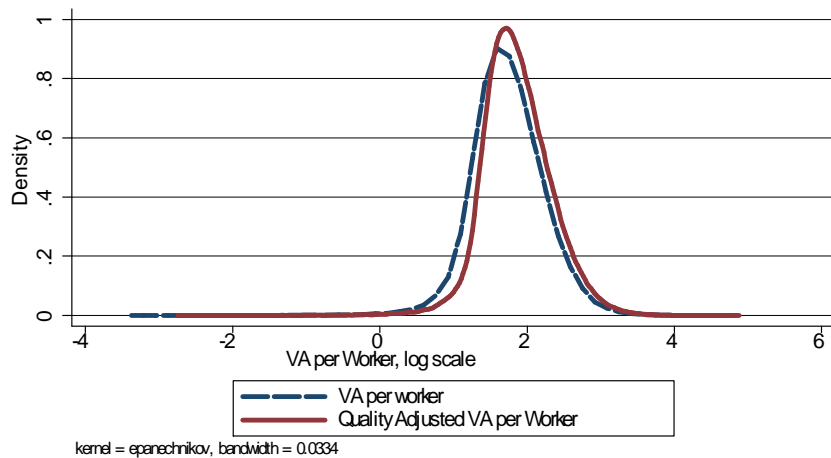

kernel = epanechnikov, bandwidth = 0.0334

Figure 31: Quality Adjusted VA per Worker: Exporters vs Nonexporters
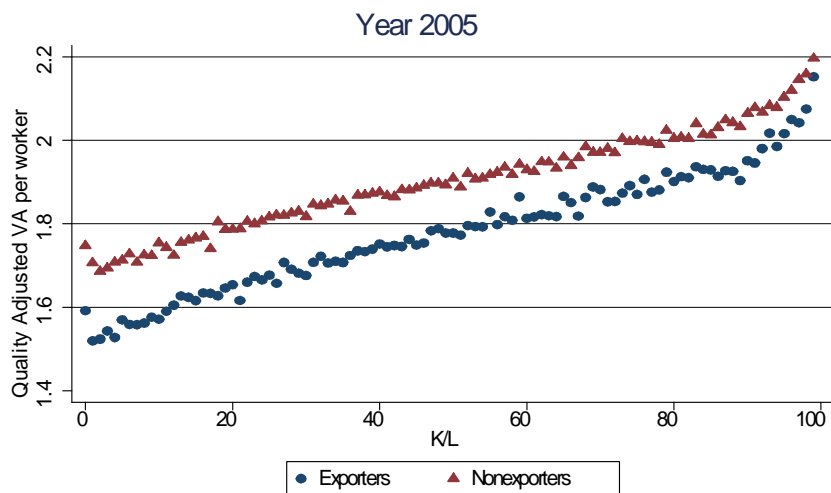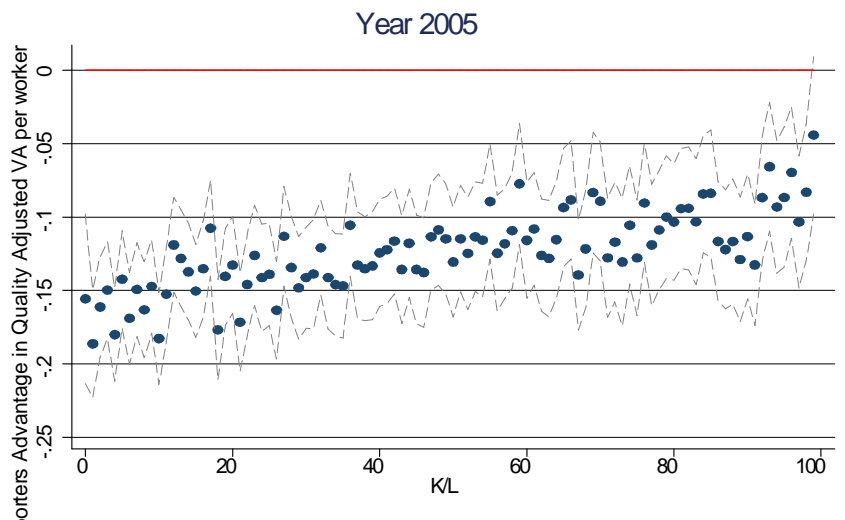
Figure 32: Exporters Advantage in Quality Adjusted VA per Worker

(2008) and Syverson (2010) point out, the inherent variation in firm-level microdata is typically large enough to swamp small measurement-induced differences in productivity metrics. High productivity producers tend to look efficient regardless of the specific way their productivity is measured.

C   Some Evidence from Indonesian Plant-Level Data

As another example of a developing country, Indonesian plant-level data also show some patterns significantly different from the US, France, and other countries in the literature, but similar to China. Indonesia's manufacturing survey is conducted annually and covers all establishments with more than 20 employees.[21]

For exporters, how much do they sell abroad and how is the export intensity related to firm's efficiency? Figure 33 and 34 plot the distribution of export intensity for Indonesia exporters. The dots in Figure 33 (Figure 34) indicate the mean value of log domestic sales (log value added per worker) within each export intensity bin. Firstly, the distribution of export intensity is significantly different from the US, France, and other countries in the literature. More than 30 percent of exporters only export and among them 75 percent do not import. Second, firm's productivity in terms of sales in one market is decreasing with the export intensity. In a standard n-country Melitz model and if foreign markets are tougher, we would expect that more productive firms have higher export intensity.

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[21]I thank Chang-Tai Hsieh for providing Indonesian plant-level data. Results shown in this section are for the year 1996.

Figure 33: Distribution of Export Intensity for Indonesian Exporters and the Mean Domestic Sales by Export Intensity
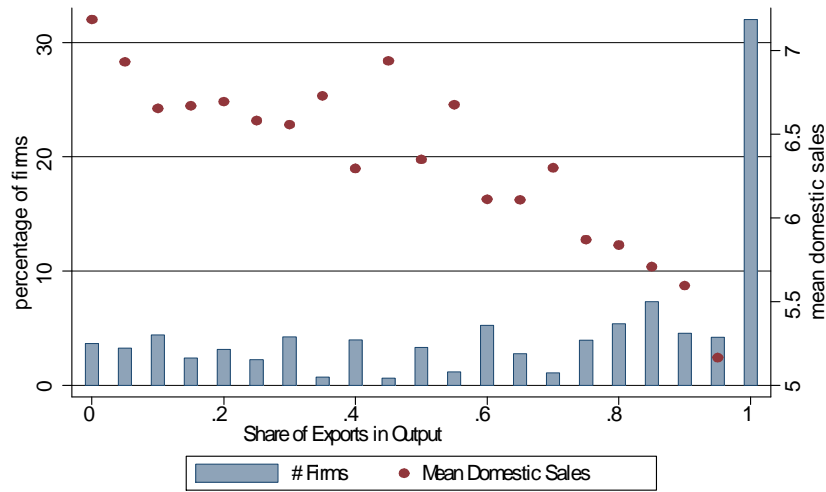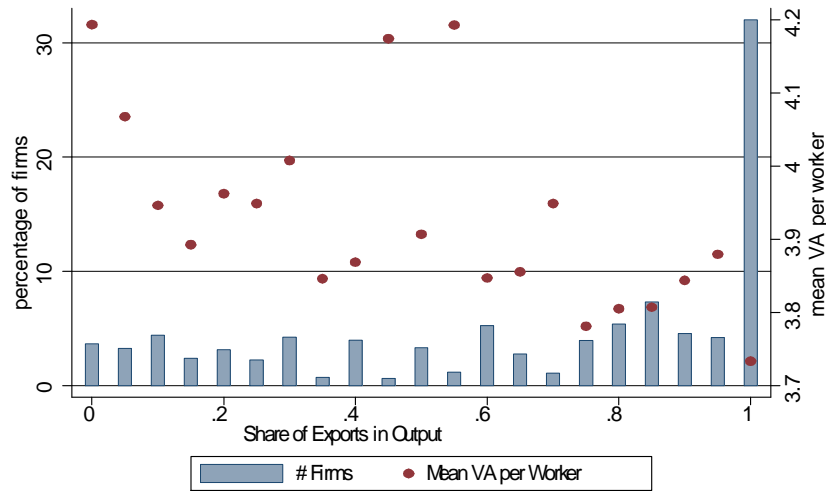

Figure 34: Distribution of Export Intensity for Indonesian Exporters and the Mean Value Added per Worker by Export Intensity

In the sample, on average Indonesian exporters are more productive than their non-exporting counterparts with higher domestic sales and value added per worker. But in the comparative advantage sector – Furniture sector – exporters have smaller domestic sales than non-exporters. Figure 35 plots the distribution of export intensity for the Furniture and Chemicals sectors. The patterns are similar to what I found for Chinese sectors: comparative advantage plays a role in firms' market selection and export intensity.

Figure 35: Distribution of Export Intensity: Comparative Advantage Sector and Comparative Disadvantage Sector
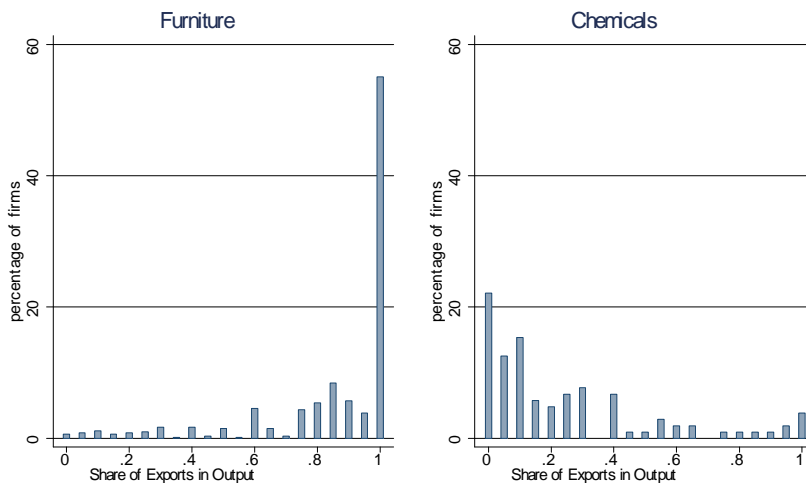
D   Simulation and Estimation

The simulation algorithm for each sector is the same as that in Eaton, Kortum, and Kramarz (2010) except that I draw potential producers who sell in at least one market, which can be the domestic or exporting market.

Define

$$u(j) = Tz(j)^{-\theta}, \tag{21}$$

as firm j's standardized unit cost. The standardized costs have a uniform distribution that doesn't depend on any parameters.

The unit cost for a Chinese firm in sector i in market n is:

$$c_n^i(j) = \frac{w^{\beta_i} r^{1-\beta_i} d_{n,CN} (1 + \tau_{n,CN})}{z(j)} = \left(\frac{u(j)}{\pi_{n,CN} \Phi_n^i} \right)^{1/\theta}. \tag{22}$$

It follows that

$$\bar{c}_n^i = \left(\frac{\overline{u}_n^i}{\pi_{n,CN}^i \Phi_n^i} \right)^{1/\theta}. \tag{23}$$

Substituting (8) and (13) for $\bar{c}_n^i$ and P_n^i into (23), we get $\overline{u}_n^i$. Firm j will enter market n if its $u(j)$ and $\varepsilon_n(j)$ satisfy:

$$u(j) \leq \overline{u}_n^i(j) = c_1 \left(\frac{\pi_{n,CN}^i X_n^i}{E_n} \right) \varepsilon_n(j)^{-\frac{\theta}{\sigma-1}}. \tag{24}$$

Conditional on firm j's passing this hurdle, firm j's sales in market n is:

$$s_{n,CN}^i(j) = \varepsilon_n(j) \left[1 - \left(\frac{u(j)}{\overline{u}_n^i(j)} \right)^{\lambda/\widetilde{\theta}} \right] \left(\frac{u(j)}{\overline{u}_n^i(j)} \right)^{-1/\widetilde{\theta}} \sigma E_n, \tag{25}$$

where $\widetilde{\theta} = \frac{\theta}{\sigma-1} > 1$.

Given values of the parameters, for each sector I create an artificial set of Chinese firms. Each firms has the option to sell in the domestic or/and the foreign market.

The simulation and estimation steps are:

1. Fixed the realizations of the stochastic components of the model: Draw realizations of $v(j)$'s independently from the uniform distribution $U[0,1]$, which will be used to construct standardized unit cost $u(j)$; Draw realization of firm-by-country specific entry shocks from log normal distribution.

2. Given the parameters for relative hurdles across industries $a - bi$, I construct the relative entry hurdles $\left(\frac{\overline{u}_x(j)}{\overline{u}_d(j)} \right)^i = (a - bi) \left(\frac{\varepsilon_x(j)}{\varepsilon_d(j)} \right)^{-\frac{\theta}{\sigma-1}}$ for each firm j.

3. Calculate $\overline{u}(j) = \max\{\overline{u}_n(j)\}$, the maximum value consistent with selling in some market. Construct $u(j) = v(j)\overline{u}(j)$. A measure $\overline{u}(j)$ of firms has a standardized unit cost below $\overline{u}(j)$, so the artificial firm j gets weight $\omega(j) = \overline{u}(j)$.

4. Calculate $\delta_{n,CN}(j)$, which indicates whether artificial firm j enters market n, as determined by the entry hurdles: $\delta_{n,CN}(j) = \begin{cases} 1 \text{ if } u(j) \leq \overline{u}_n(j) \\ 0 \text{ otherwise.} \end{cases}$. Conditional on entry, calculate sales in market n using (25).

5. Now we know for each artificial draw of firms, its weight, where it sells, and how much it sells. For each sector, I construct the following moments to match with the data: the differences of value added per worker between exporters and non-exporters, mean export intensity among exporters, and the fraction of exporters that only export.