Accounting for Chinese Exports*

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Abstract

While much attention has been devoted to the *consequences* of Chinese export growth, we instead focus in this paper on uncovering the *causes* of Chinese trade. To do so, we study detailed data on Chinese exporting from 2000 to 2013, and first show that there have been important changes in the structure of Chinese trade, most notably a rapid increase in exporting and entry by private Chinese firms from 2000 to 2008, and a slowdown in exporting and entry by both foreign and private Chinese firms after 2008. To explain these patterns, we construct a structural model of Chinese trade with heterogeneous firms, endogenous entry, multiple internal production locations, and input-output linkages between multiple sectors. We use the model to develop a structural decomposition of Chinese exports into various factors: export demand, foreign competition, entry costs, marketing costs, wages, capital prices, imported input prices, and total factor productivities. We then simulate counterfactuals within the model to quantify the contribution of each factor to changes in aggregate Chinese exports. Our findings suggest that falling barriers to entry and rapid TFP growth, especially for private Chinese firms, were the key drivers of Chinese export growth from 2000 to 2007, and that stagnation in these same factors were central to the relative slowdown in Chinese exporting from 2008 to 2013.

1 Introduction

China's participation in the world market for goods and services has been one of the most important developments for the global economy in recent decades. Between 2000 and 2016, the annual value of Chinese exports grew by a staggering 742%, compared with overall world export growth of 107% and OECD export growth of 86% over the same time period. In the process, the share of world exports accounted for by exports from China grew from 3.5% to 14.3%. At the same time, there have been important changes in the dynamics of Chinese trade. The most notable of these has been the slowdown in exports: China witnessed an export growth rate of 474% from 2000 to 2008 compared with a much more meager growth rate of 47% from 2008 to 2016 .

The rapid growth in Chinese trade volumes has unsurprisingly been accompanied by an explosion of research on the topic. However, much of this work has focused on the *consequences* of China's participation in world markets. In this paper, we instead focus on uncovering the *causes* of Chinese trade: what explains the dynamics of Chinese exporting? To provide answers, we study detailed transactions-level trade data and firm-level production data for Chinese firms from 2000 to 2013. We first document how patterns of Chinese

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exporting have changed over the sample period, focusing on four key margins: (i) the destination market for exports; (ii) the ownership of exporting firms; (iii) the location of export production in China; and (iv) the sector of goods being exported. We show that there have been important changes in the structure of Chinese trade, most notably a rapid increase in exporting and entry by private Chinese firms and a slowdown in exporting by foreign firms operating within China.

To explain these patterns, we investigate multiple potential drivers of the dynamics in Chinese trade patterns: (i) changes in world demand for Chinese exports; (ii) changes in foreign competition and market access for Chinese firms in Chinese export markets; (iii) changes in costs of entry into export markets for Chinese firms; (iv) changes in costs of firm entry within China; (v) changes in labor costs within China; (vi) capital accumulation by firms in China; (vii) changes in access to imported intermediates for firms in China; and (viii) changes in productivity for firms in China.

To quantify the contribution of each of these factors to changes in Chinese export patterns, we construct a structural model of Chinese trade with heterogeneous firms, endogenous entry, multiple internal production locations, and input-output linkages between multiple sectors. In the model, firms of distinct ownership types produce in different provinces and export a range of products to various international markets. The structure of the model allows us to map each of the above-mentioned drivers of Chinese trade to a corresponding structural parameter that can be either estimated or calibrated using our available data. We then we simulate counterfactuals within the model to predict what patterns of Chinese exporting would have looked like in the absence of each factor.

This paper is most closely related to recent work by Liu and Ma (2018), who also study the factors driving Chinese exports in the context of a quantitative structural trade model. There are several important differences between their approach and ours. First, they study drivers of long differences in Chinese exports between 1990 and 2005, using trade transactions data for only one year of Chinese exports (2005). In contrast, we focus on the evolution of Chinese exporting and its driving factors over a 14-year period, from 2000 to 2013, using trade transactions data for each year. We document that there are important differences in the dynamic patterns of Chinese exports over this time frame. Second, Liu and Ma (2018) focus on changes in tariffs and barriers to internal migration within China. As such, they develop a model in which an exogenous measure of firms sort across production locations. In contrast, we focus on endogenous entry by firms into China, and show that there are important changes in entry costs over the sample period. Finally, we emphasize the margin of firm ownership, and show that there are important differences in productivity dynamics between foreign and domestic firms operating in China.

This paper also builds on a growing body of research studying productivity and firm dynamics in China. Brandt et al. (2012) estimate firm-level productivity for China's manufacturing sector for the years 1998-2006, and find high rates of productivity growth on average, with firm entry playing a key role in aggregate productivity dynamics. Brandt et al. (2017) study the effects of China's accession to the WTO, and find that tariff reductions raised both firm- and sector-level productivity. Khandelwal et al. (2013) find similar productivity-enhancing effects from the removal of quotas for Chinese textile and clothing exports.

This paper is also complementary to the rapidly-growing literature on the impact of Chinese trade. Autor et al. (2013, 2016), Feenstra and Sasahara (2018), and Pierce and Schott (2016) document the effects of Chinese import competition on labor markets in the US, finding negative effects on employment and wages. Hsieh and Ossa (2016) and di Giovanni et al. (2014) estimate the effects of Chinese productivity growth on the rest of the world through trade, finding generally small effects on real income but positive effects from productivity growth in certain Chinese sectors. Several papers have also studied the effects of Chinese trade on innovation in other countries. For example, Autor et al. (2017) document a negative impact of Chinese import competition on innovation by US firms, while Bloom et al. (2016) find positive impacts on innovation by European firms. Hombert and Matray (2018) provide evidence that R&D intensive US firms are more resilient to the negative effects of competition from Chinese imports.

The outline of the paper is as follows. Section 2 describes the main data sources that we use to study the patterns of Chinese trade, and documents some key patterns in Chinese exports over the last two decades. Section 3 then develops a dynamic structural model of Chinese trade with heterogeneous firms, sector-level input-output linkages, and endogenous firm entry. We use the model to study the drivers of Chinese exports, both in the cross-section and over time. Section 4 then describes the estimation procedure that we use to connect the model with data and also presents our main estimates of the structural drivers of Chinese exporting. Section 5 describes the counterfactual exercises that we use to quantify the drivers of Chinese trade. Finally, Section 6 concludes.

2 Data and Empirical Patterns

2.1 Data sources

2.1.1 Chinese customs data

The main source of trade data that we study is a transactions-level dataset of Chinese exports and imports collected by the Customs Administration of China. These data are available for the years 2000-2013, and provide measures of exporting and importing by destination and course country respectively, firm ownership (state-owned enterprise, private domestic, or foreign), sector (at the HS-8 classification), and location of production (province) of the exported goods. We focus on trade in manufacturing (HS-2 codes 28-97), which accounts for more than 90% of the value of Chinese exports in each year.

2.1.2 Annual Survey of Manufacturing and Industrial Census

In addition to the customs data, we utilize information from the Chinese Annual Survey of Manufacturing (ASM) and the industrial census. The ASM collects data for all state-owned enterprises and all non-state firms with sales above a certain threshold.[1] The ASM is available for the period 1998-2013 and for CIC-2 codes 13-42 (manufacturing; excluding agriculture, mining, and utilities). The industrial census collects information on all industrial firms in China irrespective of size, and is available for three years (1995, 2004, and 2008) and CIC-2 codes 13-46 (manufacturing and utilities; excluding agriculture and mining). We employ information from these datasets for several purposes.

First, to measure the propensity for Chinese firms to export, we require information not only on the total number of exporting firms, but counts of non-exporters as well. The ASM and census data allow us to estimate for each available year the total number of firms in operation by ownership (SOE, private domestic, or foreign), province, and main industry (at the CIC4 classification). Second, to decompose production costs, we also obtain information on capital stocks, wages, value-added, and gross output from the ASM and Census data.

[1] For years before and including 2010, the size threshold is 5 million RMB (approximately 600,000 USD) in sales. For 2011 and after, the size threshold increases to 20 million RMB (approximately 2.4 million USD). To maintain consistency across years, we exclude firms with sales below 20 million RMB from the datasets for before and including 2010.

2.1.3 Input-output data

In studying the drivers of Chinese exports, we will take sector-level input-output linkages into account. To do so, we use data on inter-sectoral sales and expenditures for the Chinese economy from the World Input-Output Database (WIOD), which provides input-output data by industry (at the ISIC-2 classification) for multiple countries (including China), for the years 2000-2014. We also obtain from the WIOD estimates of domestic final consumption by sector in China.

2.1.4 Aggregate trade data

To measure world demand for goods from each sector, we use data on aggregate imports by HS-2 sector from each country in the world, obtained from the UN COMTRADE database.

2.1.5 Concordances

As the various datasets that we study in this paper categorize product sectors using different classifications, we utilize several concordances between these classifications. First, to match the customs data with the manufacturing census data (for firm counts and wages), we construct a correspondence between CIC-4 and HS-2. There are 434 unique CIC-4 industry codes. Of these, 59.7% map into a unique HS-2 code, 24.2% map into two HS-2 codes, and the remainder of 16.1% map into more than two HS-2 codes. For the cases with one-to-many mapping, we use export shares at the HS-2 level as weights. Second, to match the customs data with the input-output data from WIOD, we construct a correspondence between ISIC-2 (Rev. 4) and HS-2.[2]

2.2 Patterns of Chinese exports

We first study how Chinese exports vary along four margins: the destination market for exports (d), the ownership of the exporting firm (n), the production location of the exported goods (h), and the sector of goods exported (s). In what follows, we study export data for 2000-2013, and use the following categorizations. Destination markets d are 11 geographic regions.[3] Firm ownership categories n are $\{\text{Foreign}, \text{Private Domestic}, \text{SOE}\}$. Production locations h are the 31 Chinese provinces. Sectors s are HS-2 manufacturing categories (HS-2 codes 28-97), of which there are 69 in total.

2.2.1 Export volumes

Figure 1 shows the composition of Chinese export volumes from 2000 to 2013 by destination market, firm ownership, production location, and sector. The rapid growth in Chinese exports is readily apparent.

By destination, the ranking of markets in terms of total demand for Chinese exports remains fairly stable over the sample period, with North America, Western Europe, East Asia, and South East Asia accounting for the majority of Chinese exports.[4] Export growth to East Asia and South East Asia was slightly higher compared with North America and Western Europe, but each of these regions witnessed large increases in

[2] The WIOD data uses the ISIC-2 (Rev. 4) classification. We map this to HS-2 using the concordance ISIC Rev. 4 and ISIC Rev. 3 from Eurostat, and between ISIC Rev.3 and HS from WITS.

[3] We use the following groupings of countries: North America; East Asia; Hong Kong and Macau; South East Asia; Western Europe; Middle East; Eastern Europe, Russia, and Central Asia; Central and South America; South Asia; Africa; and the Rest of the World.

[4] A significant fraction of Chinese exports are recorded as being exported to Hong Kong and Macau. A large share of these exports are most likely re-exported to other countries, but we are unable to observe the final destination of these exports in the Chinese customs data.

Chinese exports between 2000 and 2013 of around two log points. Exports to countries outside of the four main export regions also grew in importance over the sample period, accounting for 13.6% of total exports in 2000 and 25.8% of total exports in 2013.

By firm ownership, the most noticeable development over the sample period was the simultaneous slowdown in export volumes accounted for by foreign firms operating in China and the rapid growth in exports by privately-owned Chinese firms. Over the first half of the sample period (2000-2006), average annual export growth by foreign-owned firms was 29.8%, whereas in the second half of the sample (2007-2013) this figure fell sharply to 7.5%. On the other hand, private Chinese firms accounted for less than 1% of total exports in 2000 but accounted for a sizable 40.3% of total exports by 2013. This reflects a stark change in the composition of Chinese exports. State-owned Chinese firms were a fairly stagnant source of exports, with an average annual export growth rate of 7.2%.

By production location, the majority of Chinese exports were unsurprisingly produced in coastal provinces and cities (the top five locations are Guangdong, Jiangsu, Shanghai, Zhejiang, and Shangdong). The main coastal export provinces all witnessed high rates of export growth, and the ranking of provinces in terms of total export volumes remained fairly stable over time. However, an interesting development over the sample period was the shift inland of Chinese export production: coastal provinces accounted for 92.8% of total export production in 2000 but only 85.5% in 2013.

By sector, the main sources of Chinese exports over the sample period were machinery & electrical products, textiles, metals, and transportation goods. The ranking of sectors in terms of export volumes remained fairly stable over time. Among the main export sectors, textiles witnessed the slowest export growth , with an average annual growth rate of 15.5% between 2000 and 2013. Overall, however, the sectoral composition of Chinese exports does not appear to have changed significantly over the sample period.

2.2.2 Exporter Counts

Figure 2 shows the counts of Chinese exporters from 2000 to 2013 by destination market, firm ownership, production location, and sector. In the structural model developed below, an "exporter" is an establishment that produces a single product in a single location. Hence, the exporter counts in figure 2 are based on this definition of exporters as well.[5] The dynamics of this extensive margin of Chinese exporting broadly reflects the dynamics of Chinese export volumes, although there are important differences.

By destination, there was significant entry into all of the main Chinese export markets. In the second half of the sample period (2008-2013), however, even though total export volumes continued to grow, exporter entry into the main Chinese export markets slowed noticeably.

By ownership, the slowdown in exporting by foreign firms and the rapid increase in exporting by private Chinese firms are also reflected in exporter counts. From 2008 onwards, the number of foreign exporters was fairly stagnant. In contrast, by 2008, three out of four exporters from China were privately-owned Chinese firms. Even for these private Chinese firms, however, rates of exporter entry were also fairly stagnant in the last few years of the sample period.

By production location, there were high rates of exporter entry from all the main coastal provinces over the first half of the sample period, while inland provinces also witnessed an increase in exporter counts. In 2000, 89.9% of exporters were operating in coastal provinces, whereas this figure dropped to 82.9% in 2013.

By sector, all the main Chinese export sectors witnessed high rates of exporter entry in the first half of the sample period (2000-2007), with significantly lower rates of growth in the second half of the sample

[5] For example, if the same firm produces shoes in Shanghai and books in Beijing, we count this as two exporters.

period (2008-2013).

2.2.3 Exports per Exporter

Figure 3 shows the average value of exports per exporter by destination market, firm ownership, production location, and sector. As in the preceding section, an exporter is defined as an establishment that produces a single product in a single province.

By destination, exporters that exported to larger markets also tended to have higher average export values. while the average value of exports was fairly constant throughout the sample period for all the main Chinese export markets.

By ownership, the average foreign-owned exporter was noticeably larger than the average Chinese exporter, while SOE exporters were significantly larger than privately-owned Chinese exporters. The average values of exports for foreign, private Chinese, and SOE exporters all increased throughout the sample period, with the largest rate of growth observed for private Chinese exporters. However, these growth rates were small compared to the overall growth in Chinese export volumes. Together with the patterns documented in the preceding sections, this suggests that the rapid growth in exporting by private Chinese firms occurred mainly along the extensive margin (exporter entry) rather than the intensive margin.

By production location, exporters from the largest export provinces also tended to have higher average export values. Growth in the intensive margin of exporting was minimal across most of the main coastal exporting provinces.

By sector, exporters in the machinery & electrical and transportation sectors were noticeably larger than exporters from the other main Chinese export sectors. As above, intensive margin export growth across most sectors was small compared to overall export growth.

2.2.4 Export Propensity

Figure 4 shows the export propensities (i.e. fraction of firms that export) among firms operating in China by destination market, firm ownership, production location, and sector. Since the Chinese customs data is informative only about exporting firms, we compute these export propensities from the ASM data for each year. Although the ASM data covers all SOEs, it includes only above-scale non-state firms. Hence, to the extent that export propensities are higher among larger firms, this likely overstates the true propensity of exporting among all firms in China. Nonetheless, we view the dynamics of export propensities among all firms except the smallest as interesting and worth investigation in its own right.

By destination, these export propensities are generally higher for larger Chinese export markets and are fairly similar among the largest markets. Even for the top Chinese export destinations, however, only a small fraction (between 10% and 20%) of firms in China are active exporters to each market in any given year. This is consistent with empirical findings from other sources of international trade data that exporting is a relatively rare activity at the firm-level.

By ownership, however, there are stark differences in export propensities for foreign versus Chinese firms. In any given year, around 60% of foreign firms in China were active exporters, whereas the export propensity among private Chinese firms remains fairly constant at around 20% over the sample period. The latter fact indicates that the rapid growth in entry into exporting by private Chinese firms occurred in parallel with rapid growth in the overall number of such firms. As might be expected, SOEs are characterized by higher export propensities than for private Chinese firms (around 50%), although the rate of exporting for these firms is still smaller than that for foreign firms.

By location and sector, there is substantial heterogeneity in export propensities both across locations and sectors as well as over time. The fact that export propensities at the location- and sector-levels generally decline with time is mainly due to a compositional effect: the share of firms accounted for by private Chinese firms increases over the sample period, and private Chinese firms tend to have much lower export propensities than foreign firms and SOEs.

3 Model

To investigate the underlying drivers of the patterns in Chinese export dynamics documented above, we now develop a structural model of Chinese trade. This model will serve two purposes. First, it provides an accounting framework that allows us to keep track of multiple potential drivers of Chinese exports in a structurally-consistent way. Second, the structure of the model will allow for counterfactual simulations, which we will use to quantify the contribution of each potential driver to changes in Chinese exports. To study the variation of Chinese exports along the four margins described above, the model will feature heterogeneous firms of distinct ownership types (n) that produce differentiated products (s) in various locations in China (h) and export these products to multiple destination markets (d).

Specifically, we will develop a structural decomposition of exports R_{dnhs} to market d by firms of ownership n operating in location h producing sector s goods into the following driving factors: (i) export demand (E_{ds}) in each destination-sector market; (ii) foreign competition (P^*_{ds}) and market access for Chinese firms (τ_{ds}) in each destination-sector market; (iii) fixed costs of exporting (f^M_{dnhs}) to each destination market for firms in each ownership-production-sector triplet; (iv) fixed costs of entry (f^E_{nhs}) for firms in each ownership-production-sector triplet; (v) labor costs (W_h) in each production location; (vi) capital stocks (K_{ns}) for firms in each ownership-sector pair; (vii) accesses to imported inputs (P^I_{ns}) for firms in each ownership-sector pair; and (viii) total factor productivities (T_{nhs}) for firms in each ownership-location-sector triplet.

Since exposition of the model will mainly address its structure within a given period, we will omit time subscripts except where necessary to discuss dynamic firm entry and exit.

3.1 General Environment

We first define the *margins* of Chinese exports as follows: (i) markets, $d \in \Omega_D \equiv \{0, \cdots, D\}$, where market 0 is the domestic Chinese market and the remaining markets are export markets; (ii) firm ownership types , $n \in \Omega_N \equiv \{1, \cdots, N\}$; (iii) production locations in China, $h \in \Omega_H \equiv \{1, \cdots, H\}$; and (iv) sectors, $s \in \Omega_S \equiv \{1, \cdots, S\}$.

Within a $\{n, h, s\}$-tuple, we allow firms to be heterogeneous in idiosyncratic TFP ϕ. The distribution (CDF) of ϕ amongst $\{n, h, s\}$ firms in operation is denoted by G_{nhs} with support Σ_{nhs}, while the measure of $\{n, h, s\}$ firms in operation (including non-exporters) is denoted by N_{nhs}. Our assumptions about firm entry and exit will imply that one can treat G_{nhs} and Σ_{nhs} as exogenous, while N_{nhs} is endogenously determined. In equilibrium, $\{n, h, s\}$ firms will serve market d if and only if $\phi \geq \phi^M_{dnhs}$, where ϕ^M_{dnhs} is an endogenous cutoff productivity.

We also assume that every production location in Ω_H has a fixed and finite quantity of inelastically-supplied labor that is immobile across locations. The supply of labor in location h is denoted by $\bar{L}_h$ while its wage is denoted by W_h. In addition, there are stocks of ownership-sector-specific capital denoted by $\bar{K}_{ns}$

with price P^K_{ns}, which are freely mobile across production locations.[6] We abstract from investment and treat these capital stocks as endowments of the economy.[7]

3.2 Export Demand

Foreign consumers in export market d spend a fixed amount of nominal income E_{ds} on imports of sector s goods from all source countries. Within each sector, these consumers have CES preferences over differentiated varieties from all source countries with elasticity of substitution σ_s across varieties. Hence, demand in market d for Chinese exports by $\{n, h, s, \phi\}$ firms takes a constant-elasticity form:

$$X_{dnhs}(\phi) = A_{dnhs} p_{dnhs}(\phi)^{-\sigma_s} \tag{1}$$

where $p_{dnhs}(\phi)$ is the price charged by a $\{n, h, s, \phi\}$ firm in market d. The term A_{dnhs} is a demand shifter that we assume can be written as:

$$A_{dnhs} = A_{ds} \nu_{dnhs} \tag{2}$$

where ν_{dnhs} is a preference weight and A_{ds} is a destination-sector specific component of the demand shifter. The latter is in turn given by:

$$A_{ds} = \frac{E_{ds}}{(P^*_{ds})^{1-\sigma_s} + (\tau_{ds} P_{ds})^{1-\sigma_s}} \tag{3}$$

where P^*_{ds} is a measure of competition from firms outside of China and P_{ds} is a price index of sector s varieties exported to market d by firms in China net of iceberg trade costs τ_{ds}. In what follows, we will treat E_{ds} and P^*_{ds} as exogenous variables, while the Chinese price index P_{ds} will be endogenously determined. The demand shifter for the Chinese market A_{0s} is also endogenous and determined in general equilibrium.

Domestic household preferences in location h are assumed to take a quasi-linear form:

$$U_h = C_{h0} + \frac{1}{H} \sum_{s=1}^{S} \gamma_s \log C_{hs} \tag{4}$$

where C_{h0} is a homogeneous outside good and C_{hs} is consumption of sector s output. We assume that all goods are freely tradable across locations in China and normalize the price of the outside good to 1, which then fixes total domestic household expenditure on each sector:

$$\sum_{h=1}^{H} P_s C_{hs} = \gamma_s \tag{5}$$

Note also that all household expenditure is assumed to be allocated to domestic output, such that importing is performed only by firms and not directly by households.

[6] Capital stocks are ownership-sector-specific in the sense that they can only be used for production by firms of the corresponding ownership-sector type.

[7] This assumption is innocuous for the estimation of the structural factors in the model, since we employ direct measures of capital stocks at the ownership-sector level. In the counterfactual simulations, however, this assumption implies that capital stocks will not respond endogenously to changes in other structural factors.

3.3 Production

3.3.1 Homogeneous goods sector

In each location h, the homogeneous good is produced under perfect competition using local labor as the only factor with unit input requirement $\frac{1}{W_h}$. We also assume that the supply of local labor is large enough in every location such that the homogeneous good is produced in all locations. This pins down the wage W_h in each location h.

3.3.2 Firm-level production

Firms in the differentiated goods sectors produce under a market structure of monopolistic competition. Each $\{n, h, s, \phi\}$ firm produces output $X_{nhs}(\phi)$ by combining value-added $V_{nhs}(\phi)$ with quantities of a composite intermediate input $M_{nhs}(\phi)$ using a CES technology with elasticity of substitution ϵ_V:

$$X_{nhs}(\phi) = \phi T_{nhs} \left[\left(\omega^V_{nhs}\right)^{\frac{1}{\epsilon_V}} V_{nhs}(\phi)^{\frac{\epsilon_V - 1}{\epsilon_V}} + \left(1 - \omega^V_{nhs}\right)^{\frac{1}{\epsilon_v}} M_{nhs}(\phi)^{\frac{\epsilon_V - 1}{\epsilon_V}} \right]^{\frac{\epsilon_V}{\epsilon_V - 1}} \tag{6}$$

Note that aggregate TFP is denoted by T_{nhs}, while firm-specific TFP is denoted by ϕ. Value-added is produced by combining labor $L_{nhs}(\phi)$ and capital $K_{nhs}(\phi)$ using a CES technology with elasticity of substitution ϵ_L:

$$V_{nhs}(\phi) = \left[\left(\omega^L_{nhs}\right)^{\frac{1}{\epsilon_L}} L_{nhs}(\phi)^{\frac{\epsilon_L - 1}{\epsilon_L}} + \left(1 - \omega^L_{nhs}\right)^{\frac{1}{\epsilon_L}} K_{nhs}(\phi)^{\frac{\epsilon_L - 1}{\epsilon_L}} \right]^{\frac{\epsilon_L}{\epsilon_L - 1}} \tag{7}$$

The composite intermediate input $M_{nhs}(\phi)$ is produced by combining an imported input bundle $M^I_{nhs}(\phi)$ and a domestic input bundle $M^D_{nhs}(\phi)$ using a CES technology with elasticity of substitution ϵ_I:

$$M_{nhs}(\phi) = \left[\left(\omega^I_{nhs}\right)^{\frac{1}{\epsilon_I}} M^I_{nhs}(\phi)^{\frac{\epsilon_I - 1}{\epsilon_I}} + \left(1 - \omega^I_{nhs}\right)^{\frac{1}{\epsilon_I}} M^D_{nhs}(\phi)^{\frac{\epsilon_I - 1}{\epsilon_I}} \right]^{\frac{\epsilon_I}{\epsilon_I - 1}} \tag{8}$$

Finally, the domestic input composite is produced as a Cobb-Douglas aggregation of inputs from all sectors:

$$M^D_{nhs}(\phi) = \prod_{s'=1}^{S} \left[\frac{M^D_{nhss'}(\phi)}{\alpha_{ss'}} \right]^{\alpha_{ss'}} \tag{9}$$

where $M_{nhss'}(\phi)$ denotes usage of intermediates from sector s' and $\{\alpha_{ss'}\}_{s,s' \in \Omega_S}$ is the sector-level input-output matrix with $\sum_{s'=1}^{S} \alpha_{ss'} = 1$ for all $s \in \Omega_S$.[8] To model trade costs, we also assume that selling sector s output to destination market d incurs an iceberg trade cost $\tau_{ds} \geq$, with $\tau_{0s} = 1$.

The above assumptions imply that the marginal cost of production for a $\{n, h, s, \phi\}$ firm is given by:

$$\eta_{nhs}(\phi) = \eta_{nhs}/\phi \tag{10}$$

where η_{nhs} is the aggregate component of marginal cost:

$$\eta_{nhs} = \frac{1}{T_{nhs}} \left[\omega^V_{nhs} \left(P^V_{nhs}\right)^{1-\epsilon_V} + \left(1 - \omega^V_{nhs}\right) \left(P^M_{nhs}\right)^{1-\epsilon_V} \right]^{\frac{1}{1-\epsilon_V}} \tag{11}$$

[8] We assume a Cobb-Douglas technology in (9) to simplify the calibration of sector-level input-output shares using observable input-output data.

The price of value-added, P^V_{nhs}, is a function of the relevant prices of labor and capital:

$$P^V_{nhs} = \left[\omega^L_{nhs}\left(W_h\right)^{1-\epsilon_L} + \left(1-\omega^L_{nhs}\right)\left(P^K_{ns}\right)^{1-\epsilon_L}\right]^{\frac{1}{1-\epsilon_L}} \tag{12}$$

while the intermediate input price index, P^M_{nhs}, is a function of the relevant imported and domestic input bundle prices:

$$P^M_{nhs} = \left[\omega^I_{nhs}\left(P^I_{ns}\right)^{1-\epsilon_I} + \left(1-\omega^I_{nhs}\right)\left(P^D_{s}\right)^{1-\epsilon_I}\right]^{\frac{1}{1-\epsilon_I}} \tag{13}$$

In what follows, we will assume that the prices of imported inputs P^I_{ns} are exogenous and vary only by ownership-sector. Finally, the domestic intermediate input bundle price is given by:

$$P^D_s = \prod_{s'=1}^{S}\left(P_{s'}\right)^{\alpha_{ss'}} \tag{14}$$

where P_s denotes the price of sector s output.[9]

In equilibrium, all firms producing in sector s face a constant demand price elasticity of $-\sigma_s$. Given the assumed market structure of monopolistic competition, all firms within a sector s will then charge a common and constant markup $\mu_s \equiv \frac{\sigma_s}{\sigma_s-1}$ over their respective marginal costs. Sales and profits are then given by:

$$R_{dnhs}\left(\phi\right) = \Phi_{dnhs}\phi^{\sigma_s-1} \tag{15}$$

$$\pi_{dnhs}\left(\phi\right) = \frac{1}{\sigma_s}\Phi_{dnhs}\phi^{\sigma_s-1} \tag{16}$$

where Φ_{dnhs} is an aggregate sales shifter:

$$\Phi_{dnhs} \equiv A_{dnhs}\left(\mu_s\tau_{ds}\eta_{nhs}\right)^{1-\sigma_s} \tag{17}$$

Aggregate exports by $\{n,h,s\}$ firms to market d are then given by:

$$R_{dnhs} = \Phi_{dnhs}\int_{\phi^M_{dnhs}}^{\infty}\phi^{\sigma_s-1}dG_{nhs}\left(\phi\right)N_{nhs} \tag{18}$$

while aggregate cost among all $\{n,h,s\}$ firms can be expressed as:

$$C_{nhs} = \mu_s^{-\sigma_s}\eta_{nhs}^{1-\sigma_s}N_{nhs}\sum_{d=0}^{\infty}A_{ds}\tau_{ds}^{1-\sigma_s}\int_{\phi^M_{dnhs}}^{\infty}\phi^{\sigma_s-1}dG_{nhs} \tag{19}$$

Finally, aggregate factor demands at the sector-level are given by:

$$W_hL_{nhs} = s^L_{nhs}s^V_{nhs}C_{nhs} \tag{20}$$

$$P^K_{ns}K_{nhs} = \left(1-s^L_{nhs}\right)s^V_{nhs}C_{nhs} \tag{21}$$

$$P^I_{nhs}M^I_{nhs} = s^I_{nhs}\left(1-s^V_{nhs}\right)C_{nhs} \tag{22}$$

$$P_{s'}M^D_{nhss'} = \alpha_{ss'}\left(1-s^I_{nhs}\right)\left(1-s^V_{nhs}\right)C_{nhs} \tag{23}$$

where s^V_{nhs}, s^L_{nhs}, and s^I_{nhs} denote respectively the value-added share of total cost, the labor share of value-

[9] Since we assume that goods are freely tradable across locations in China and firms of different ownership types have the same technology (9) for producing the domestic input composite, P^D_s varies only by sector.

added, and the imported input share of total intermediate costs:

$$s^V_{nhs} = \frac{\omega^V_{nhs}\left(P^V_{nhs}\right)^{1-\epsilon_V}}{\omega^V_{nhs}\left(P^V_{nhs}\right)^{1-\epsilon_V} + \left(1-\omega^V_{nhs}\right)\left(P^M_{nhs}\right)^{1-\epsilon_V}} \tag{24}$$

$$s^L_{nhs} = \frac{\omega^L_{nhs}\left(W_h\right)^{1-\epsilon_L}}{\omega^L_{nhs}\left(W_h\right)^{1-\epsilon_L} + \left(1-\omega^L_{nhs}\right)\left(P^K_{ns}\right)^{1-\epsilon_L}} \tag{25}$$

$$s^I_{nhs} = \frac{\omega^I_{nhs}\left(P^I_{ns}\right)^{1-\epsilon_I}}{\omega^I_{nhs}\left(P^I_{ns}\right)^{1-\epsilon_I} + \left(1-\omega^I_{nhs}\right)\left(P^D_{s}\right)^{1-\epsilon_I}} \tag{26}$$

3.3.3 Sector-level production

Sector-level output is produced under perfect competition and free entry using a CES technology combining firm-level output from firms of all nationalities and across all locations of production:

$$M_s = \left[\sum_{n=1}^{N}\sum_{h=1}^{H}\int_{\phi^M_{0nhs}}^{\infty} N_{nhs}\left[X_{0nhs}\left(\phi\right)\right]^{\frac{\sigma_s-1}{\sigma_s}} dG_{nhs}\left(\phi\right)\right]^{\frac{\sigma_s}{\sigma_s-1}} \tag{27}$$

Note that the elasticity of substitution in the sectoral production function σ_s is assumed to be the same as the price elasticity in final demand (1). Domestic demand for output of a $\{n, h, s, \phi\}$ firm is then given by:

$$X_{0nhs}\left(\phi\right) = A_{0s} p_{0nhs}\left(\phi\right)^{-\sigma_s} \tag{28}$$

where the demand shifter is:

$$A_{0s} \equiv M_s\left(P_s\right)^{\sigma_s} \tag{29}$$

and the sectoral price index is:

$$P_s = \left[\sum_{n=1}^{N}\sum_{h=1}^{H} N_{nhs}\int_{\phi^M_{0nhs}}^{\infty}\left[p_{0nhs}\left(\phi\right)\right]^{1-\sigma_s} dG_{nhs}\left(\phi\right)\right]^{\frac{1}{1-\sigma_s}} \tag{30}$$

Since all firms within a sector s charge a constant markup μ_s over their respective marginal costs, the sector price can also be expressed as:

$$P_s = \mu_s\left[\sum_{n=1}^{N}\sum_{h=1}^{H} N_{nhs}\eta_{nhs}^{1-\sigma_s}\int_{\phi^M_{0nhs}}^{\infty}\phi^{\sigma_s-1} dG_{nhs}\left(\phi\right)\right]^{\frac{1}{1-\sigma_s}} \tag{31}$$

3.4 Market entry costs

To model the extensive margin of how many firms export to a given destination market, we assume that in every period of selling to market d, a firm of ownership n producing in location h and sector s must pay a fixed market entry cost f^M_{dnhs} in units of local labor. Since firm export sales are increasing in idiosyncratic TFP ϕ, this implies that if not all $\{n, h, s\}$ firms export to a market d, then the marginal firm that does export must have idiosyncratic TFP ϕ^M_{dnhs} that satisfies the following market entry condition:

$$\frac{1}{\sigma_s}\Phi_{dnhs}\left(\phi^M_{dnhs}\right)^{\sigma_s-1} = W_h f^M_{dnhs} \tag{32}$$

The price index for Chinese exports in sector s to foreign market d net of iceberg trade costs that appears in the foreign market demand shifter (2) is then given by:

$$P_{ds} = \mu_s \left[\sum_{n=1}^{N} \sum_{h=1}^{H} N_{nhs} \eta_{nhs}^{1-\sigma_s} \nu_{dnhs} \int_{\phi_{dnhs}^M}^{\infty} \phi^{\sigma_s - 1} dG_{nhs}(\phi) \right]^{\frac{1}{1-\sigma_s}} \tag{33}$$

We assume that $f_{0nhs}^M = 0$, so that $\phi_{0nhs}^M = 0$ and all firms in China sell to the domestic market.

3.5 Firm entry and exit

To describe firm entry and exit, we now introduce dynamics and time subscripts. To enter as a potential producer at date y, each $\{n, h, s\}$ firm must pay an entry cost f_{nhsy}^E in units of local labor. In addition, firms are subject to an exogenous rate of exit denoted by δ_{nhsy}. We also assume that idiosyncratic TFP ϕ for $\{n, h, s\}$ firms evolves according to a stationary first-order Markov process, with TFP values for new entrants drawn from the stationary distribution G_{nhs}.

To characterize the firm entry decision, first let $\bar{\pi}_{nhsy}(\phi)$ denote total profit net of marketing costs for a $\{n, h, s, \phi\}$ firm:

$$\bar{\pi}_{nhsy}(\phi) = \sum_{d=0}^{D} \left[\pi_{dnhsy}(\phi) - W_{hy} f_{dnhsy}^M \right] \mathbf{1}_{\left[\phi \geq \phi_{dnhsy}^M\right]} \tag{34}$$

The value of being a $\{n, h, s, \phi\}$ firm at date y then satisfies the following Bellman equation:

$$\mathcal{V}_{nhsy}(\phi) = \bar{\pi}_{nhsy}(\phi) + \delta_{nhsy} \mathbb{E}\left[\max\left\{\mathcal{V}_{nhs,y+1}(\phi'), 0\right\} | \phi\right] \tag{35}$$

Note that we assume perfect foresight with respect to aggregate variables. Hence, the only uncertainty at the firm-level is with respect to idiosyncratic TFP ϕ. Furthermore, since we assume zero fixed costs of operation, firm exit is purely exogenous. This implies that the equilibrium distribution of idiosyncratic TFPs is also exogenous and equal to G_{nhs}. Consequently, the stochastic process for idiosyncratic TFP ϕ is irrelevant for aggregate variables and requires no further assumptions beyond stationarity. The expected value of a $\{n, h, s\}$ firm then satisfies the aggregate version of (35):

$$\mathcal{V}_{nhsy} = \bar{\pi}_{nhsy} + \delta_{nhsy} \mathcal{V}_{nhs,y+1} \tag{36}$$

where $\bar{\pi}_{nhsy} \equiv \int_0^\infty \bar{\pi}_{nhsy}(\phi)\, dG_{nhs}(\phi)$.

Finally, the free-entry condition requires:

$$W_{hy} f_{nhsy}^E = \mathcal{V}_{nhsy} \tag{37}$$

3.6 Market clearing

To close the model, we impose market clearing. For firm-level output, total output produced must be equal to total output sold in each market $d \in \Omega_D$:

$$X_{nhs}(\phi) = \sum_{d=0}^{D} X_{dnhs}(\phi) \tag{38}$$

At the sector-level, we assume that output in each sector s is used for final consumption and domestic intermediate inputs:

$$M_s = \sum_{h=1}^{H} C_{hs} + \sum_{n=1}^{N}\sum_{h=1}^{H}\sum_{s'=1}^{S} M^D_{nhs's} \tag{39}$$

$$= \gamma_s/P_s + \sum_{n=1}^{N}\sum_{h=1}^{H}\sum_{s'=1}^{S} M^D_{nhs's} \tag{40}$$

Market clearing for capital of ownership n in sector s requires:

$$\sum_{h=1}^{H} N_{nhs}K_{nhs} = \bar{K}_{ns} \tag{41}$$

Market clearing for local labor is assured by the quasi-linear structure of household preferences, as long as the homogeneous good is indeed produced in every location $h \in \Omega_H$. This requires that total labor demand in each location h by firms in the differentiated goods sector is less than the total supply of local labor:

$$L^P_h + L^M_h + L^E_h < \bar{L}_h \tag{42}$$

where L^P_h, L^M_h, and L^E_h denote labor used for production, marketing, and entry respectively:

$$L^P_h = \sum_{n=1}^{N}\sum_{s=1}^{S} L_{nhs} \tag{43}$$

$$L^M_h = \sum_{d=0}^{D}\sum_{n=1}^{N}\sum_{s=1}^{S} N_{nhs} f^M_{dnhs} \int_{\phi^M_{dnhs}}^{\infty} dG_{nhs}(\phi) \tag{44}$$

$$L^E_h = f^E_{nhs} N^E_{nhs} \tag{45}$$

and N^E_{nhs} is the measure of (n, h, s) entrants, which satisfies:

$$N^E_{nhsy} = N_{nhsy} - \left[1 - \left(1 - \delta_{nhs,y-1}\right) N_{nhs,y-1}\right] \tag{46}$$

3.7 Equilibrium Definition and Solution Method

Having described the structure of the model, we now define equilibrium concepts and outline the numerical solution approach. We emphasize that numerical solution of the model is not required for the estimation and calibration of the model's parameters as discussed in section 4. Instead, numerical solutions are required only for the simulation of model counterfactuals discussed in section 5.

3.7.1 Static Equilibrium with Fixed Entry

We first define a static equilibrium of the model with fixed entry as follows.

Definition 1. Given measures of operating firms and entrants $\{N_{nhs}, N^E_{nhs}\}$, a static equilibrium with fixed entry is a set of prices $\{P_s, P^V_{nhs}, P^M_{nhs}, P^D_s, P^K_{ns}, P_{ds}\}$, marginal costs η_{nhs}, factor shares $\{s^V_{nhs}, s^L_{nhs}, s^I_{nhs}\}$, factor demands $\{L_{nhs}, K_{nhs}, M^I_{nhs}, M^D_{nhss'}\}$, sector output quantities M_s, domestic and foreign demand shifters $\{A_{0s}, A_{ds}\}$, aggregate exports R_{dnhs}, aggregate costs C_{nhs}, sales shifters Φ_{dnhs}, and market entry cutoffs ϕ^M_{dnhs}, all of which jointly satisfy equations (2), (11)-(14), (17)-(26), (29), (31)-(33), (40)-(41), and (42)-(45).

Despite the large number of equilibrium variables, numerical solution of a static equilibrium with fixed entry is computationally feasible. The solution approach can be separated into four stages. First, given capital prices P^K_{ns}, production costs and prices $\{\eta_{nhs}, P_s, P^V_{nhs}, P^M_{nhs}, P^D_s\}$ can be solved for by iterating on equations (11)-(14) and (31). Factor shares $\{s^V_{nhs}, s^L_{nhs}, s^I_{nhs}\}$ are then given by equations (24)-(26). Second, given the solution from stage 1, the variables involving foreign export markets $\{A_{ds}, \Phi_{dnhs}, P_{ds}, \phi^M_{dnhs}\}$ can be solved for by iterating on (2), (17), and (32)-(33), with exports R_{dnhs} given by (18). Third, given the solution from stages 1 and 2, the domestic demand shifter A_{0s}, aggregate costs C_{nhs}, and quantities $\{M_s, M^D_{nhss'}\}$ can be solved by iterating on equations (19), (23), (29), and (40). The remaining factor demands $\{L_{nhs}, K_{nhs}, M^I_{nhs}\}$ are then given by (20)-(22). Finally, guesses of capital prices P^K_{ns} must be iterated on to ensure that the capital market clearing condition (41) holds, and local labor supplies $\bar{L}_h$ must be large enough such that (42)-(45) are satisfied.

3.7.2 Dynamic Equilibrium

Having defined a static equilibrium with fixed entry, we can now define a dynamic equilibrium of the model as follows.

Definition 2. Given initial values of operating firm measures N_{nhs0} and terminal values of continuation values $\mathcal{V}_{nhs,Y+1}$, a dynamic equilibrium of the model for a set of periods $y \in \{1, \cdots, Y\}$ is a sequence of static equilibrium variables for each date y satisfying the conditions in Definition 1, and a set of sequences of operating firm measures, entrant measures, and firm values $\left\{N_{nhsy}, N^E_{nhsy}, \mathcal{V}_{nhsy}\right\}$ for each date y that satisfies (36)-(37) and (46).

Numerical solution of a dynamic equilibrium of the model for periods $\{1, \cdots, Y\}$ can be obtained via backward induction. Starting in period Y, given a guess of operating firm measures N_{nhsY}, the algorithm outlined in section 3.7.1 yields a static solution for period Y variables and hence a value of $\mathcal{V}_{nhsY}$ from equation (36). N_{nhsY} can then be solved for by iterating on the entry condition (37). Repeating this for all preceding periods yields solutions for $\{N_{nhsy}, V_{nhsy}\}$ for all $y \in \{1, \cdots, Y\}$. The measures of entrants N^E_{nhsy} can then be computed from (46).

4 Estimation Procedure and Results

The model developed in section 3 offers a framework for studying how various structural factors determine patterns of Chinese exporting. We now discuss the procedure that we adopt to estimate and calibrate the structural parameters of the model. Before doing so, however, there are two issues that need to be addressed.

First, some firms in the data export in multiple HS-2 sectors and produce goods in multiple provinces, but the model abstracts from multi-product firms operating in multiple locations. Hence, we deal with this by treating each exporter-province-sector observation in the data as a separate firm. This matters for our quantitative results only to the extent that firm operating decisions are made jointly across province-sector units of production rather than independently.

Second, since the Chinese trade transactions data is informative only about exporting firms, we require a method of imputing total firm counts (including non-exporters). To estimate total firm counts (N_{nhsy})

at the ownership-province-sector level for each year, we combine the customs data with the ASM data and adopt the following imputation procedure for each $\{n, h, s, y\}$ unit. First, for units with a positive exporter count in customs and a positive exporter count in the ASM, we compute the propensity of exporting in the ASM data as $p^{exp}_{nhsy} = N^{exp,asm}_{nhsy}/N^{asm}_{nhsy}$, and then impute total firm counts as $N_{nhsy} = N^{exp,customs}_{nhsy}/p^{exp}_{nhsy}$.[10] The implicit assumption is that the probability of observing a firm in the ASM is the same for exporters versus non-exporters. This is of course unlikely to hold exactly, since the ASM surveys only above-scale non-state firms and larger firms are more likely to export. Nonetheless, the ASM provides the best available means of measuring export propensities. Second, for units with a positive exporter count in customs and a zero exporter count in the ASM, we compute the propensity of exporting by collapsing the ASM data to the province-sector, ownership-sector, ownership-province, and sector levels, in that order.[11] At each step, we use the aggregated export propensities to impute total firm counts given the observed exporter counts in the customs data. [12] Using this procedure, every $\{n, h, s, y\}$ unit with a positive exporter count in the customs data is assigned an imputed firm count $N_{nhsy} \geq N^{exp}_{nhsy}$. Finally, for units with a zero exporter count in customs and a positive firm count in the ASM, we simply impute $N_{nhsy} = N^{asm}_{nhsy}$. [13]

4.1 Estimation Procedure

The parameters of model for periods $y \in \{1, \cdots, Y\}$ are: (i) foreign market-sector import expenditures, E_{dsy}; (ii) foreign market-sector competition, P^*_{dsy}; (iii) trade costs, τ_{dsy}; (iv) market entry costs, f^M_{dnhsy}; (v) local wages, W_{hy}; (vi) capital stocks, K_{nsy}; (vii) imported input prices, P^I_{nsy}; (viii) aggregate TFP values, T_{nhsy}; (ix) firm entry costs, f^E_{nhsy}; (x) firm exit rates, δ_{nhsy}; (xi) the time discount factor β; (xii) elasticities of substitution across varieties within each sector, σ_s; (xiii) elasticities of substitution in the firm-level production functions, $\{\epsilon_V, \epsilon_L, \epsilon_I\}$; (xiv) factor weights in the firm-level production functions, $\{\omega^V_{nhs}, \omega^L_{nhs}, \omega^I_{nhs}\}$; (xv) sector-level consumption shares, γ_s; (xvi) sector-level input-output shares $\alpha_{ss'}$; and (xvii) idiosyncratic TFP distributions, G_{nhs}. To estimate these parameters, we utilize several sources of data that are summarized in Table 1. The dimensions $\{d, n, h, s\}$ used in the estimation are the same as those described in section 2.2, and the estimation proceeds in five stages.

4.1.1 Parameters directly observable from data

In the first stage, we calibrate a set of parameters directly from data. We assume that G_{nhs} is the CDF of a log-normal distribution with mean zero, and calibrate the standard deviation of each distribution $\sigma_{\phi,nhs}$ as well as the elasticity of substitution for each sector σ_s using measures of sales and TFP dispersions.[14] Next, the consumption shares and input-output coefficients $\gamma_s, \alpha_{ss'}$ are calibrated using the WIOD input-output data, and the firm-level production function substitution elasticities are set at $\epsilon_V = \epsilon_L = \epsilon_I = 2$.

[10]These units account for around 95% of total export values in the customs data in each year. There are no observations for which ASM export propensity is greater than one.

[11]These units account for less than 5% of total export values in the customs data in each year.

[12]For example, at the sector-province level, the estimated propensity of exporting in the ASM is $p^{exp}_{hsy} = \frac{\sum_{n=1}^{N} N^{exp,asm}_{nhsy}}{\sum_{n=1}^{N} N^{asm}_{nhsy}}$, and the imputed firm count is $N_{nhsy} = N^{exp,customs}_{nhsy}/p^{exp}_{hsy}$.

[13]These units account for around 3% of total output in the ASM data on average across years. Note that within this set of units, there are some units that have a zero exporter count in customs but a positive exporter count in the ASM. These units account for less than 1% of total exports in the ASM on average across years. We treat these as misreported data (in the ASM), and ignore these export values and exporter counts.

[14]The former are obtained from the ASM data while the latter are obtained from Brandt et al. (2012). Specifically, the model predicts that firm-level log sales for sector s firms with idiosyncratic TFP ϕ are given by a constant plus $(\sigma_s - 1)\log\phi$. Hence, the standard deviation of log TFP is given by the standard deviation of log sales divided by $\sigma_s - 1$.

We also obtain direct measures of average wages at the province level, capital stocks at the ownership-sector level, and exit rates at the ownership-province-sector level from the ASM data to calibrate W_{hy}, K_{nsy}, and δ_{nhsy} respectively. We use data on total imports by HS-2 sector for each country in the world from the UN COMTRADE database to calibrate E_{dsy}. Finally, since our data is at annual frequency, we set the time discount factor at $\beta = .95$.

4.1.2 Calibrating f^M_{dnhs} and Φ_{dnhs} using aggregate exports and export propensities

In the second stage of the estimation, we solve for ϕ^M_{dnhs}, f^M_{dnhs}, and Φ_{dnhs} from (23), (32), and the fraction of exporters to a market:

$$R_{dnhs} = \Phi_{dnhs} \int_{\phi^M_{dnhs}}^{\infty} \phi^{\sigma_s - 1} dG_{nhs}(\phi)\, N_{nhs} \tag{47}$$

$$\frac{1}{\sigma_s} \Phi_{dnhs} \left(\phi^M_{dnhs}\right)^{\sigma_s - 1} = W_h f^M_{dnhs} \tag{48}$$

$$\frac{N_{dnhs}}{N_{nhs}} = \int_{\phi^M_{dnhs}}^{\infty} dG_{nhs}(\phi) \tag{49}$$

This yields values for the market entry cost parameters f^M_{dnhs}.

4.1.3 Fixed effects regression of Φ_{dnhs} on market access and marginal cost components

In the third stage, we decompose the sales shifter Φ_{dnhs} into the following demand- and supply-side components:

$$\Phi_{dnhs} \equiv \mu_s^{1-\sigma_s} \times \underbrace{A_{ds}\tau_{ds}^{1-\sigma_s}}_{\text{destination-sector}} \times \underbrace{\eta_{nhs}^{1-\sigma_s}}_{\text{ownership-location-sector}} \times \underbrace{\nu_{dnhs}}_{\text{residual}} \tag{50}$$

where the factors on the right-hand side of (50) are estimated via linear fixed effects regression. The key identifying assumption is that within each sector s, the preference weights ν_{dnhs} are uncorrelated with both the market access terms $A_{ds}\tau_{ds}^{1-\sigma_s}$ and marginal costs η_{nhs}. For example, foreign consumers may have a preference for Chinese imports that are produced by firms of one ownership type over another or that are produced in one Chinese production location over another. The identifying assumption requires that these preference biases are not systematically correlated with, for example, total import expenditures E_{ds} across destinations.

Note that identification of the fixed effects in (50) also requires normalization of one factor per sector. Our approach is to calibrate the market access term $A_{ds}\tau_{ds}^{1-\sigma_s}$ directly for North America ($d = NA$).[15] Specifically, in each year of our analysis, we use data on total imports by HS-2 sector for the US to calibrate $E_{NA,s}$ and data on the import index by HS-2 sector for the US to calibrate $\bar{P}_{NA,s} \equiv \left[\left(P^*_{NA,s}\right)^{1-\sigma_s} + \left(P_{NA,s}\right)^{1-\sigma_s}\right]^{\frac{1}{1-\sigma_s}}$.[16] Next, we calibrate $\tau_{NA,s}$ using measures of average tariffs at the HS-2 sector level applied by the US to imports from China. Finally, we normalize $A_{NAs}\tau_{NA,s}^{1-\sigma_s} = 1$ in the first year of our analysis for every sector and use growth rates of $A_{NA,s}\tau_{NA,s}^{1-\sigma_s}$ relative to the base year as our normalization for the fixed-effects regression of equation (50).[17]

[15] The North American market is comprised of the USA and Canada. In the average sample year, the US accounts for 93.3% of Chinese exports to North America.

[16] The import data is obtained from the UN COMTRADE database, while the import price indices are constructed by the US Bureau of Labor Statistics.

[17] Note that since we are utilizing only growth rates of $A_{NA,s}\tau_{NA,s}^{1-\sigma_s}$ for the normalization, any components of this term that

4.1.4 Calibrating production function parameters and prices

In the fourth stage, we calibrate the parameters of the firm-level production functions and the remaining prices in the model. We first compute the domestic intermediate input price index P_s^D from (14) and (31), given the estimates of η_{nhs} from above. We then use data on value-added shares of total costs, labor shares of value-added, and imported input shares of total intermediate expenditures from the customs and ASM data to calibrate s_{nhs}^V, s_{nhs}^L, and s_{nhs}^I respectively.[18] Capital prices are calibrated using the capital demand and market clearing equations, (21) and (41):

$$P_{ns}^K = \frac{\left(1 - s_{nhs}^L\right) s_{nhs}^V R_{nhs}}{\mu_s K_{ns}} \tag{51}$$

The weight on labor in value-added production is then calibrated using the labor share equation (25):

$$\omega_{nhs}^L = \frac{s_{nhs}^L \left(P_{ns}^K\right)^{1-\epsilon_L}}{\left(1 - s_{nhs}^L\right) \left(W_h\right)^{1-\epsilon_L} + s_{nhs}^L \left(P_{ns}^K\right)^{1-\epsilon_L}} \tag{52}$$

while the weight on value-added is calibrated using the value-added share equation (24), given value-added and intermediate prices given by (12) and (13):

$$\omega_{nhs}^V = \frac{s_{nhs}^V \left(P_{ns}^V\right)^{1-\epsilon_V}}{\left(1 - s_{nhs}^V\right) \left(P_{nhs}^M\right)^{1-\epsilon_V} + s_{nhs}^V \left(P_{ns}^V\right)^{1-\epsilon_V}} \tag{53}$$

Since we cannot differentiate price from quality in the import data, we normalize $\omega_{nhs}^I = \frac{1}{2}$ and calibrate the imported input prices from (26) as:

$$P_{ns}^I = \left(\frac{s_{ns}^I}{1 - s_{ns}^I}\right)^{\frac{1}{1-\epsilon_I}} P_s^D \tag{54}$$

Note that here we aggregate imported input shares of total intermediate expenditures to the ownership-sector level. We then recover aggregate TFP values from equation (11), as:

$$T_{nhs} = \left[\omega_{nhs}^V \left(P_{nhs}^V\right)^{1-\epsilon_V} + \left(1 - \omega_{nhs}^V\right) \left(P_{nhs}^M\right)^{1-\epsilon_V}\right]^{\frac{1}{1-\epsilon_V}} / \eta_{nhs} \tag{55}$$

With our estimates of marginal costs η_{nhs} and market entry cutoffs ϕ_{dnhs}^M, we also compute the export price index P_{ds} from (33). Using our estimates of $A_{ds}\tau_{ds}^{1-\sigma_s}$ from (50) and E_{ds} from UN COMTRADE data, we can then recover the foreign competition statistic P_{ds}^* relative to the iceberg trade cost from (2):

$$\left(\frac{P_{ds}^*}{\tau_{ds}}\right)^{1-\sigma_s} = \frac{E_{ds}}{A_{ds}\tau_{ds}^{1-\sigma_s}} - P_{ds}^{1-\sigma_s} \tag{56}$$

remain constant over time are irrelevant for the analysis. In particular, in calibrating the trade cost $\tau_{NA,s}$, we can reasonably ignore the contribution of distance and transportation costs.

[18] Estimates of the labor shares s_{nhs}^L are obtained from Hsieh and Klenow (2009), who adjust the labor shares in the ASM data to account for non-wage compensation. These are estimated only at the sector level. Our estimates of s_{nhs}^V are obtained directly from the ASM data, while estimates of s_{nhs}^I are computed using import data from Chinese customs and total intermediate expenditures from the ASM data.

4.1.5 Calibrating firm entry costs

Conditional on the measures of operating firms N_{nhsy} in each year, the static factors can be estimated year-by-year using the procedure described above. In the final calibration stage, we compute $\mathcal{V}_{nhsy}$ from equation (36) and calibrate the firm entry costs f^E_{nhsy} using the entry condition (37). Note that this requires values for the terminal continuation values $\mathcal{V}_{nhs,Y+1}$ in the last year of available data. We assume that these values are given by the present discounted value of future profits under a scenario in which average profits $\bar{\pi}_{nhsy}$ grow at a constant rate equal to the growth rate of aggregate profits across all firms over the last two years of the sample. This growth rate is equal to 5.76%.

4.2 Estimation Results

4.2.1 Foreign import demand, E_{dsy}

Figure 5 shows total import expenditures E_{dsy} by destination market (d) and sector (s). By destination, import expenditures rose steadily over the first half of the sample period (2000-2006) for all the main Chinese export markets. However, over the second half of the sample period (2007-2013), import demand was fairly stagnant for the three largest markets (North America, Western Europe, and East Asia), with demand growth observed only for South East Asia. The slowdown in international trade during the recession of 2009 is also clearly evident. Similar patterns are observed at the sector level, with growth in import demand for most of the major Chinese export sectors occurring primarily between 2000 and 2006 and noticeable slower growth from 2007 onward.

4.2.2 Foreign market competition, P^*_{dsy}/τ_{dsy}

Figure 6 shows the estimates of foreign competition prices P^*_{dsy}/τ_{dsy} by destination market (d) and sector (s). These prices should be interpreted as reflecting Chinese market shares in each destination-sector market: given values for the Chinese export price index P_{ds}, China's market share for sector s in destination d is monotonically increasing in P^*_{dsy}/τ_{dsy}. Hence, larger values of P^*_{dsy}/τ_{dsy} indicate that firms from China are relatively more competitive compared with firms outside of China.

At the destination level, foreign competition prices are generally constant throughout the sample period for most of the major Chinese export markets, with the one notable exception being a rise in P^*_{ds}/τ_{dy} for South East Asia from 2007 onward. This reflects China's increasing share of the South East Asian market during this period. In levels, the estimates imply that firms from China face tougher competition in Western Europe, Eastern Europe, and Russia relative to the other major export markets. At the sector level, foreign competition prices are fairly stable over time, although there is substantial heterogeneity in the levels of these prices across sectors. Specifically, firms from China are relatively less competitive in the machinery & electrical sectors and are relatively more competitive in the textiles and metals sectors.

4.2.3 Firm entry costs, f^E_{nhsy}

Figure 7 shows the estimates of entry costs f^E_{nhsy} by ownership (n), production location (h), and sector (s). Estimated entry costs consistently decline over the first half of the sample period (2000-2006) across all ownership types, provinces, and sectors. However, from 2007 onward, entry costs remain fairly constant and even increase for some groups of firms (for example, private Chinese firms). These dynamics reflect the rapid increase in firm entry between 2000 and 2006 implied by the patterns shown in Figures 2 and 4, as well as the leveling off of entry rates from 2007 onward.

Note also that there is substantial heterogeneity across provinces and sectors in terms of entry cost levels. Entry costs are generally higher in the main coastal export provinces (except for Shanghai) than in other provinces, with a difference of around one log point. Entry costs are also higher in the machinery & electrical, transportation, and chemicals sectors as compared with other sectors such as textiles.

4.2.4 Export marketing costs, f^M_{dnhsy}

Figure 8 shows the estimates of marketing costs f^M_{dnhsy} by destination market (d), ownership (n), production location (h), and sector (s). As with entry costs, marketing costs generally decline over the first half of the sample (2000-2006) for the main Chinese export markets and remain fairly constant or even increase from 2007 onwards. Relative to the entry cost estimates, however, the initial decline in marketing costs is much less pronounced. By ownership, for example, the median marketing cost for foreign firms is almost constant throughout the sample and only declines from 2000-2002 for private Chinese firms. This reflects the fact that export propensities for firms of a given ownership type are fairly constant over the sample period, as shown in Figure 4.

In terms of levels, note that marketing costs are estimated to be higher for the largest Chinese export markets (North America, Western Europe, and East Asia) than for other markets. At the ownership level, foreign firms are estimated to face higher marketing costs than Chinese firms. This may seem surprising given that export propensities are much higher for foreign firms (Figure 4). However, this is largely driven by the fact that the average foreign exporter also earns a much higher value of export sales than the average Chinese exporter (Figure 3).

4.2.5 Marginal costs, η_{nhsy}

Figure 9 shows the estimates of marginal costs η_{nhsy} by ownership (n), production location (h), and sector (s). Note that throughout the sample period, foreign firms are estimated to have substantially lower marginal costs than Chinese firms. However, marginal costs generally increase for foreign firms and remain constant or decline for Chinese firms over the sample period. At the province level, median marginal costs increase for most provinces, while at the sector level, marginal costs increase for some sectors (e.g. metals and chemicals) but are fairly constant for others (e.g. machinery & electrical and textiles).

4.2.6 Wages, W_{hy}

Figure 10 shows the estimates of wages W_{hy} by production location (h). There is substantial wage growth across all provinces throughout the sample period, with average annual growth rates for the main export production locations of between 10 to 15%. Note that there is also substantial cross-sectional heterogeneity in wage costs across provinces. Even among the top five export production provinces shown in Figure 10, the maximum-minimum ratio of average province wages varies between 1.8 and 3 times over the sample period.

4.2.7 Capital stocks , K_{nsy}, and capital prices, P^K_{nsy}

Figure 11 shows the estimates of capital stocks K_{nsy} and capital prices P^K_{nsy} by ownership (n) and sector (s). At the ownership level, there is substantial capital accumulation by foreign and private Chinese firms while median SOE capital remains fairly constant throughout the sample period. The rate of capital accumulation by private Chinese firms over the sample period exceeded that for foreign firms in the aggregate: the ratio of total private Chinese firm capital to foreign firm capital was 0.81 in 2000 and increased to 2.06 in 2013. Capital per firm for private Chinese firms, however, declined by more than an order of magnitude from 2000 to 2013, reflecting the fact that the rate of entry by private Chinese firms outstripped the rate of capital accumulation over the sample period. In contrast, capital per firm for foreign firms increased by 79% between 2000 and 2013. At the sector level, consistent capital accumulation is observed in all the main Chinese export sectors.

These dynamics in capital stocks are reflected in the dynamics of capital prices. At the ownership level, the price of foreign and SOE capital remains fairly constant throughout the sample period, whereas the price of private Chinese firm capital increases dramatically. This again is indicative that despite positive capital accumulation in the aggregate, capital per private Chinese firm became scarcer over the sample period. The rising prices of private Chinese firm also reflects rising marginal revenue products of capital, which are driven at least in part by rising total factor productivities for these firms (see Figure 13 below). At the sector level, returns to capital generally increased for the main Chinese export sectors.

4.2.8 Imported input prices, P^I_{nsy}, and import shares, s^I_{nsy}

Figure 12 shows the estimates of imported input prices P^I_{nsy} and imported input shares of total intermediate costs s^I_{nsy} by ownership (n) and sector (s). At the ownership level, as expected, foreign firms are estimated to face the lowest import prices while private Chinese firms face the highest import prices. Somewhat surprisingly, the estimated import prices for private Chinese firms rise steadily throughout the sample period, a trend that is also reflected at the sector level in all the main Chinese export sectors. These rising import prices can be understood by observing that imported shares of intermediate costs declined steadily for private Chinese firms and in all the main Chinese export sectors throughout the sample period. Coupled with the fact that changes in firm entry and total factor productivities generally lowered the cost of domestic intermediates in China, these declining import shares are translated into higher estimated prices of imported inputs.

4.2.9 Total factor productivities, T_{nhs}

Finally, Figure 13 shows the estimates of TFP factors T_{nhsy} by ownership (n), production location (h), and sector (s). At the start of the sample period, the median estimated technology factor is substantially higher for foreign firms than for Chinese firms and is larger for SOEs than for privately-owned Chinese firms. However, there is a significant narrowing of the TFP gap between foreign and private Chinese firms, especially over the first half of the sample period, such that by 2013 the median TFP factor for foreign and private Chinese firms are almost identical. In addition, although TFP growth was generally positive for all firm ownership types from 2000 to 2008, TFP growth rates are noticeably lower from 2008 onward. These dynamic patterns are also observed at the province and sector level: the highest rates of TFP growth for individual provinces and sectors occur for the most part between 2000 and 2008.

5 Counterfactual Exercises

5.1 Methodology

The estimation results discussed above illuminate several important dynamic trends in the potential drivers of Chinese export patterns. First and foremost, there is a noticeable difference in the dynamic patterns observed in the first half of the sample period as compared with the second half. Between 2000 and 2006, entry and marketing costs decline steadily, foreign import demand increases, and TFP growth is positive especially for private Chinese firms. From 2007 onward, however, we see a leveling off of all the aforementioned structural factors. In addition, capital prices and imported input prices increase steadily for private Chinese firms and in most of the main Chinese export sectors.

To formally quantify how changes in these factors shaped the dynamic patterns of Chinese exporting over the sample period, we now use the structural model developed in section 3 to perform counterfactual exercises. To begin, note that if one were to solve for the model's equilibrium given the estimated structural parameters (either statically for each year conditional on entry as in section 3.7.1 or dynamically over the sample period as in section 3.7.2), the predicted values of exports R_{dnhsy} would exactly match the corresponding export values in the data by construction.

Hence, to quantify the contribution of each structural factor to Chinese exports, we adopt several approaches. First, for each year y, let R_y denote the aggregate value of Chinese exports observed in the data. Then, for each year y and a given set of structural parameters ξ, let $\hat{R}_y^+(\xi)$ denote the equilibrium value of exports when all structural parameters are set at their estimated values in year y except for ξ, which is set at its estimated value in year $y+1$. Similarly, let $\hat{R}_y^-(\xi)$ denote the equilibrium value of exports when all structural parameters are set at their estimated values in year y except for ξ, which is set at its estimated value in year $y-1$. We then measure the contribution of changes in ξ to changes in aggregate Chinese exports in each year using the following statistics:

$$\delta_y^-(\xi) \equiv R_y/R_{y-1} - \hat{R}_y^-(\xi)/R_{y-1} \tag{57}$$

$$\delta_y^+(\xi) \equiv \hat{R}_{y-1}^+(\xi)/R_{y-1} - 1 \tag{58}$$

$$\Delta_y^-(\xi) \equiv 1 - \frac{\hat{R}_y^-(\xi)/R_{y-1} - 1}{R_y/R_{y-1} - 1} \tag{59}$$

$$\Delta_y^+(\xi) \equiv \frac{\hat{R}_{y-1}^+(\xi)/R_{y-1} - 1}{\hat{R}_y/R_{y-1} - 1} \tag{60}$$

Intuitively, the first statistic $\delta_y^+(\xi)$ measures how many percentage points of aggregate export growth between years $y-1$ and y are accounted for solely by changes in ξ between $y-1$ and y. Similarly, the second statistic $\delta_y^-(\xi)$ measures the decline in percentage growth of aggregate exports between years $y-1$ and y that would result from eliminating changes in ξ between years $y-1$ and y. The third and fourth statistics, $\Delta_y^+(\xi)$ and $\Delta_y^-(\xi)$, are analogous to the $\delta_y^+(\xi)$ and $\delta_y^-(\xi)$ except that we normalize each statistic by the actual growth rate of aggregate exports.[19]

[19] Hence, the units of $\left\{\delta_y^+, \delta_y^-\right\}$ are percentage points, while the units of $\left\{\Delta_y^+, \Delta_y^-\right\}$ are percentages (of growth rates).

5.2 Results

Tables 2-9 show the results of our counterfactual simulations for the following eight drivers of Chinese export growth: (i) foreign import demand , E_{dsy}; (ii) foreign competition in Chinese export markets, P^*_{dsy}; (iii) export marketing costs, f^M_{dnhsy}; (iv) firm entry,[20] N_{nhsy}; (v) labor costs, W_{hy}; (vi) capital stocks, K_{nsy}; (vii) imported input prices, P^I_{nsy}; and (viii) total factor productivities, T_{nhsy}. For brevity, these tables show results only for the statistic δ^-_y, while results for the remaining statistics are relegated to the appendix.[21]

Each table shows the counterfactual estimates for a particular factor, both in the aggregate and along each of the relevant dimensions (destinations, ownership, province, and sector). As a concrete example, Table 2 for foreign demand E_{dsy} shows the following. The first row of results shows estimates for δ^-_y holding constant (across each consecutive pair of years) E_{dsy} for all destinations and sectors. The second block of results shows estimates for δ^-_y holding constant E_{dsy} for different sets of destinations. The third block of results shows estimates for δ^-_y holding constant E_{dsy} for different sets of sectors.

There are several main takeaways from these counterfactual results. First, in the aggregate, firm entry and TFP growth have contributed the most positively to Chinese export growth over the sample period, while growth in foreign demand and capital accumulation have played secondary but still quantitatively important roles. Changes in foreign competition in Chinese export markets have had a mostly positive although somewhat erratic effect on Chinese exports. On the other hand, rising wages across all the main Chinese export provinces have unsurprisingly had a large negative effect on Chinese export growth. Increases in marketing costs in the aggregate have also contributed negatively to Chinese exporting, although this effect has been secondary compared with changes in Chinese labor costs. Fluctuations in access to imported intermediates also appear to have had a mainly negative effect on exporting, although this effect has been erratic over time.

Second, in parallel with the dynamics of the estimated structural factors discussed in section 4, there also appears to have been significant structural changes in the contributions of these factors to Chinese export growth between 2000 and 2013. Most noticeably, the large positive contributions of firm entry between 2000 and 2007 appear to have diminished significantly from 2008 onwards. In the first half of the sample period, the average contribution of entry to export growth was 19.3% compared with 6.5% in the second half of the sample. In addition, the positive contributions of both TFP growth and foreign demand growth also appear to have diminished substantially after 2008. The positive effects of capital accumulation were fairly constant throughout the sample period, although the magnitudes of these contributions remained relatively small. In contrast, the negative effects of wage growth on Chinese exporting persisted through 2008 and beyond. Taken together, slowdowns in firm entry, TFP growth, and foreign demand coupled with a steady rise in labor costs appear to largely account for the slowdown in aggregate Chinese exports after 2008.

Third, underlying these aggregate dynamics are important patterns of heterogeneity across various Chinese export markets, firm ownership types, Chinese provinces, and sectors. By destination, positive effects of foreign demand on export growth between 2000 and 2007 are observed primarily for developed country markets (North America, Western Europe, and East Asia). After 2008, the decline in these effects are also the sharpest for the developed country markets, whereas declines in demand contributions from South East Asia and the rest of the world were markedly more gradual. The effects of changes in foreign competition on export growth also differ across export markets, with positive effects observed in most years for North

[20] To reduce the computational burden of simulating a large number of counterfactuals, we account for firm entry directly through the measures of operating firms N_{nhsy} instead of entry costs f^E_{nhsy}. This allows us to compute the counterfactuals for firm entry by solving for static equilibria (Definition 1) instead of the full dynamic equilibrium (Definition 2).

[21] Qualitatively, we find that the main conclusions of the analysis are similar across all four statistics.

America, in contrast with mostly negative effects in the East Asian markets.

By firm ownership, entry by foreign and private Chinese firms had large and positive effects on export growth, with a significant slowdown in these effects post-2008. Net exit of state firms, on the other hand, contributed negatively to export growth in most years. Similarly, capital accumulation by both foreign and private Chinese firms had consistently positive effects on export growth, in contrast with more moderate or even negative effects of stagnant capital stocks for SOEs. Strong TFP growth for private Chinese firms was also a consistently positive driver of export growth before 2009.

By production location, firm entry in all of the main Chinese export provinces contributed positively to export growth before 2008, with smaller and more erratic effects observed from 2009 onwards. Entry appears to have had the most positive effects on export growth in the two largest export provinces, Guangdong and Jiangsu. On the other hand, the negative effects of wage growth on exports are also observed across all the main export provinces and persist throughout the sample period.

Finally, by sector, the machinery and electrical sectors stand out as the most dynamic area of Chinese export growth, exhibiting the strongest positive effects of foreign demand, firm entry, capital accumulation, and TFP growth. Entry in the textiles, metals, and chemicals sectors also had large positive contributions to aggregate export growth, especially before 2008, while TFP growth in textiles is also a significant factor.

6 Conclusion

In this paper, we have documented that there are significant structural changes underlying the expansion of Chinese exporting over the last two decades. The initial years following China's entry into the WTO (2000-2007) were characterized by: (i) rising foreign demand for Chinese exports; (ii) rapid entry of private Chinese firms into exporting; (iii) falling barriers to entry for both foreign and private Chinese firms in China; (iv) substantial TFP growth for private Chinese firms; (v) high rates of capital accumulation by both foreign and private Chinese firms; (vi) high growth in returns to private Chinese firm capital; and (vii) rising wages across all Chinese provinces.

From 2008 onward, however, many of these dynamic patterns appear to have changed substantially. The period 2008-2013 was characterized by: (i) a slowdown in foreign demand for Chinese exports; (ii) a slowdown in export growth by foreign firms; (iii) a slowdown in entry by both foreign and Chinese firms; (iv) a slowdown in growth of returns to capital for private Chinese firms; (v) a slowdown in TFP growth for private Chinese firms; (vi) continued increases in wages across all Chinese provinces.

Our quantitative accounting of these drivers of Chinese trade patterns suggest that falling barriers to entry and TFP growth, especially for private Chinese firms, were the main factors underlying the rapid growth of Chinese exports between 2000 and 2007. However, stagnation in the dynamics of these very same factors were also central to the relative slowdown in Chinese exporting between 2008 and 2013. Consequently, our findings suggest that the future path of the "China shock" very much depends on the future dynamics of entry barriers and TFP growth for Chinese firms.

References

Autor, David H, David Dorn, and Gordon H Hanson, "The China Syndrome: Local Labor Market Effectsof Import Competition in the United States," *American Economic Review*, 2013, *103* (6), 2121–2168.

_ , _ , and _ , "The China Shock: Learning from Labor-Market Adjustment to Large Changes in Trade," *Annual Review of Economics*, 2016, *8*, 205–240.

_ , _ , _ , Gary Pisano, and Pian Shu, "Foreign Competition and Domestic Innovation: Evidence from U.S. Patents," Working paper. 2017.

Bloom, Nicholas, Mirko Draca, and John van Reenen, "Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity," *Review of Economic Studies*, 2016, *83*, 87–117.

Brandt, Loren, Johannes Van Biesebroeck, and Yifan Zhang, "Creative Accounting or Creative destruction? Firm-level Productivity Growth in Chinese Manufacturing," *Journal of Development Economics*, 2012, *97* (2), 339–351.

_ , _ , Luhang Wang, and Yifan Zhang, "WTO Accession and Performance of Chinese Manufacturing Firms," *American Economic Review*, 2017, *107* (9), 2784–2820.

di Giovanni, Julian, Andrei A Levchenko, and Jing Zhang, "The Global Welfare Impact of China: Trade Integration and Technological Change," *American Economic Journal: Macroeconomics*, 2014, *6* (3), 153–183.

Feenstra, Robert C and Akira Sasahara, "The "China Shock", Exports and U.S. Employment: A Global Input-Output Analysis," *Review of International Economics*, 2018, *26* (5), 1053–1083.

Hombert, Johan and Adrien Matray, "Can Innovation Help U.S. Manufacturing Firms Escape Import Competition from China?," *Journal of Finance*, 2018, *73* (5), 2003–2039.

Hsieh, Chang-Tai and Ralph Ossa, "A Global View of Productivity Growth in China," *Journal of International Economics*, 2016, *102*, 209–224.

Khandelwal, Amit K, Peter K Schott, and Shang-Jin Wei, "Trade Liberalization and Embedded Institutional Reform: Evidence from Chinese Exporters," *American Economic Review*, 2013, *103* (6), 2169–2195.

Liu, Chen and Xiao Ma, "China's Export Surge and the New Margins of Trade," Working paper. 2018.

Pierce, Justin R and Peter K Schott, "The Surprisingly Swift Decline of US Manufacturing Employment," *American Economic Review*, 2016, *106* (7), 1632–1662.

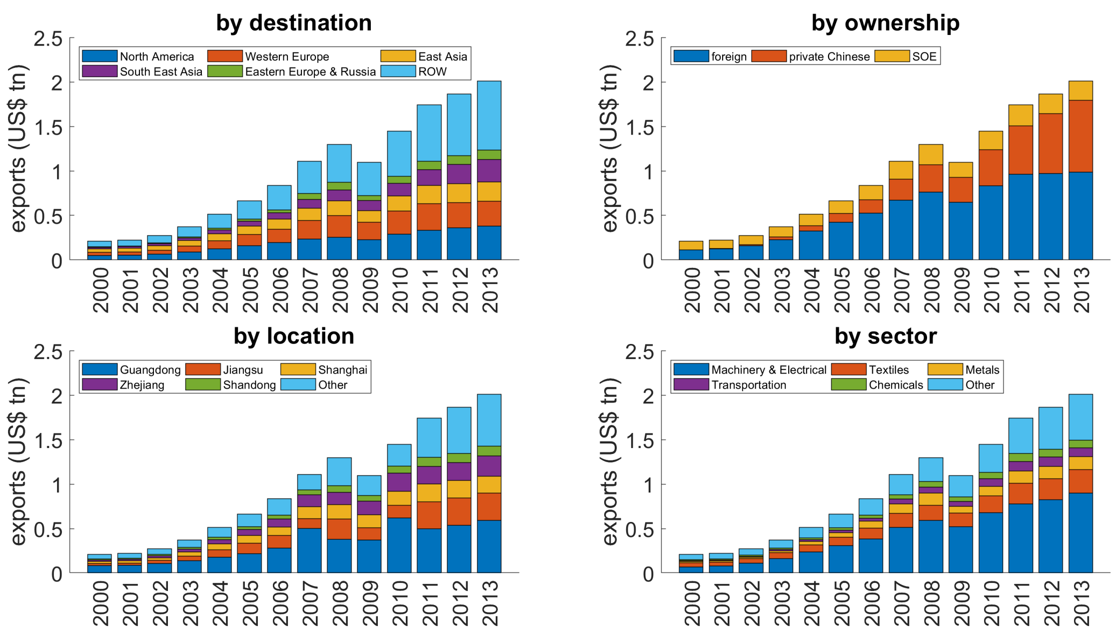


Figure 1: Exports by destination, firm ownership, production location, and sector

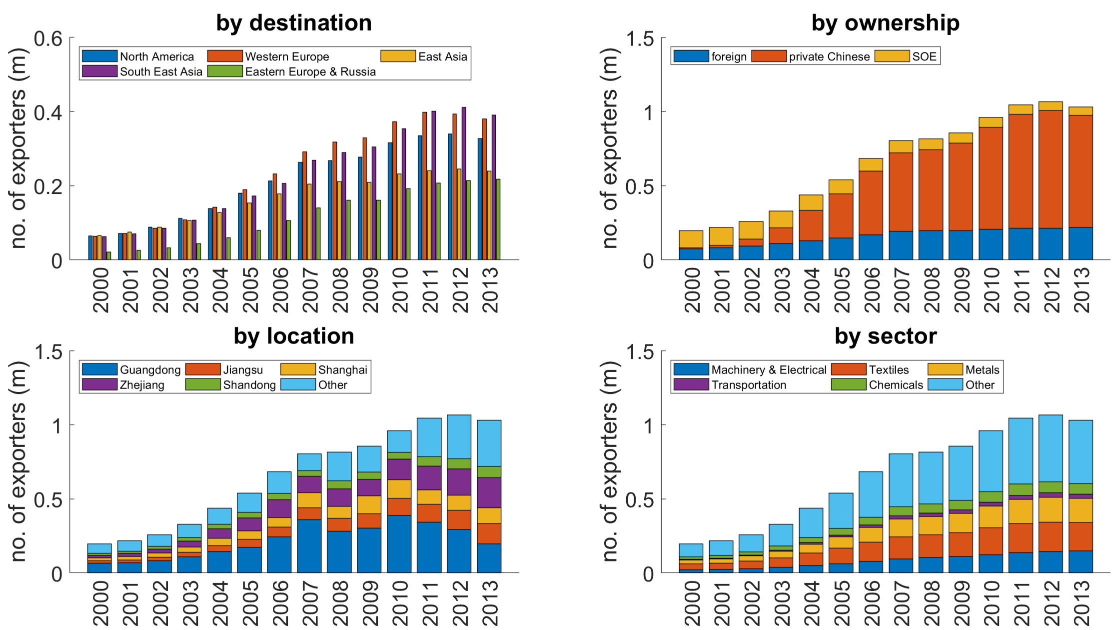


Figure 2: Exporter counts by destination, firm ownership, production location, and sector

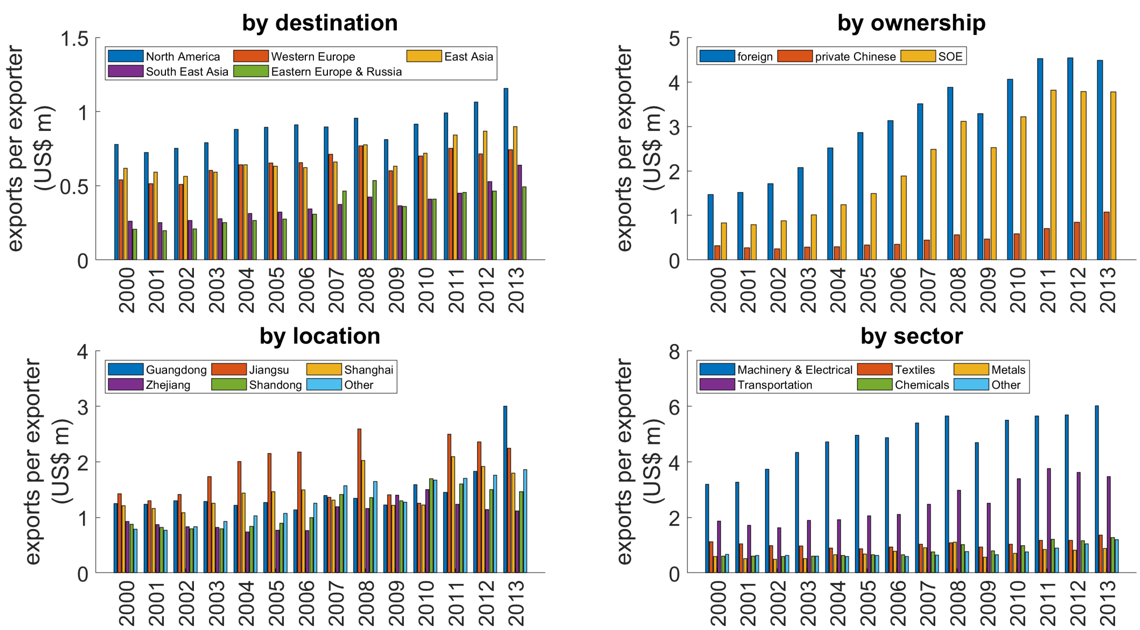


Figure 3: Exports per exporter by destination, firm ownership, production location, and sector

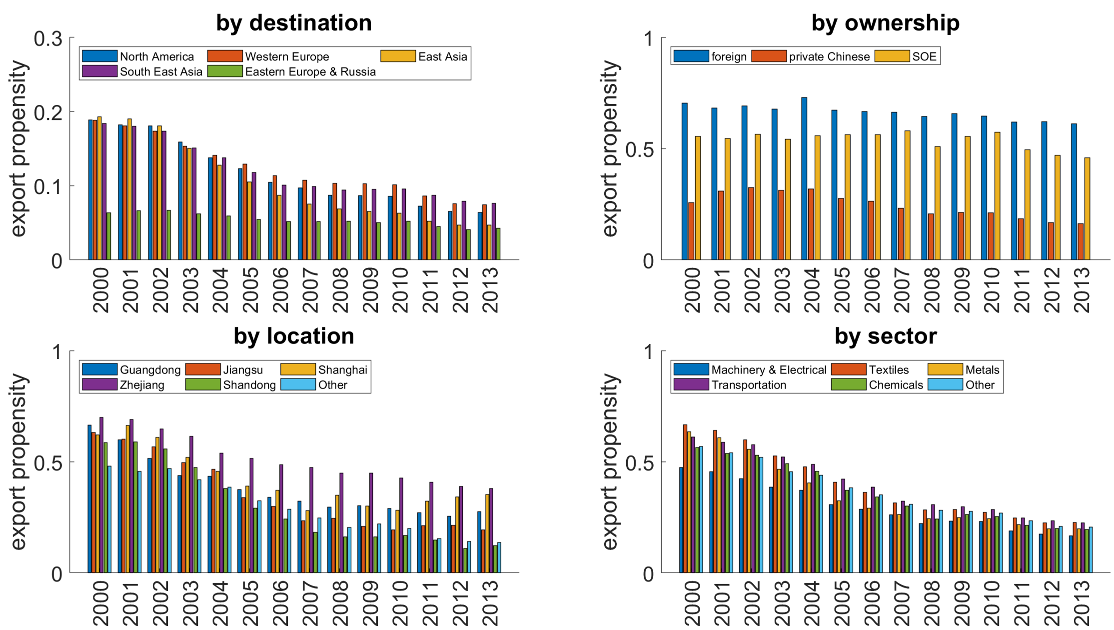
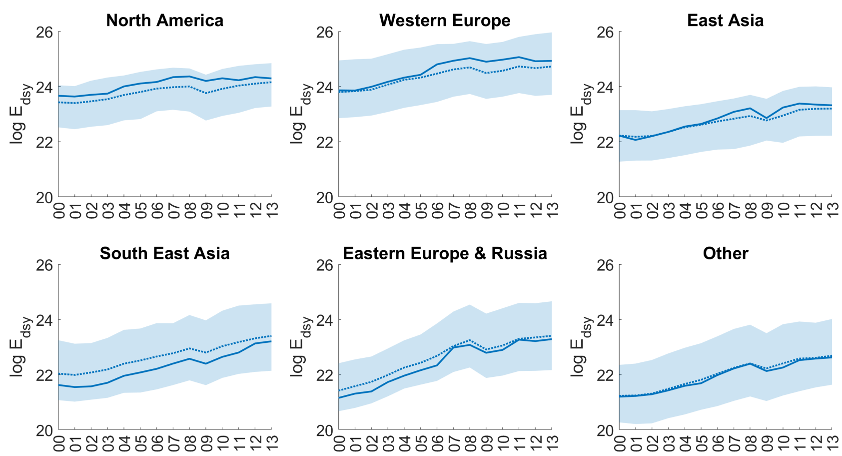


Figure 4: Export propensity by destination, firm ownership, production location, and sector

(a) Foreign Import Demand, By Destination



(b) Foreign Import Demand, By Sector

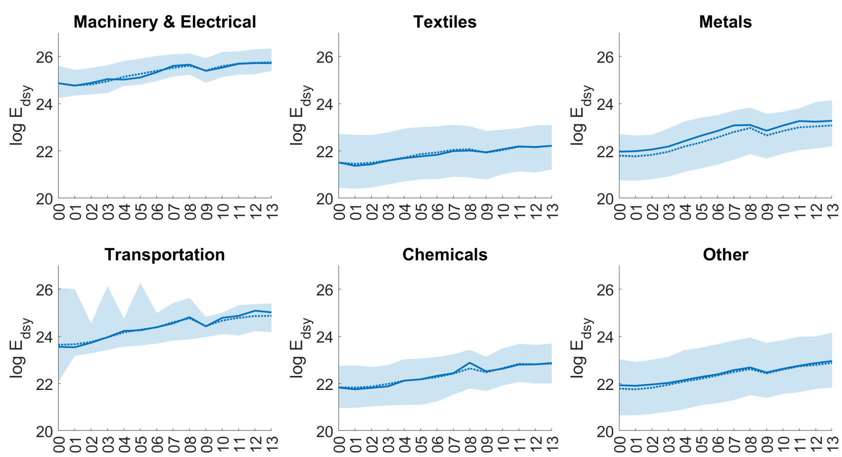
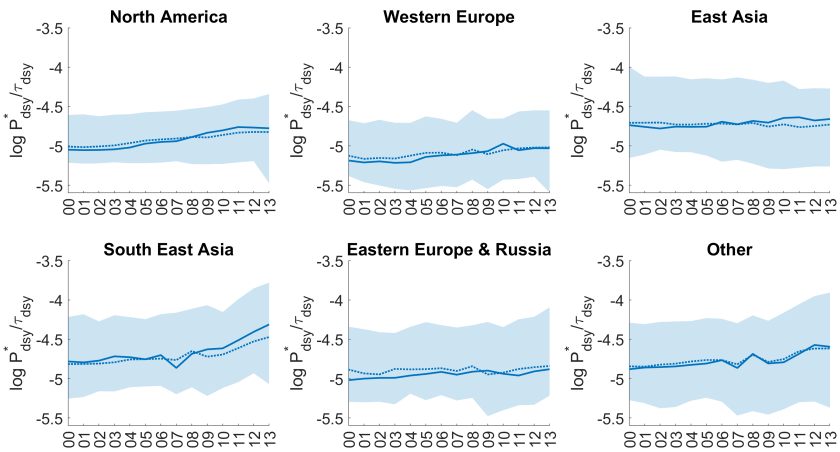


Figure 5: Estimates of foreign demand, E_{dsy}

Note: In each figure, the solid line indicates the median of the statistic across all firms within the respective group and year, the dotted line indicates the mean, and the shaded region indicates the inter-quartile range.

(a) Foreign Market Competition, By Destination



(b) Foreign Market Competition, By Sector

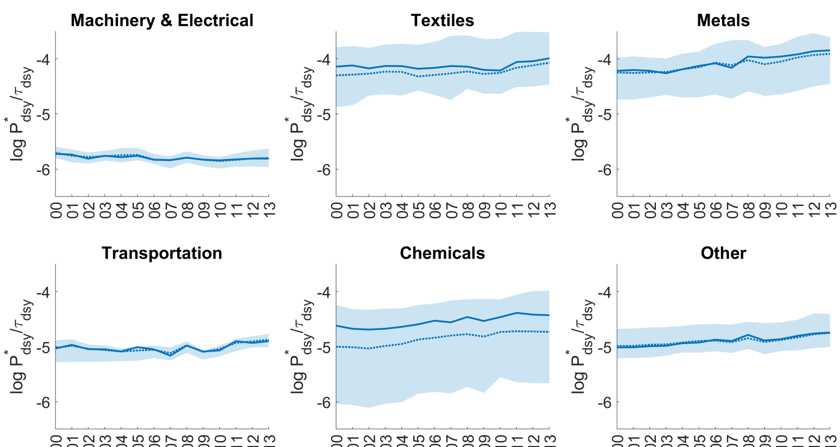
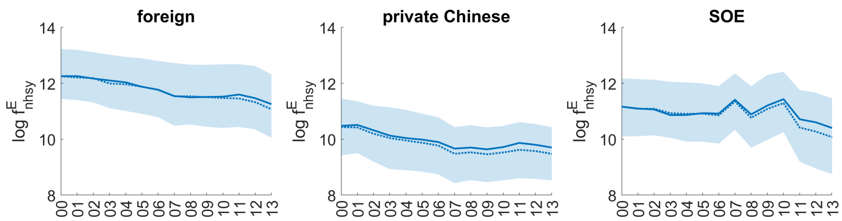


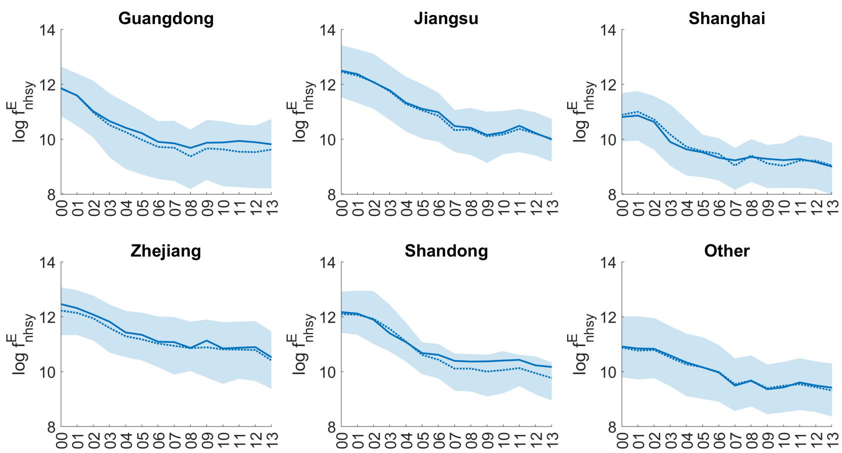
Figure 6: Estimates of foreign competition, P^*_{dsy}/τ_{dsy}

Note: In each figure, the solid line indicates the median of the statistic across all firms within the respective group and year, the dotted line indicates the mean, and the shaded region indicates the inter-quartile range.

(a) Entry Costs, By Ownership



(b) Entry Costs, By Province



(c) Entry Costs, By Sector

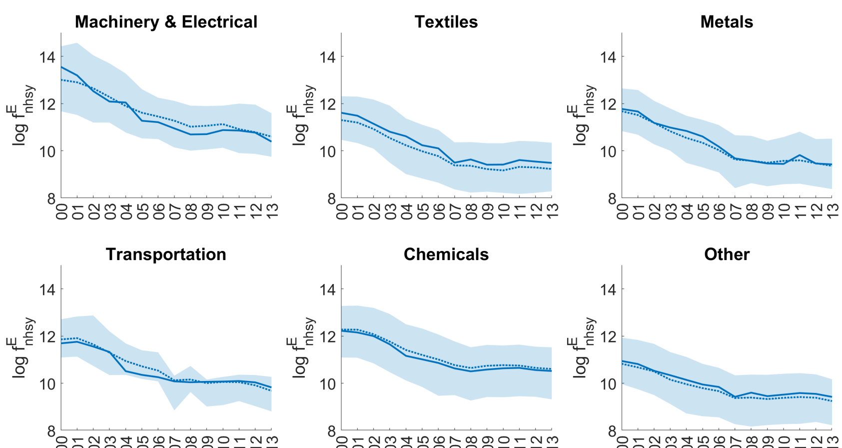
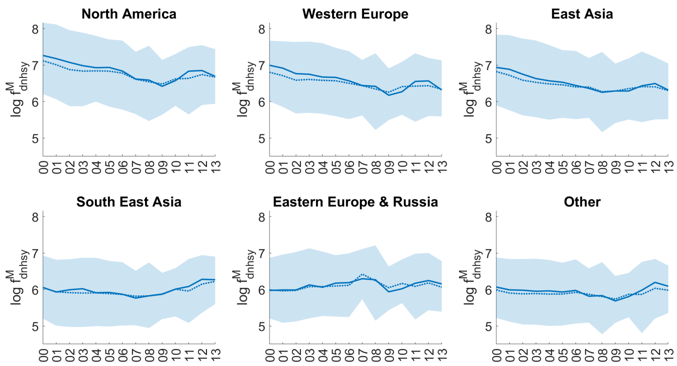


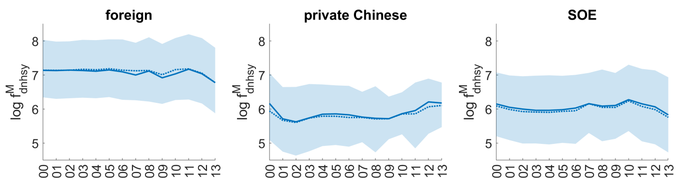
Figure 7: Estimates of entry costs, f^E_{nhsy}

Note: In each figure, the solid line indicates the median of the statistic across all firms within the respective group and year, the dotted line indicates the mean, and the shaded region indicates the inter-quartile range.

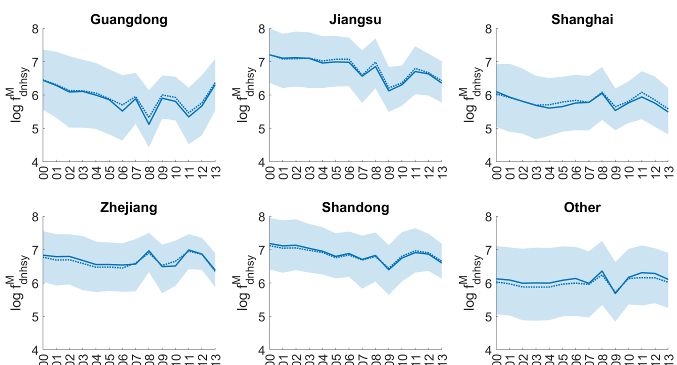
(a) Marketing Costs, By Destination



(b) Marketing Costs, By Ownership



(c) Marketing Costs, By Province



(d) Marketing Costs, By Sector

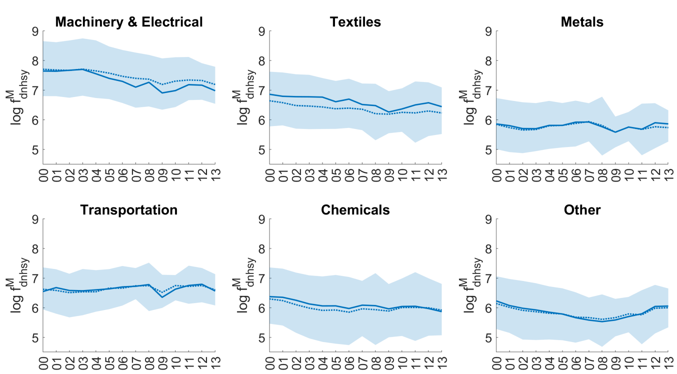
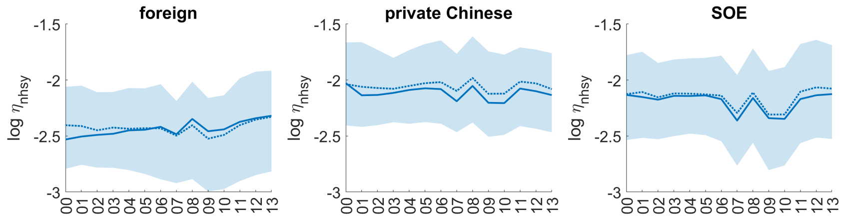


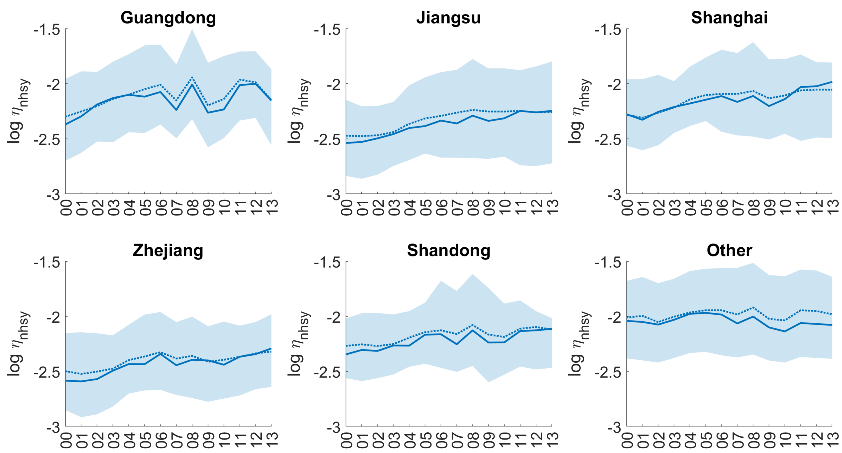
Figure 8: Estimates of marketing costs, f^{M}_{dnhsy}

Note: In each figure, the solid line indicates the median of the statistic across all firms within the respective group and year, the dotted line indicates the mean, and the shaded region indicates the inter-quartile range.

(a) Marginal Costs, By Ownership



(b) Marginal Costs, By Province



(c) Marginal Costs, By Sector

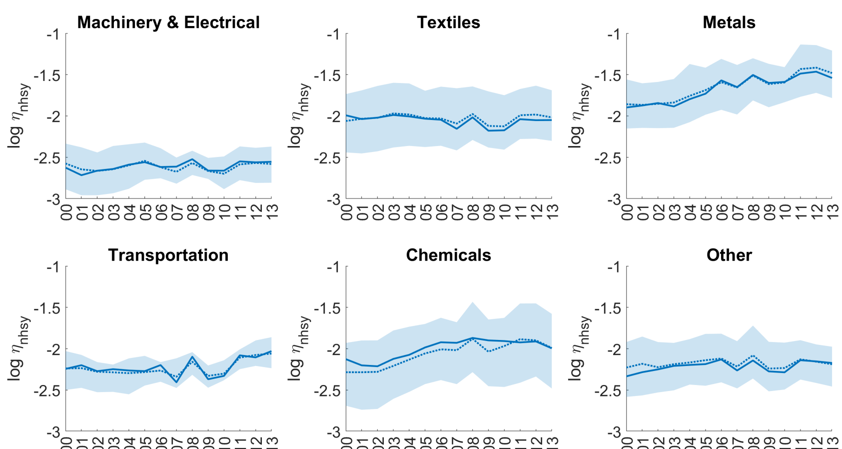


Figure 9: Estimates of marginal costs, η_{nhsy}

Note: In each figure, the solid line indicates the median of the statistic across all firms within the respective group and year, the dotted line indicates the mean, and the shaded region indicates the inter-quartile range.

(a) Wages, By Province

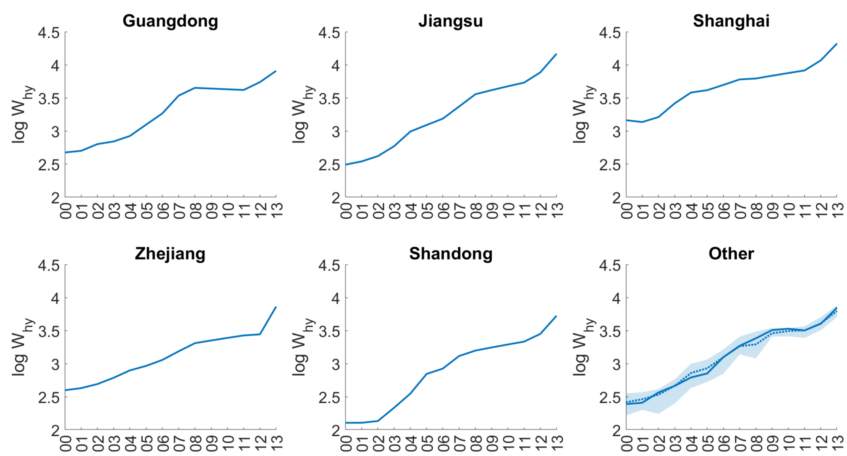


Figure 10: Estimates of wages, W_{hy}

Note: In each figure, the solid line indicates the median of the statistic across all firms within the respective group and year, the dotted line indicates the mean, and the shaded region indicates the inter-quartile range.

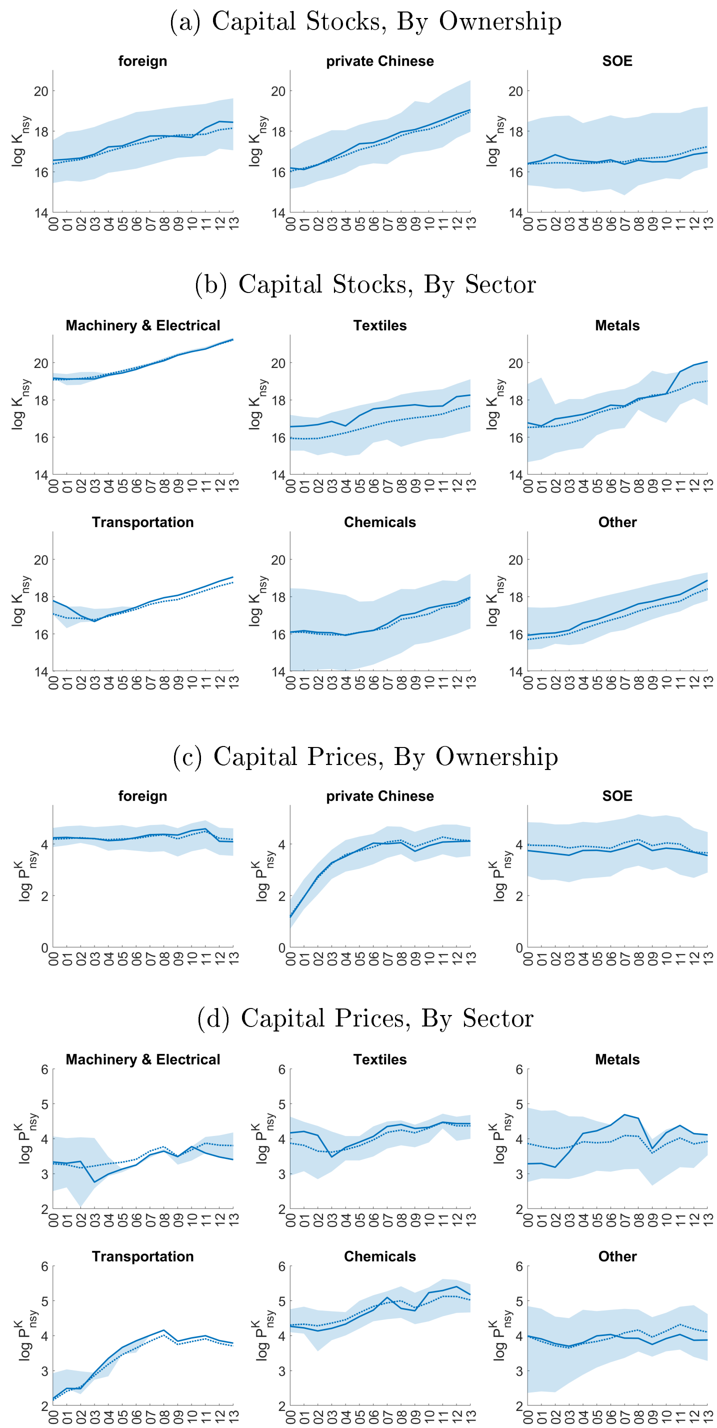


Figure 11: Estimates of capital stocks, K_{ns}, and capital prices, P^K_{nsy}

Note: In each figure, the solid line indicates the median of the statistic across all firms within the respective group and year, the dotted line indicates the mean, and the shaded region indicates the inter-quartile range.

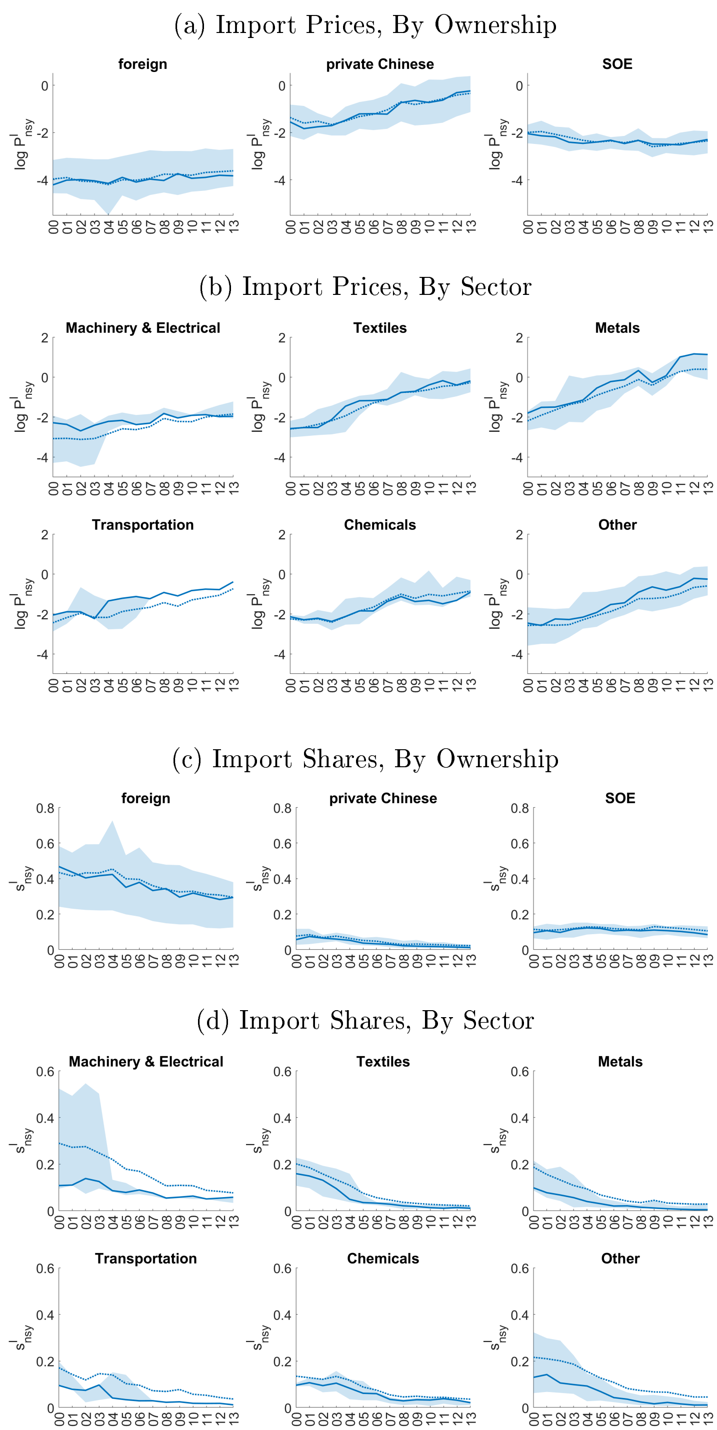
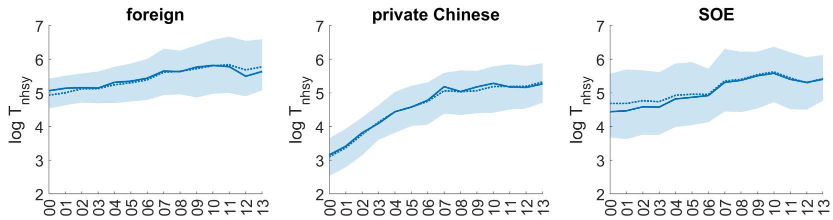


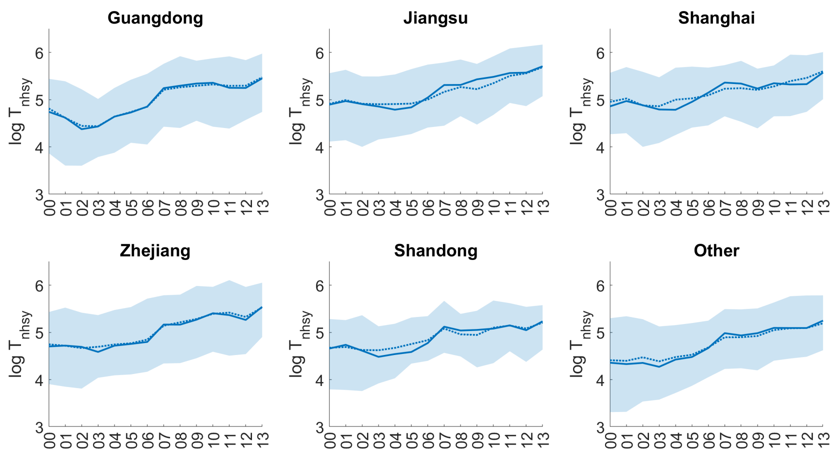
Figure 12: Estimates of imported input prices, P^I_{nsy}, and imported input shares, s^I_{nsy}

Note: In each figure, the solid line indicates the median of the statistic across all firms within the respective group and year, the dotted line indicates the mean, and the shaded region indicates the inter-quartile range.

(a) Total Factor Productivities, By Ownership



(b) Total Factor Productivities, By Province



(c) Total Factor Productivities, By Sector

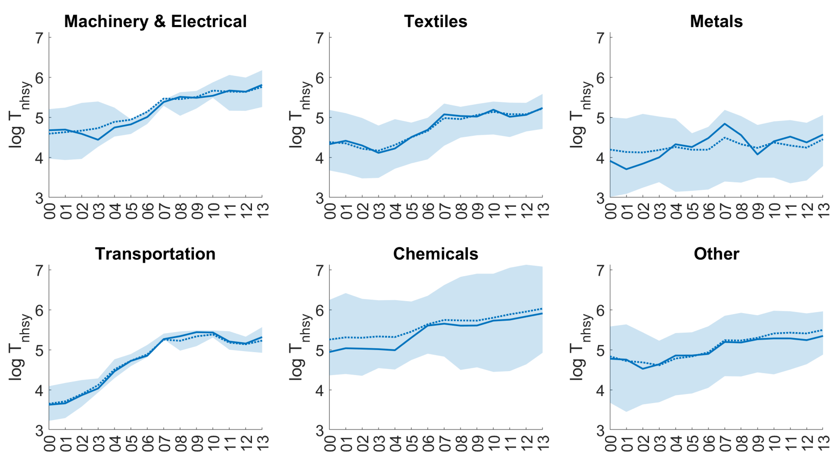


Figure 13: Estimates of technologies, T_{nhsy}

Note: In each figure, the solid line indicates the median of the statistic across all firms within the respective group and year, the dotted line indicates the mean, and the shaded region indicates the inter-quartile range.

Variable	Destination	Ownership	Province	HS-2 sector	Year	Source
exports	y	y	y	y	y	Chinese customs
imports		y	y	y	y	Chinese customs
firm counts		y	y	y	y	ASM
capital stocks		y		y	y	ASM
value-added		y	y	y	y	ASM
exit rates		y	y	y	y	ASM
sales/TFP dispersions		y	y	y		ASM; Brandt et al. (2012)
wages				y	y	ASM
labor shares of value-added				y		Hsieh-Klenow (2009)
input-output flows				yy		WIOD
foreign country imports	y			y	y	UN COMTRADE
US variables: consumption, import price index, tariffs on Chinese imports				y	y	WIOD; BLS; WITS

Table 1: Data Used for Baseline Model Estimation

Stat.: δ_y^- (E_{dsy})	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13
Aggregate	-5.3	3.9	13.8	19.2	10.6	11.7	12.9	7.8	-15.2	19.5	12.0	1.7	3.1
N. America	-1.8	1.3	1.7	3.8	2.6	2.1	1.1	0.2	-3.4	3.6	1.8	0.8	0.2
W. Europe	-0.3	0.2	3.3	3.5	1.6	2.1	2.4	1.2	-3.3	2.2	1.9	-1.6	0.4
E. Asia	-1.5	0.0	2.3	2.8	1.2	1.2	1.2	0.9	-1.8	2.2	1.4	0.0	-0.1
S. E. Asia	-0.8	0.6	1.0	1.9	0.9	0.9	1.3	1.1	-1.6	2.1	1.2	0.9	0.2
E. Europe & Russia	0.3	0.4	0.8	0.9	0.6	0.9	1.9	1.1	-1.8	0.9	0.9	0.0	0.2
Other	-1.3	1.4	4.4	5.8	3.5	4.4	4.9	3.0	-4.2	7.7	4.5	1.6	2.1
Mach. & Elec.	-4.1	1.3	6.4	9.9	5.4	5.7	5.3	2.9	-7.0	9.6	4.4	0.8	1.1
Textiles	-0.3	0.2	1.9	1.8	0.8	1.3	1.8	0.5	-1.5	1.6	1.8	-0.2	0.6
Metals	-0.4	0.4	0.9	2.3	1.1	1.5	1.9	1.5	-2.4	1.6	1.2	-0.1	0.0
Transportation	-0.1	0.2	0.8	0.5	0.4	0.5	0.6	0.6	-0.9	1.4	0.5	0.1	-0.2
Chemicals	-0.1	0.2	0.7	0.8	0.5	0.4	0.6	0.7	-0.8	0.9	0.9	-0.1	0.0
Other	-0.4	1.6	2.9	3.7	2.3	2.3	2.5	1.5	-3.1	3.9	3.0	1.2	1.6

Table 2: Contribution of Changes in Foreign Demand E_{dsy} to Chinese Export Growth

Note: Values are shown in units of percentage points (%).

Stat.: $\delta_y^-\left(P^*_{dsy}\right)$	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13
Aggregate	-11.8	-5.8	2.8	9.3	1.8	-12.6	-2.8	11.8	-13.0	1.3	6.6	5.6	0.6
N. America	-0.8	-0.8	0.4	1.1	0.9	0.4	1.1	1.4	-0.6	0.7	1.2	0.6	-0.2
W. Europe	-5.2	-1.6	0.6	3.1	0.3	-5.6	0.4	2.7	-2.7	1.2	0.1	0.7	-0.6
E. Asia	-0.2	-0.2	-1.5	0.4	-0.2	-0.9	0.7	0.0	-0.7	-0.6	-1.0	0.5	0.3
S. E. Asia	-1.3	-1.0	0.7	1.4	0.0	-2.1	-2.9	2.4	-2.0	-0.9	2.4	1.1	0.9
E. Europe & Russia	-0.3	-0.6	0.8	-0.1	0.1	-0.7	-1.0	1.1	-2.1	0.1	0.9	0.4	-0.1
Other	-4.3	-1.8	1.8	3.1	0.6	-3.8	-1.3	3.4	-5.4	0.4	2.7	2.3	0.3
Mach. & Elec.	-9.7	-4.0	1.9	3.5	0.7	-16.0	-0.1	3.7	-3.2	-4.5	-1.1	3.7	1.2
Textiles	-0.3	0.2	1.1	0.1	-2.8	0.3	-0.4	0.5	-1.3	0.5	1.9	0.7	0.4
Metals	-0.5	-0.5	0.0	3.0	1.2	2.4	-0.1	3.1	-2.6	1.6	2.1	-0.3	-0.8
Transportation	0.3	-0.8	-0.1	-0.1	-0.1	-0.1	-0.3	0.7	-1.6	0.2	0.8	0.2	0.2
Chemicals	-1.0	-0.8	0.6	0.6	0.9	0.5	0.5	0.8	-1.0	1.3	-0.3	0.0	-0.2
Other	-0.5	0.0	-0.5	2.0	2.0	0.4	-2.4	2.8	-3.7	2.0	3.1	1.4	-0.1

Table 3: Contribution of Changes in Foreign Competition P^*_{dsy} to Chinese Export Growth

Note: Values are shown in units of percentage points (%).

Stat.: $\delta_y^-\left(f_{dnsy}^M\right)$	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13
Aggregate	-0.1	-1.6	-3.1	-1.7	-2.1	-1.3	-7.4	-6.7	-3.9	-10.1	-10.5	-0.7	2.6
N. America	0.2	-0.4	-0.8	-0.4	-0.5	-0.1	-0.2	-1.0	-0.7	-1.9	-1.9	-0.1	0.6
W. Europe	0.1	-0.1	-1.0	0.0	-0.3	0.1	-1.3	-1.3	-0.3	-2.0	-1.9	0.4	1.0
E. Asia	0.0	0.0	-0.1	-0.1	-0.1	0.1	-0.5	-0.6	-0.3	-1.0	-0.9	0.1	0.3
S. E. Asia	0.1	-0.1	-0.1	-0.2	-0.1	0.0	-0.6	-0.5	-0.3	-0.8	-0.7	-0.1	0.1
E. Europe & Russia	-0.1	-0.2	-0.3	-0.1	-0.2	-0.3	-1.4	-0.9	-0.6	-1.0	-1.1	0.1	0.3
Other	-0.3	-0.9	-0.9	-0.9	-0.9	-1.0	-3.3	-2.4	-1.8	-3.7	-4.0	-1.1	0.3
Foreign	0.0	-0.8	-1.7	-0.8	-1.3	0.0	-2.9	-1.8	-1.9	-4.1	-3.0	0.7	1.8
Private Chinese	-0.2	-0.3	-1.1	-0.3	-0.5	-0.8	-3.5	-4.7	-1.8	-5.4	-7.5	-1.4	0.6
SOE	0.1	-0.5	-0.4	-0.6	-0.3	-0.5	-0.9	-0.2	-0.3	-0.8	0.0	0.0	0.2
Guangdong	0.1	-0.3	-1.5	-0.4	0.2	0.3	-1.3	0.4	-1.5	-2.4	-0.5	-0.5	-0.5
Jiangsu	0.2	-0.4	-0.8	-0.1	-0.9	-0.3	0.0	-1.7	0.1	-1.5	-2.7	0.3	0.9
Zhejiang	-0.1	0.2	-0.3	-0.3	-0.3	0.0	-0.5	-0.9	0.3	-0.6	-0.8	0.3	0.4
Shanghai	-0.1	-0.1	-0.1	-0.1	-0.3	-0.3	-2.7	-1.1	-1.3	-2.3	-1.6	0.2	1.9
Shandong	0.0	-0.2	0.0	-0.2	0.0	-0.3	-0.6	-0.8	-0.3	-0.8	-1.1	-0.1	0.3
Other	-0.1	-0.8	-0.4	-0.7	-0.8	-0.7	-2.4	-2.6	-1.3	-2.8	-3.9	-1.1	-0.5
Mach. & Elec.	-0.1	-1.3	-2.1	-0.5	-0.7	0.3	-2.3	-1.9	-1.7	-4.1	-3.2	0.1	0.9
Textiles	0.0	0.1	-0.2	0.0	-0.1	-0.4	-0.8	-0.8	-0.6	-0.8	-1.2	0.2	0.5
Metals	0.0	-0.1	-0.2	-0.7	-0.3	-0.8	-1.7	-1.3	-0.1	-1.2	-1.3	0.0	0.3
Transportation	0.0	0.0	-0.1	0.0	-0.1	-0.1	-0.4	-0.3	-0.2	-0.5	-0.4	0.0	0.2
Chemicals	0.0	0.0	-0.1	-0.2	-0.2	-0.1	-0.7	-0.6	-0.4	-0.9	-0.7	0.0	0.2
Other	0.0	-0.3	-0.4	-0.3	-0.7	-0.1	-1.5	-1.8	-1.0	-2.7	-3.6	-1.0	0.5

Table 4: Contribution of Changes in Marketing Costs f_{dnsy}^M to Chinese Export Growth

Note: Values are shown in units of percentage points (%).

Stat.: $\delta_y^-(N_{nhsy})$	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13
Aggregate	10.2	15.1	24.5	19.4	24.8	16.9	23.8	7.7	1.3	11.0	13.4	3.1	2.7
Foreign	7.5	9.5	14.1	7.5	14.8	7.7	9.6	6.0	-1.6	2.9	6.5	-0.9	1.5
Private Chinese	3.1	7.9	13.0	14.3	13.4	11.7	11.0	5.5	2.3	8.2	9.8	4.5	1.5
SOE	-0.1	-2.1	-2.1	-2.2	-2.7	-2.2	3.9	-4.0	0.5	0.0	-2.5	-0.5	-0.3
Guangdong	-0.4	1.8	5.9	2.5	4.2	4.7	21.1	-11.2	4.9	7.2	-7.8	-0.7	-3.5
Jiangsu	3.5	4.2	6.0	3.5	9.6	3.7	0.2	6.7	-3.3	2.3	6.2	-0.5	2.6
Zhejiang	1.6	2.1	2.9	2.7	2.1	0.8	2.5	-0.3	0.9	-0.5	0.7	-0.1	0.2
Shanghai	2.7	4.1	4.9	6.4	4.0	4.2	3.3	-1.1	1.9	2.2	0.1	1.4	1.9
Shandong	0.7	1.1	1.7	1.7	1.6	0.7	-0.2	2.8	-0.7	0.0	2.0	1.2	0.0
Other	2.0	1.5	3.0	2.4	3.5	2.8	-2.2	11.2	-1.9	-0.3	13.0	1.8	1.6
Mach. & Elec.	4.9	7.6	11.5	5.8	10.9	6.4	9.8	2.2	-0.7	3.2	3.7	0.2	1.8
Textiles	0.9	2.2	2.8	2.6	2.2	2.1	1.6	1.4	0.1	1.1	1.8	0.5	0.1
Metals	1.0	1.7	2.9	4.6	3.7	2.0	4.0	1.3	0.7	1.8	1.8	0.5	0.2
Transportation	0.4	0.3	0.7	0.3	0.7	0.4	1.0	0.6	-0.1	0.2	0.7	0.0	-0.1
Chemicals	2.2	1.7	2.5	2.5	4.1	2.4	3.9	3.4	0.4	2.1	3.4	0.4	0.5
Other	1.2	2.5	6.0	5.3	5.6	4.8	5.3	-1.1	0.7	3.0	2.8	1.6	0.1

Table 5: Contribution of Changes in Firm Entry N_{nhsy} to Chinese Export Growth

Note: Values are shown in units of percentage points (%).

Stat.: δ_y^- (W_{hy})	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13
Aggregate	-4.1	-16.8	-27.7	-36.6	-25.9	-28.3	-49.0	-27.6	-5.6	-6.5	-8.8	-23.7	-62.2
Guangdong	-1.4	-6.6	-2.5	-5.1	-9.9	-9.4	-28.6	-5.7	0.4	0.8	0.5	-4.9	-7.2
Jiangsu	-1.3	-2.5	-6.3	-10.7	-4.8	-4.5	-6.4	-9.8	-1.6	-2.1	-2.8	-7.5	-16.2
Zhejiang	0.5	-1.6	-5.9	-4.7	-0.8	-1.6	-1.9	-0.3	-0.7	-0.9	-0.8	-2.7	-4.7
Shanghai	-0.6	-1.6	-2.9	-3.8	-2.1	-3.0	-5.3	-4.3	-1.2	-1.9	-1.4	-0.5	-22.0
Shandong	0.0	-0.3	-2.8	-3.2	-5.3	-1.1	-2.9	-1.2	-0.5	-0.6	-0.6	-1.7	-5.0
Other	-1.4	-4.3	-7.6	-9.6	-3.1	-9.2	-5.4	-7.0	-2.3	-2.1	-3.8	-7.4	-14.0

Table 6: Contribution of Changes in Wages W_{hy} to Chinese Export Growth

Note: Values are shown in units of percentage points (%).

Stat.: δ_y^- (K_{nsy})	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13
Aggregate	2.1	5.0	9.4	14.2	10.6	10.8	12.7	11.8	6.8	8.1	6.9	14.8	11.6
Foreign	3.2	4.6	7.1	11.0	6.2	6.8	6.3	4.9	1.9	1.9	1.5	4.6	2.7
Private Chinese	0.4	1.1	2.7	4.0	4.2	4.0	5.4	6.9	4.3	5.5	5.0	9.1	8.6
SOE	-1.5	-0.7	-0.3	-0.8	0.2	0.1	1.1	0.1	0.6	0.6	0.3	1.1	0.3
Mach. & Elec.	2.2	3.4	4.9	6.9	4.2	4.7	5.3	4.1	2.7	2.9	2.2	4.8	4.2
Textiles	-0.4	0.0	0.5	0.6	0.7	0.8	0.8	0.5	0.3	0.3	0.3	1.1	0.8
Metals	0.2	-0.6	0.9	1.4	1.4	1.8	1.6	1.7	0.9	0.5	0.8	1.4	0.7
Transportation	-0.2	0.0	0.1	0.3	0.4	0.4	0.6	0.4	0.1	0.4	0.4	0.4	0.2
Chemicals	0.3	1.3	1.8	1.8	2.0	1.1	2.3	3.1	1.4	2.0	1.4	2.3	3.0
Other	0.1	1.0	1.4	3.2	2.0	2.1	2.3	2.0	1.3	1.8	1.8	5.0	3.0

Table 7: Contribution of Changes in Capital Stocks K_{nsy} to Chinese Export Growth

Note: Values are shown in units of percentage points (%).

Stat.: $\delta_y^- \left(P_{nsy}^I\right)$	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13
Aggregate	-18.3	25.2	-4.7	-22.9	-47.2	4.9	-16.0	-32.9	3.7	-3.1	-16.8	3.1	-5.1
Foreign	-17.1	25.1	-9.6	-50.1	-44.1	4.6	-14.3	-29.0	1.6	1.5	-14.1	3.9	-4.9
Private Chinese	0.0	-0.5	1.8	-2.4	-2.2	0.1	-1.8	-1.9	0.4	-0.7	-0.6	-0.5	-0.2
SOE	0.0	1.3	2.9	1.1	-0.3	0.2	0.4	-1.7	1.4	-4.4	-2.1	-0.4	0.0
Mach. & Elec.	-8.7	23.0	-8.0	29.5	-28.5	11.9	-14.7	-22.0	2.9	4.6	-8.0	6.1	-4.0
Textiles	-0.8	-1.7	0.1	-0.5	-1.8	-0.7	-0.2	-0.8	0.0	-0.1	-0.1	-0.1	-0.2
Metals	-1.8	-3.9	-2.1	-60.5	-2.6	-2.8	-0.5	-3.7	2.5	-11.0	-2.4	-1.1	0.0
Transportation	-0.4	-0.1	0.7	0.7	-0.9	0.4	-0.8	-9.2	0.3	-2.3	-0.2	-1.1	-0.2
Chemicals	-1.8	1.0	2.3	0.1	-2.1	0.7	-0.7	-0.3	0.1	-0.5	0.3	-0.1	0.0
Other	-4.8	6.3	2.1	-19.7	-10.4	-4.6	0.5	-5.6	-2.2	0.2	-6.4	-2.3	-0.9

Table 8: Contribution of Changes in Imported Input Prices P_{nsy}^I to Chinese Export Growth

Note: Values are shown in units of percentage points (%).

Stat.: δ_y^- (T_{nhsy})	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13
Aggregate	8.2	40.4	11.3	-14.3	31.6	33.3	82.4	-0.6	-13.8	54.8	30.3	-46.2	23.6
Foreign	16.2	29.8	-9.5	-31.1	29.2	14.7	48.0	-5.6	5.3	36.4	18.3	-36.5	5.4
Private Chinese	3.8	12.1	21.7	21.3	17.6	19.8	30.7	1.4	-21.0	16.5	14.4	-10.1	17.4
SOE	-8.2	-0.6	-7.9	-68.4	-17.8	-7.5	10.5	1.3	-4.8	1.5	-1.0	-7.0	-0.1
Guangdong	8.5	20.4	1.7	6.5	10.8	11.0	36.3	6.3	-5.5	14.6	-5.3	-17.4	4.2
Jiangsu	3.6	6.9	9.6	3.5	8.6	6.0	6.8	6.6	-7.6	6.0	13.0	-4.8	4.7
Zhejiang	3.9	-2.9	7.1	3.1	1.2	-10.3	7.4	-2.9	-2.7	5.0	2.2	-3.5	2.1
Shanghai	4.1	5.4	5.6	-2.1	1.0	1.9	12.5	6.8	-8.9	11.1	4.5	-19.1	5.7
Shandong	0.0	0.4	2.1	-17.5	3.2	-0.2	3.9	-16.9	-5.0	3.0	2.3	-10.5	1.7
Other	-21.1	4.4	-28.0	-40.3	-3.7	1.2	7.0	-14.1	-7.3	6.0	6.0	-15.8	-2.4
Mach. & Elec.	15.2	31.8	13.5	34.8	27.3	34.5	46.2	0.5	8.7	38.6	21.6	-6.8	14.6
Textiles	3.3	-1.9	3.3	7.5	10.4	6.0	10.8	-3.0	2.2	4.5	-0.9	-5.3	3.8
Metals	-26.3	5.8	1.5	-73.0	-5.7	-10.9	9.8	-14.9	-16.4	5.2	1.5	-3.0	9.2
Transportation	0.4	1.2	2.7	3.9	1.1	1.6	3.8	1.0	-0.8	0.3	-1.7	-1.8	0.4
Chemicals	5.8	7.3	-4.5	-3.9	-3.5	0.2	11.3	7.3	-4.6	1.6	10.6	-1.5	-2.5
Other	4.4	1.7	-7.1	-0.7	3.5	2.3	21.4	7.5	-3.3	7.6	1.8	-27.3	-0.3

Table 9: Contribution of Changes in Total Factor Productivities T_{nhsy} to Chinese Export Growth

Note: Values are shown in units of percentage points (%).