Migration, Tariffs, and China's Export Surge

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China's Export Surge and the New Margins of Trade*

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Abstract

We build a multi-sector spatial general equilibrium model to account for China's export surge between 1990 and 2005. We focus on the role of the reductions in tariffs and internal migration costs during that period. Our model generates a closed-form aggregate trade elasticity that can be decomposed into four margins of adjustments. Two are the commonly studied *intensive* and *extensive margins* of exports (Chaney, 2008). The remaining two margins are the *new-firm margin* and the *export-regime margin*, for which we have found empirical support and used our reduced-form evidence to discipline the structural parameters. Using the calibrated model, we find that the reductions in tariffs and internal migration costs accounted for a third of China's export growth between 1990 and 2005. Among the four margins, we find that the *new-firm margin* played an important role in amplifying the effect of these policy changes on export growth.

JEL Codes: F1; J6. Key Words: international trade; tariffs; labor-market adjustments; migration; firm location choices.

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1 Introduction

From 1980 to 2005, the share of global trade of "Made in China" goods grew from 0.8% to 13%. While a large number of literature has examined the consequences of China's export surge (see Autor, Dorn and Hanson, 2016), fewer papers have focused on the sources causing China's export surge. In this paper, we quantify the relative contributions of several factors to China's export surge.

We build a multi-sector spatial general equilibrium model featuring heterogeneous firms' and workers' location choices. We account for China's export surge between 1990 and 2005 in light of three policy changes: changes in China's import tariffs, changes in tariffs imposed against China's exports, and changes in barriers to internal migration in China. Theoretically, we decompose the aggregate trade elasticity into four margins of firm adjustments and show that each margin has an analytic expression. Two adjustments are the standard *intensive* and *extensive margins* of trade (Chaney, 2008). The other two are the location switching of firms, referenced as the *new-firm margin*, and the choice of firms between processing and ordinary export regimes, referenced as the *export-regime margin*.[1] Empirically, we find support for the *new-firm* and *export-regime margins* by using provincial and sectoral variation on the changes in the number of firms in response to the changes in the scale of migrant employment and the changes in import tariffs respectively. Finally, we use our empirical estimates to discipline our model parameters and evaluate the importance of each margin in accounting for China's export surge.

Our model has three main components. First, each firm draws a vector of correlated productivities across foreign countries, Chinese provinces, and export regimes (processing or ordinary). The second component is the inter-sectoral input-output linkages (Caliendo and Parro, 2015). The third component is that Chinese workers with heterogeneous location preferences and migration costs sort into provinces and sectors. In this setting, a policy shock generates four types of firm adjustments. For instance, a reduction in China's import tariffs lowers the costs of intermediate inputs and attracts more firms to locate in China (the *new-firm margin*). Further, ordinary export production is subject to nominal import tariffs, whereas imported intermediate materials are duty-free for processing export production. Import tariff reductions thus induce switching from processing to ordinary regime (the *export-regime margin*). Moreover, the reduced costs of intermediate inputs incentivize existing exporters to export more (the *intensive margin*) and lead to some previously non-exporting firms to begin exporting (the *extensive margin*).

[1] Export processing is the process where firms import raw materials or intermediate inputs from abroad and export the final goods after some processing (Feenstra and Hanson, 2005). Processing firms are not allowed to sell output domestically.

We derive analytic results that decompose the aggregate trade elasticity into four margins. The *intensive margin* and the *extensive margin* replicate the exact formula in Chaney (2008). We show that the *new-firm margin* is determined by the correlation of firms' productivity draws across locations, and the *export-regime margin* depends on the correlation of firms' productivity draws between processing and ordinary regimes. This analytic result is important as it guides our empirical strategy to discipline the parameter values for the *new-firm* and *export-regime margins*. It also guides our parameter restrictions for our quantitative exercises to decompose the export impact into four margins of firm adjustments.

We assemble a dataset from various Chinese sources to show that the *new-firm* and *export-regime margins* are prominent in the time period of this study. First, we validate the *new-firm margin* by showing that between 1990 and 2005, the rise in migrant employment strongly increased the number of firms across provinces and sectors. To address the endogeneity issues, we construct a Card-type instrument for changes in migrant employment in each province and sector by exploiting historical patterns of location and sector sorting for workers from different provinces of origin. Second, to validate the *export-regime margin*, we use provincial import penetration and sectoral input-output linkages to construct changes in production costs resulting from import tariff reductions (WTO). We instrument potentially endogenous tariff changes with maximum tariff levels under the WTO agreement, extending the strategy developed in Brandt, Van Biesebroeck, Wang and Zhang (2017). We explore cross-sectoral variation to find that decreases in import tariffs led to a rise in the relative number of ordinary firms to processing firms.[2]

We rely on the reduced-form estimates to discipline the two key model parameters that govern the *new-firm* and *export-regime margins* using an indirect inference approach. Specifically, we choose the correlation of productivity draws across locations to target our reduced-form estimate on the extent to which the number of firms responded to migration shocks. We choose the correlation of productivity draws between ordinary and processing regimes to target our reduced-form estimate on the response of the relative number of ordinary to processing firms to import tariff changes.

We combine detailed transaction-level customs data, firm-level data, international and intranational trade data, and micro-level population census data to account for China's export surge due to the three policy changes mentioned above. Our quantitative model includes 29 sectors, 2 export regimes (processing and ordinary), 30 Chinese provinces, and 36 foreign countries. We measure changes in tariffs on China's imports, tariffs on China's exports, and

[2] This channel was first studied in Brandt and Morrow (2017) who focused on how the value share of exports organized through ordinary trade responded to tariff changes. In contrast, in order to discipline our model parameter on firm adjustments of export regimes, we use the relative number between ordinary and processing exporters as the dependent variable.

internal migration barriers. After that, we perform two sets of counterfactual exercises. In the first set of exercises, we introduce each shock to our model, one at a time. With these exercises, we quantify the extent to which each shock promoted China's aggregate export growth between 1990 and 2005. In the second set of exercises, we re-introduce each shock to our model under parameter restrictions based on the analytic decomposition. With these exercises, we decompose the export growth resulting from each shock into four margins of firm adjustments.

We find that the three policies combined accounted for 29% of China's export growth between 1990 and 2005. More notably, the *new-firm margin* was important in explaining China's export surge: if we held the number of firms constant, the portion of China's export surge explained by the three shocks combined would drop to 16%. This difference suggests that the emergence of new firms resulting from (trade and migration) barrier reductions explained 13% of China's export surge. Individually, reductions in China's import tariffs explained 13%, whereas changes in foreign tariffs on China's exports and reductions in internal migration barriers each accounted for around 8% respectively. We also find that each shock had differential impacts on processing and ordinary exports: import tariff reductions operated primarily by boosting ordinary exports, whereas the reductions in migration barriers and in foreign tariffs on China's exports both favored processing exports.

Our paper relates to the quantitative trade and spatial equilibrium literature that studies the impact of goods and labor market integration (e.g., Allen and Arkolakis, 2014; Redding and Rossi-Hansberg, 2017, among others). On the topic of China's internal migration and trade, Tombe and Zhu (2019) analyze its impact on aggregate productivity, and Fan (2019) studies its distributional impact.[3] Both papers adopt the multi-sector Eaton-Kortum (EK) models where the scale of the economy does not change with migration or trade shocks. Complementing these two papers, we quantify the extent to which the impact of trade and migration barrier reduction on China's aggregate economic outcomes can be amplified through the creation of new firms. We build upon Arkolakis, Ramondo, Rodríguez-Clare and Yeaple (2018) (ARRY hereafter) to model firm location choices. Comparing to a model with firm entry, the advantage of modeling firm location choices is to allow arbitrary non-negative values on the elasticity of firm switching with respect to the size of local population and we discipline this elasticity using reduced-form estimates.[4] We also incorporate firm

[3]Also see Ma and Tang (2020) and Zi (2020).

[4]We do not choose a model with firm entry as our benchmark approach as it imposes strong restrictions on the relationship between the number of firms and population size. As shown in Arkolakis, Costinot and Rodríguez-Clare (2012), among the broad class of trade models, the free-entry condition implies the number of firms responds one-to-one to local population. In Appendix E, we also use an alternative model with firm entry as a robustness check. As we extend the ARRY model to a nested-CES demand system, our paper relates to the quantitative trade literature with non-CES demand systems (Adao, Costinot and Donaldson, 2017; Lind and Ramondo, 2018).

sorting into ordinary and processing regimes to distinguish the differential tariff treatments between the two regimes (Branstetter and Lardy, 2006). In this aspect, our paper relates to Brandt, Li and Morrow (2018), who build an EK model with ordinary and processing regimes to quantify the welfare losses of restricting processing output from selling domestically. The main difference of our approach is that we decompose export growth into multiple margins of adjustments.

Recent papers find that the decline of trade barriers and China's WTO accession had a significant contribution to China's productivity growth (Yu, 2015; Brandt et al., 2017). One important source behind the rapid productivity growth is the massive number of new firms (Brandt, Van Biesebroeck and Zhang, 2012). Khandelwal, Schott and Wei (2013) find that the elimination of export quota boosted export growth, which was mainly due to the entry of new firms. These previous papers primarily use reduced-form approach. With a general equilibrium setting, we complement the literature by quantifying the role of new firms induced by trade barrier reductions in explaining the export growth. A recent working paper by Brandt and Lim (2019) also accounts for China's export growth. Our approach differs from theirs in two main aspects. First, they focus on changes in productivity, demand, and labor and firm-entry costs between 2000 and 2013, whereas we study migration and tariff barrier changes. Second, they calibrate their model to analyze evolution of China's export growth. We focus on China's export growth between 1990 and 2005 and use empirical estimates to discipline the degree of firm adjustments to barrier reductions.[5]

This paper proceeds as follows: Section 2 presents facts to motivate our analysis; Section 3 presents our model; and Section 4 decomposes the aggregate trade elasticity into multiple margins. Section 5 validates the *new-firm* and *export-regime margins*. Section 6 discusses our data sources and measures policy shocks. Section 7 presents the quantitative results, and Section 8 concludes.

2 Motivating Facts

We describe the magnitude of the tariff changes we analyze. We also present facts to motivate the importance of internal migration in manufacturing employment and the importance of the growing number of firms and their potential contribution to China's export growth.

There has been a dramatic decline in the world's Most-Favored-Nation (MFN) tariffs since the Uruguay Round in 1991 (Caliendo, Feenstra, Romalis and Taylor, 2015). As China joined the WTO and gained the Most-Favored-Nation (MFN) status in foreign countries, the

[5] We choose the time window between 1990 and 2005 because of data availability.

data show a decline in tariffs levied by foreign countries on China's exports between 1990 and 2005 (see Appendix Figure 10).[6] The decline in China's import tariffs was even more prominent, which on average declined from over 40% to less than 10%. Substantial heterogeneity emerged in import tariff reductions across sectors (see Appendix Figure 11). China's import tariff reductions were only applied to ordinary producers, whereas processing firms had enjoyed duty-free imported intermediate materials since 1987. Therefore, we distinguish Chinese firms by processing and ordinary export regimes in the model.

2.1 Migrants' Employment and Manufacturing Exports

We define migrants as individuals whose *Hukou* is not registered in the province where they are currently working. We measure migrants' employment shares using micro-level data from the 2005 Population Census. The left-hand panel of Figure 1 presents cross-sectional data in 2005 on the share of inter-provincial migrants in total manufacturing employment against manufacturing export-output ratios for each province. It is evident that provinces where migrants comprised larger portions of manufacturing employment were more export-oriented and accounted for higher shares of national exports (export volumes are reflected by circle size). Two noteworthy provinces are Guangdong and Shanghai, where migrants accounted for 55.6% and 40.1% of provincial manufacturing employment respectively.

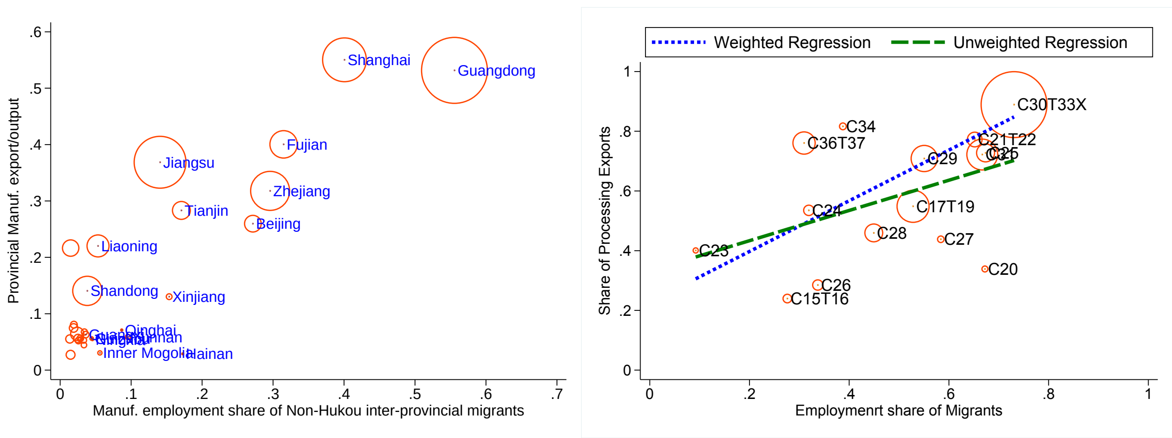


Figure 1: Migrants' Manufacturing Employment Shares against Provincial Export-Output Ratios (left-hand); Migrants' Sectoral Employment Shares against Processing Export Shares across Manufacturing Sectors—Guangdong Province (right-hand)

Notes: The circle size of the left-hand panel measures provincial export volume. The circle size of the right-hand panel reflects provincial processing export volume in each sector. Sectors are labelled using International Standard Industrial Classification (ISIC) Revision 3 codes (see Appendix Table 8). Fitted lines from an export-weighted regression (in blue) and an unweighted regression (in green) confirm a strong positive correlation.

[6]There have also been significant declines in non-tariff trade barriers, which are not captured by the tariff data. Examples are the reduction in uncertainty as China gained permanent MFN status (Handley and Limão, 2017), and the elimination of export intermediaries (Bai, Krishna and Ma, 2017).

While yearly data on the provincial level of internal migration and export growth are difficult to obtain, Appendix B provides additional evidence for the timing of provincial migration and exports at three time points, 1990, 2000, and 2005. We find evidence that the massive migration to coastal provinces started no later than the surge in Chinese exports. The timing suggests agglomeration economies at coastal provinces arose from internal migration. We model these agglomeration forces as external economies of scale (Ethier, 1982), where the provincial and sectoral TFP increases with their employment.

The right-hand panel plots migrants' sectoral employment shares (x-axis) against the share of processing exports in total sectoral exports (y-axis) in Guangdong Province. Migrants' employment shares were higher in processing-oriented manufacturing sectors than in sectors that were less concentrated in processing exports.

2.2 The Number of Firms and Manufacturing Exports

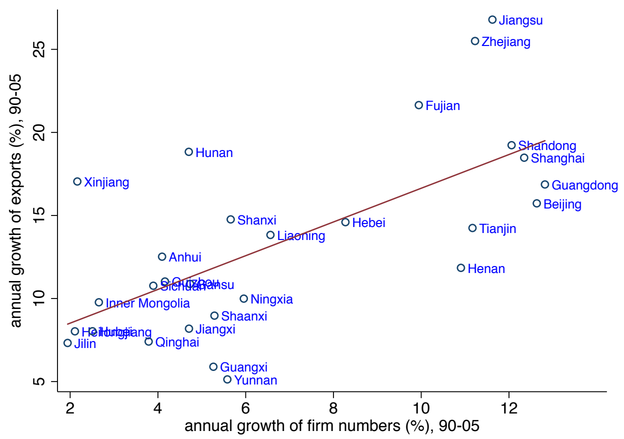


Figure 2: Provincial Annual Growth of Exports and the Number of Firms

Notes: The number of firms in 1990 and 2005 are obtained from the Industrial Statistical Yearbook and the Firm Census, respectively. We use the 2004 Firm Census to measure the number of firms in 2005, as it provides full coverage of manufacturing firms.

Figure 2 plots annual export growth against annual growth rates of the number of manufacturing firms for each province between 1990 and 2005. It shows that provinces where the number of manufacturing firms expanded faster also experienced stronger export growth. Although rapid increases in the number of firms are partially due to reduced barriers to firm entry, reductions in tariffs and migration barriers also lead to the emergence of new firms.[7] Therefore, reductions in tariffs or migration barriers affect aggregate exports not only through the *intensive* and *extensive margins* of trade, as in Chaney (2008), but also by attracting more firms to locate in China and driving firms to switch between processing and ordinary

[7]This fact is consistent with the recent finding in Khandelwal et al. (2013), where trade liberalization led to a rapid expansion in the number of China's manufacturing firms.

regimes.[8] Motivated by this, we build firm sorting across locations and across regimes into a Melitz-Chaney model.

3 A Spatial Equilibrium Model with Firms' Location Choices

We build a multi-sector spatial general equilibrium model with heterogeneous firms' and workers' location choices. The world has a total number M_s of potential intermediate-good producers (firms) in each sector s.[9] We treat each foreign country as a single region. In China, we consider provinces as regions, and in each province we further consider processing and ordinary export regimes. Firms decide in which country to produce and whether to export; if located in China, firms also choose a combination of province and export regime.[10] In China, workers are imperfectly mobile across provinces and sectors, but are perfectly mobile between processing and ordinary firms within each province-sector pair. In foreign countries, we simply assume that workers are perfectly mobile across sectors.

We use index $l(m)$ to denote a combination of province l and export regime $m \in \{\mathcal{O}, \mathcal{P}\}$, where $\mathcal{O}$ and $\mathcal{P}$ denote ordinary and processing regimes respectively. We use j or n to index foreign countries. For ease of description, we mostly present our model based on China's provinces and export regimes. We discuss the setup for foreign countries when a distinction arises. All proofs are provided in Appendix A.

3.1 Final-good Producers

In province l and regime m, non-tradable final goods are produced using a Dixit-Stiglitz production function

$$Q_{l(m),s} = \left(\sum_j \int q_{j,l(m),s}(\omega)^{\frac{\sigma-1}{\sigma}} \mathrm{d}\omega + \sum_{l'} \int q_{l'(\mathcal{O}),l(m),s}(\omega)^{\frac{\sigma-1}{\sigma}} \mathrm{d}\omega \right)^{\frac{\sigma}{\sigma-1}},$$

where $q_{j,l(m),s}(\omega)$ is the quantity of intermediate goods ω shipped from foreign country j to $l(m)$, and $q_{l'(\mathcal{O}),l(m),s}(\omega)$ is the quantity sourced from domestic ordinary producers in province l'. Since processing producers must sell their output overseas, the summation combines

[8] Because processing and ordinary producers face differential tariff treatments, China's reductions in import tariffs affect aggregate exports by causing firms to switch between processing and ordinary regimes. Also note that migrants' sectoral employment shares differ between processing- and ordinary-oriented sectors. Therefore, reductions in migration barriers would differentially affect processing and ordinary producers and cause firms to switch between these two export regimes.

[9] Idea-based growth literature (e.g., Jones, 1995; Kortum, 1997) typically assumes that the total number of ideas scales with population. In our model, the population is constant in the quantitative analysis, and therefore we assume that the number of potential producers is constant.

[10] We do not distinguish between export regimes in foreign countries.

intermediate goods sourced from all foreign countries and domestic ordinary producers in all China's provinces. $\sigma > 1$ is the elasticity of substitution across varieties. The final good can be either consumed by households or used as raw materials to produce intermediate goods. The price index of the final good in $l(m)$ and sector s is

$$P_{l(m),s} = \left(\sum_{j} \int p_{j,l(m),s}(\omega)^{1-\sigma} \mathrm{d}\omega + \sum_{l'} \int p_{l'(\mathcal{O}),l(m),s}(\omega)^{1-\sigma} \mathrm{d}\omega \right)^{\frac{1}{1-\sigma}}.$$

Foreign producers can source from processing and ordinary regimes of China. The production function in foreign country n and sector s is

$$Q_{n,s} = \left(\sum_{j} \int q_{j,n,s}(\omega)^{\frac{\sigma-1}{\sigma}} \mathrm{d}\omega + \sum_{l'} \sum_{m'} \int q_{l'(m'),n,s}(\omega)^{\frac{\sigma-1}{\sigma}} \mathrm{d}\omega \right)^{\frac{\sigma}{\sigma-1}}.$$

The price index in country n and sector s is

$$P_{n,s} = \left(\sum_{j} \int p_{j,n,s}(\omega)^{1-\sigma} \mathrm{d}\omega + \sum_{l'} \sum_{m'} \int p_{l'(m'),n,s}(\omega)^{1-\sigma} \mathrm{d}\omega \right)^{\frac{1}{1-\sigma}}.$$

3.2 Intermediate-good Producers

3.2.1 Production Technology

Firms with productivity $\phi_{l(m),s}$ employ $L_{l(m),s}$ efficiency units of labor and $Q_{l(m),s,k}$ units of raw materials (final goods) from sector k to produce $q_{l(m),s}$ units of output, according to the following production function

$$q_{l(m),s} = \phi_{l(m),s} L_{l(m),s}^{\lambda^L_{l(m),s}} \prod_k Q_{l(m),s,k}^{\lambda^k_{l(m),s}}, \tag{1}$$

where $\lambda^L_{l(m),s}$ is the share of workers' value added, and $\lambda^k_{l(m),s}$ is the share of expenses on raw materials from sector k. We assume $\lambda^L_{l(m),s} + \sum_k \lambda^k_{l(m),s} = 1$.

The implied unit cost of the input bundle is

$$c_{l(m),s} = \left(\frac{w_{l(m),s}}{\lambda^L_{l(m),s}} \right)^{\lambda^L_{l(m),s}} \prod_k \left(\frac{P_{l(m),k}}{\lambda^k_{l(m),s}} \right)^{\lambda^k_{l(m),s}}.$$ [11]

Two of the three policies we analyze would affect exports directly through the unit cost. First, decreases in barriers to labor mobility would reduce wages $w_{l(m),s}$. Second, the decline in import tariffs would change the price index $P_{l(m),k}$ for ordinary producers by lowering the

[11] The unit cost of the input bundle is common to all firms in province l and export regime m.

prices of imported inputs. However, it has no direct impact on the price index for processing producers who have faced no import tariffs since 1987.

In each sector, each firm draws a vector of productivities, $\left\{\vec{\phi}_{l(m),s}, \vec{\phi}_{j,s}\right\}$, across China's provinces and regimes, and across foreign countries from a multivariate Pareto distribution with the following cumulative distribution function (CDF) (Arkolakis, Rodríguez-Clare and Su, 2016):

$$F\left(\vec{\phi}_{l(m),s}, \vec{\phi}_{j,s}\right) = 1 - \left[\sum_l \left(\sum_m A_{l(m),s} \phi_{l(m),s}^{-\frac{\theta}{1-\rho}}\right)^{\frac{1-\rho}{1-\gamma}} + \sum_j A_{j,s} \phi_{j,s}^{-\frac{\theta}{1-\gamma}}\right]^{1-\gamma}, \tag{2}$$

with support defined on values greater than $\left[\sum_l \left(\sum_m A_{l(m),s}\right)^{\frac{1-\rho}{1-\gamma}} + \sum_j A_{j,s}\right]^{\frac{1-\gamma}{\theta}}$.

The parameter ρ captures the correlation of productivity draws between processing and ordinary regimes, while the parameter γ captures the correlation across locations. Each correlation parameter takes a value between 0 and 1, with values closer to 1 indicating a stronger correlation. These two correlation parameters govern the *new-firm* and *export-regime margins* of the aggregate trade elasticity, which will be shown in Section 4.

We assume $\theta > \sigma - 1$. A larger θ corresponds to a smaller productivity dispersion across the continuum of firms. As the timing of migration and export growth suggests a story of agglomeration economies (discussed in Section 2.1), we assume $A_{l(m),s} = \bar{A}_{l(m),s} L_{l(m),s}^{\alpha}$ with α governing the agglomeration externality.

3.2.2 Firm's Problem

Firms face fixed marketing costs of exporting and two types of variable trade costs—iceberg trade costs and *ad valorem* tariffs following Costinot and Rodríguez-Clare (2014). They solve a sequential optimization problem. In the first stage, for each destination market n, firms choose where to locate by minimizing the unit cost of exporting to destination n. In the second stage, given location and regime choices, firms decide whether to export to destination n and the optimal price if exporting. We solve the firm's optimization problem through backward induction.

Optimal Price: Under monopolistic competition, firms choose the optimal price to maximize profits if they were to produce in $l(m)$ and export to foreign country n,

$$\pi(\phi_{l(m),s}) = \max_{p_{l(m),n,s}} \left\{ \frac{p_{l(m),n,s} q_{l(m),n,s}}{\tilde{t}_{i,n,s}} - q_{l(m),n,s} \frac{c_{l(m),s} d_{l(m),n,s}}{\phi_{l(m),s}} - c_{n,s} f_{n,s} \right\},$$

subject to the quantity demanded, $q_{l(m),n,s} = \left[p_{l(m),n,s}\right]^{-\sigma} E_{n,s}P_{n,s}^{\sigma-1}$, where $E_{n,s}$ is destination n's total expenditure in sector s. The expression, $\tilde{t}_{i,n,s} = 1 + t_{i,n,s}$, incorporates the export tariff levied by foreign country n on Chinese goods and is constant across all provinces and regimes. Firms also need to pay fixed marketing costs in terms of input bundles of destination n, denoted as $c_{n,s}f_{n,s} > 0$.[12] The optimal price is set with a markup $\frac{\sigma}{\sigma-1}$ over the marginal cost of selling to country n

$$p_{l(m),n,s} = \frac{\sigma}{\sigma-1}\tilde{t}_{i,n,s}\frac{c_{l(m),s}d_{l(m),n,s}}{\phi_{l(m),s}}.^{13} \tag{3}$$

Exporting Decisions: Firms will only export from $l(m)$ to destination n if the profit is positive. Given the demand and the optimal price in equation (3), the zero-profit productivity cutoff above which the firm would export from $l(m)$ to destination n is

$$\phi^*_{l(m),n,s} = \frac{\sigma}{\sigma-1}c_{l(m),s}d_{l(m),n,s}\tilde{t}_{i,n,s}^{\frac{\sigma}{\sigma-1}}\left(\frac{\sigma c_{n,s}f_{n,s}}{E_{n,s}}\right)^{\frac{1}{\sigma-1}}\frac{1}{P_{n,s}}. \tag{4}$$

In related papers that model firms' location choices in the spatial equilibrium, Suárez Serrato and Zidar (2016) and Fajgelbaum, Morales, Serrato and Zidar (2018) assume zero fixed costs. Here we allow for positive fixed costs, and therefore our model captures firms' decisions on whether to export to given markets (the *extensive margin* of trade).[14] Another point to note from equation (4) is that by modeling revenue tariffs, the zero-profit productivity cutoff is more responsive to tariff changes than to changes in iceberg costs.

Firm's Location and Regime Choices: We define a cost-adjusted productivity, which relates to the inverse unit cost of exporting to destination n, as follows

$$\widetilde{\phi}_{l(m),n,s} = \frac{\phi_{l(m),s}}{c_{l(m),s}d_{l(m),n,s}\tilde{t}_{i,n,s}}. \tag{5}$$

Choosing where to locate by minimizing the unit cost to serve destination n is equivalent to choosing the highest cost-adjusted productivity:

$$Y = \underset{l(m),j}{\operatorname{argmax}} \left\{\vec{\tilde{\phi}}_{l(m),n,s}, \vec{\tilde{\phi}}_{j,n,s}\right\},$$

[12] $f_{n,s}$ is the fixed cost in units of input bundles at destination n. Although our model remains tractable by considering $f_{n,s}$ to be specific to l and m, we assume that $f_{n,s}$ is the same across l and m. This is because the l and m components in fixed costs are over-identified and can be absorbed into $A_{l(m),s}$ in our calibration.

[13] Alternatively, we can also quantify the impact of China's elimination of trading rights on export growth by incorporating a commission rate charged by export intermediaries into $\tilde{t}_{i,n,s}$. However, we do not pursue this exercise as the commission rate is unobserved (Bai et al., 2017).

[14] Without fixed marketing costs, every firm makes positive profits and exports to every market under monopolistic competition.

where Y is a discrete random variable denoting firms' location and regime choices. We omit subscript n and s, but we are aware that Y is destination- and sector-specific.

3.2.3 Firm Sorting and the Distribution of Maximum Productivity

Definition. ***(The Maximum of Cost-adjusted Productivity)*** *Let Z be a continuous random variable such that*

$$Z = \max_{l(m),j} \left\{ \vec{\vec{\tilde{\phi}}}_{l(m),n,s}, \vec{\vec{\tilde{\phi}}}_{j,n,s} \right\}.$$

According to the maximization problem regarding firms' location and regime choices, Z is the equilibrium (cost-adjusted) productivity of all operating firms (after sorting into locations and regimes). Again, we omit subscript n and s, but we are aware that Z is also specific to each destination and sector. Assume that $f_{n,s}$ is large enough such that $\phi^*_{r,n,s} > c_{r,s} d_{r,n,s} \tilde{t}_{r,n,s} Z^* \ \forall\ r$, where Z^* is the lower bound of the support for Z. This restriction ensures that some firms would not serve market n from everywhere. We focus on $Z > Z^*$ and obtain the following proposition.[15]

Proposition 1. ***(The Marginal Density of** Y **and** Z**)***

(a) Firm Sorting Probability: The probability density function of Y is

$$P\Big(Y = l(m)\Big) = \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}} \times \frac{\Psi_{l,n,s}}{\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}}, \tag{6}$$

$$P\Big(Y = j\Big) = \frac{\psi_{j,n,s}}{\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}}, \tag{7}$$

where $\psi_{l(m),n,s} = A_{l(m),s}\Big(c_{l(m),s} d_{l(m),n,s} \tilde{t}_{i,n,s}\Big)^{-\frac{\theta}{1-\rho}}$, $\psi_{j,n,s} = A_{j,s}\Big(c_{j,s} d_{j,n,s} \tilde{t}_{j,n,s}\Big)^{-\frac{\theta}{1-\gamma}}$, $\Psi_{l,n,s} = \Big[\sum_m \psi_{l(m),n,s}\Big]^{\frac{1-\rho}{1-\gamma}}$. $\tilde{t}_{i,n,s}$ and $\tilde{t}_{j,n,s}$ include tariffs levied by destination n on China's and country j's exports, respectively.

(b) Z follows a univariate Pareto distribution with the following probability density function

$$f\Big(Z = z\Big) = \left(\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\right)^{1-\gamma} \theta z^{-\theta-1}. \tag{8}$$

(c) Y and Z are independent.

Part (a) states that the probability of firms' location and regime choices is determined by structural parameters (θ, ρ, and γ), firm-level TFP, trade costs, and production costs. Part

[15] The density distribution at Z^* depends on the relative lower bounds of $\vec{\vec{\tilde{\phi}}}_{l(m),n,s}$ and $\vec{\vec{\tilde{\phi}}}_{j,n,s}$. As firms with Z^* are not actively operating, we do not consider them in the analysis.

(b) states that in each sector, the maximum of cost-adjusted productivity follows a univariate Pareto distribution. The scale parameter is captured by firms' market access to destination market n. Part (c) states that Y and Z are independent, implying that the distribution for the maximum of cost-adjusted productivity conditional on choosing each $l(m)$ or j still has the density defined in equation (8).[16] As a result, conditional on being located in $l(m)$, the unadjusted productivity, which differs from the cost-adjusted productivity by a scale $c_{l(m),s} d_{l(m),n,s} \tilde{t}_{i,n,s}$, also follows a Pareto distribution.

Corollary. *The unadjusted productivity for firms choosing r has a Pareto CDF function $G_{\phi|r} \equiv P\Big(\phi_{r,s} \leq z \mid Y = r\Big)$, $r \in \big\{l(m), j\big\}$:*

$$1 - \left(\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\right)^{1-\gamma} \left(c_{r,s} d_{r,n,s} \tilde{t}_{r,n,s}\right)^{\theta} z^{-\theta}. \tag{9}$$

So far we have shown that the unadjusted productivity after firm sorting across location and regimes follows a univariate Pareto distribution. Therefore, we can derive aggregate trade shares and price indices similarly as in the Melitz-Chaney model, except for two key differences: (1) we need to keep track of the endogenous number of firms defined in equations (6) and (7), and (2) the scale parameter of the Pareto distribution is an endogenous variable that captures changes in market access resulting from firm sorting. The cumulative distribution function defined in equation (9) allows us to obtain the aggregate trade share and prices.

3.3 Aggregate Trade Shares and Prices

The share of country n's expenditure in sector s that is spent on goods produced by $l(m)$ is

$$\Pi_{l(m),n,s} = \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}} \times \frac{\Psi_{l,n,s} \tilde{t}^{\vartheta}_{i,n,s}}{\left[\sum_l \Psi_{l,n,s}\right] \tilde{t}^{\vartheta}_{i,n,s} + \sum_j \psi_{j,n,s} \tilde{t}^{\vartheta}_{j,n,s}}. \tag{10}$$

Analogously, the share of country n's expenditure in sector s that is spent on goods produced by foreign country j is

$$\Pi_{j,n,s} = \frac{\psi_{j,n,s} \tilde{t}^{\vartheta}_{j,n,s}}{\left[\sum_l \Psi_{l,n,s}\right] \tilde{t}^{\vartheta}_{i,n,s} + \sum_j \psi_{j,n,s} \tilde{t}^{\vartheta}_{j,n,s}}. \tag{11}$$

[16] Another implication is that $P\Big(Y = l(m)\Big)$ reflects not only the probability of location choices among exporting firms, but also the probability among all firms with $Z > Z^*$, since the independence property implies $P\Big(Y = l(m) \mid Z > Z^*\Big) = P\Big(Y = l(m) \mid Z > \tilde{\phi}^*_{l(m),n,s}\Big)$.

Equation (10) specifies the key factors that determine trade shares. Our counterfactual analysis quantifies the impact of changes in $c_{l(m),s}$ (resulting from internal migration or import tariff changes) and changes in export tariffs on China's export surge. We attribute the residual of export growth to $A_{l(m),s}$ and non-tariff trade costs $d_{l(m),n,s}$.

Another noteworthy point is that as a *macro-level* consequence of modelling revenue tariffs, the changes in export tariffs have an additional impact on aggregate trade, which is captured by $\vartheta = \frac{\sigma-1-\theta}{\sigma-1}$, rather than entering symmetrically into iceberg trade costs. We also obtain the aggregate price index in country n and sector s as

$$P_{n,s} = \left[\Theta M_s \Big(\frac{c_{n,s} f_{n,s}}{E_{n,s}}\Big)^{\vartheta} \Big(\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big)^{-\gamma} \Big(\Big[\sum_l \Psi_{l,n,s}\Big] \tilde{t}_{i,n,s}^{\vartheta} + \sum_j \psi_{j,n,s} \tilde{t}_{j,n,s}^{\vartheta}\Big)\right]^{-\frac{1}{\theta}}, \quad (12)$$

where $\Theta = \sigma^{\frac{\sigma-\theta-1}{\sigma-1}} \left(\frac{\theta}{\theta-\sigma+1}\right)\left(\frac{\sigma}{\sigma-1}\right)^{-\theta}$.

3.4 Workers' Preferences and Labor Markets

Preferences. Workers' preferences over final goods are $U = \prod_s C_s^{\beta_s}$, with $\beta_s > 0$ denoted as the expenditure share on the final good produced by sector s and $\sum_s \beta_s = 1$.

Chinese Labor Markets: Chinese workers are grouped based on the province of their *Hukou* registration, and we index group by g. Workers sort into provinces and sectors based on their idiosyncratic location preferences, following Tombe and Zhu (2019). Within each province and sector, workers are perfectly mobile between processing and ordinary firms, $w_{l,s} = w_{l(\mathcal{P}),s} = w_{l(\mathcal{O}),s}$. Each worker supplies one unit of labor.

Specifically, a worker chooses provinces and sectors by maximizing $\tau_{g,l,s} \times a_{g,l,s} \times V_{l,s}$. $\tau_{g,l,s}$ represents migration frictions which act as proportional adjustments to real expenditure.[17] Migration frictions are modelled as group-destination-sector-specific because Section 2.1 suggests that there was a large degree of heterogeneity in migrants' employment shares across provinces and sectors.[18] Preferences over locations $a_{g,l,s}$ are drawn independently across l and s from a Fréchet distribution with CDF $G(a) = \exp\left(-a_{g,l,s}^{\kappa}\right)$, where a larger shape parameter κ corresponds to a smaller degree of heterogeneity in location preferences across workers. $V_{l,s} = \frac{w_{l,s}}{P_l}$ is the real wage per efficiency unit in l and s, where P_l is the

[17]The assumption that migration costs are proportional adjustments to real expenditure is commonly exploited in the literature; for example, see Borjas (1987), Chiquiar and Hanson (2005), Caliendo, Parro, Rossi-hansberg and Sarte (2016), and Galle, Rodriguez-Clare and Yi (2017). One interpretation is that migrants may enjoy fewer working/leisure hours because of more time spent traveling (Bryan and Morten, 2019).

[18]In provinces such as Guangdong and Zhejiang, migrants were disproportionately employed in manufacturing sectors, whereas in Shanghai and Beijing, migrants were disproportionately employed in the hotel & restaurant service and retail sectors.

aggregate price index in province l.[19]

With Fréchet-distributed location preferences, we obtain the closed-form solution for the fraction of group g workers in province l and sector s:

$$\Lambda_{g,l,s} = \frac{\tau_{g,l,s}^{\kappa} V_{l,s}^{\kappa}}{\sum_{l',s'} \tau_{g,l',s'}^{\kappa} V_{l',s'}^{\kappa}}. \tag{13}$$

Parameter κ governs the elasticity of labor supply with respect to real wages. We define $L_{g,l,s} = L_g \Lambda_{g,l,s}$ as efficiency units of labor provided by group g to province l and sector s.

Foreign Labor Markets: Each foreign country n has a fixed population L_n. We consider a single labor market in each foreign country, where labor is perfectly mobile across sectors, and w_n denotes the wage rate in country n.

3.5 Market Clearing Conditions

Assuming that profits are spent by managers on input bundles,[20] and tariff revenues are rebated to local workers, the market clearing condition for final goods in Chinese provinces is:

$$E_{l(m),s} = \beta_s I_{l(m)} + \sum_k \lambda_{l(m),k}^{s} \left((1-\eta) \sum_r \frac{\Pi_{l(m),r,k} E_{r,k}}{\tilde{t}_{l(m),r,k}} + \eta \sum_r \frac{\Pi_{r,l(m),k} E_{l(m),k}}{\tilde{t}_{r,l(m),k}} \right), \tag{14}$$

where $\eta = \frac{\theta - \sigma + 1}{\sigma\theta}$ is the ratio of marketing costs to net-of-tariff trade flows. The left-hand side is the value of the final good produced in $l(m)$ and sector s.[21] The first term on the right-hand side is workers' consumption. Because processing goods cannot be consumed domestically, workers spend wages and tariff revenues on ordinary goods: $I_{l(\mathcal{O})} = \sum_g \sum_s w_{l,s} L_{g,l,s} + \sum_s \sum_r \frac{t_{r,l(\mathcal{O}),s}}{\tilde{t}_{r,l(\mathcal{O}),s}} \Pi_{r,l(\mathcal{O}),s} E_{l(\mathcal{O}),s}$ and $I_{l(\mathcal{P})} = 0$. The second term sums up the material costs spent by local establishments and the marketing costs incurred by firms selling to the local market.

The labor market clears for each China's province l and sector s separately:

$$\sum_m \lambda_{l(m),s}^{L} \left((1-\eta) \sum_r \frac{\Pi_{l(m),r,s} E_{r,s}}{\tilde{t}_{l(m),r,s}} + \eta \sum_r \frac{\Pi_{r,l(m),s} E_{l(m),s}}{\tilde{t}_{r,l(m),s}} \right) = \sum_g w_{l,s} L_{g,l,s}. \tag{15}$$

[19] As workers only consume the final goods from ordinary production, $P_l = \prod_s \left(P_{l(\mathcal{O}),s} / \beta_s \right)^{\beta_s}$.

[20] This assumption allows us to directly use input-output tables to calibrate input-output parameters $\{\lambda_{l(m),s}^{L}, \lambda_{l(m),s}^{k}\}$; otherwise, we need to adjust input-output tables by firms' profit ratio to obtain $\{\lambda_{l(m),s}^{L}, \lambda_{l(m),s}^{k}\}$, and the profit ratio relies on structural parameters. As an alternative, we also experiment with the assumption that profits are spent by managers on consumption goods according to workers' preferences. This gives quantitatively similar results, which are available upon request.

[21] Since the final good is produced using only intermediate goods (either produced domestically or imported), the value of the final good equals its total expenditure on intermediate goods, $E_{l(m),s} = P_{l(m),s} Q_{l(m),s}$.

The left-hand side represents both ordinary and processing producers' expenses on labor. The right-hand side is the labor income in province l in sector s earned by workers from all labor groups.

In summary, given model fundamentals and parameters, Chinese provinces and sectors' endogenous variables $\{\Pi_{l(m),n,s}, P_{l(m),s}, \Lambda_{g,l,s}, E_{l(m),s}, w_{l,s}\}$ satisfy conditions (10), (12), and (13)–(15). The equilibrium conditions for foreign countries can be obtained analogously.

4 Decomposing the Aggregate Trade Elasticity

This section obtains an analytic expression for each of the four margins: the *intensive*, *extensive*, *new-firm*, and *export-regime margins*. Again, we develop our argument by considering exports from $l(m)$ in China to foreign destination n. Recall that the aggregate trade flow from $l(m)$ to n in sector s is

$$X_{l(m),n,s} = M_s \cdot P\Big(Y = l(m)\Big)\left[\int_{\phi^*}^{+\infty} x_{l(m),n,s}(\phi)\ \mathrm{d}G_{\phi|l(m)}\right], \tag{16}$$

where $x_{l(m),n,s}(\phi)$ denotes the sales from $l(m)$ to n in sector s by firms with productivity level ϕ. ϕ^* is the zero-profit productivity cutoff defined in equation (4).[22] $G_{\phi|l(m)}$ is given in equation (9), which represents the equilibrium productivity distribution among firms that choose $l(m)$. The gravity equation (16) resembles the one in a Melitz-Chaney model, except for two differences: (1) The number of firms $P\Big(Y = l(m)\Big)$ choosing location $l(m)$ to serve n is endogenous, and (2) the scale parameter of the unadjusted productivity distribution defined in equation (9) is also endogenous. We rewrite equation (16) as

$$X_{l(m),n,s} = M_s R\left[\int_{\phi^*}^{+\infty} x_{l(m),n,s}(\phi)\ \mathrm{d}G_{\phi}\right],$$

[22] $x_{l(m),n,s}(\phi)$ is firm's sales to n, and we write it as

$$x_{l(m),n,s}(\phi) = \Big(\frac{\sigma}{\sigma-1}\Big)^{1-\sigma}\Big(c_{l(m),s} d_{l(m),n,s}\tilde{t}_{i,n,s}\Big)^{1-\sigma}\Big(\phi_{l(m),s}\Big)^{\sigma-1} E_{n,s} P_{n,s}^{\sigma-1}.$$

where $G_\phi = 1 - \phi^{-\theta}$ and $R = P\Big(Y = l(m)\Big)\Big(c_{l(m),s} d_{l(m),n,s} \tilde{t}_{i,n,s}\Big)^{\theta}\Big(\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big)^{1-\gamma}$. Taking the derivative with respect to $d_{l(m),n,s}$ and applying the Leibniz rule, we have

$$\begin{aligned}\frac{\partial X_{l(m),n,s}}{\partial d_{l(m),n,s}} = & \underbrace{M_s R \int_{\phi^*}^{+\infty} \frac{\partial x_{l(m),n,s}(\phi)}{\partial d_{l(m),n,s}} \, \mathrm{d}G(\phi)}_{\text{Intensive Margin}} - \underbrace{M_s R \, x_{l(m),n,s}(\phi^*) G'(\phi^*) \frac{\partial \phi^*}{\partial d_{l(m),n,s}}}_{\text{Extensive Margin}} \\ & + \underbrace{\frac{\partial R}{\partial d_{l(m),n,s}} M_s \left[\int_{\phi^*}^{+\infty} x_{l(m),n,s}(\phi) \, \mathrm{d}G(\phi) \right]}_{\text{Export-regime and New-firm Margins}}\end{aligned}$$

In our model, firms first choose a location and an export regime, and then decide whether to export and the optimal volume of exports. The first two terms on the right-hand side reflect the *intensive* and *extensive margins* of firm adjustments respectively, given that firms have chosen $l(m)$. In the third term, the derivative $\frac{\partial R}{\partial d_{l(m),n,s}}$ captures the consequences of firm sorting. We break down the third term into the *new-firm* and *export-regime margins* and obtain an analytic expression of the trade elasticity as follows:

$$\underbrace{\Big(\sigma - 1\Big)}_{\text{Intensive Margin}} + \underbrace{\Big(\theta - \sigma + 1\Big)}_{\text{Extensive Margin}} + \underbrace{\frac{\theta\gamma}{1-\gamma}\Big(1 - \frac{M_{l,s}}{M_s}\Big)\frac{M_{l(m),s}}{M_{l,s}}}_{\text{New-firm Margin}} + \underbrace{\frac{\theta\rho}{1-\rho}\Big(1 - \frac{M_{l(m),s}}{M_{l,s}}\Big)}_{\text{Export-regime Margin}}, \tag{17}$$

where $M_{l,s}$ is the number of firms choosing province l in sector s, and $M_{l(m),s}$ is the number of firms choosing province l and regime m in sector s. Three comments are in order. First, despite an endogenous number of firms, the *intensive and extensive margins* in our model have the exact formula as in Chaney (2008). This implies identical *intensive* and *extensive margins* of trade among incumbents and entrants. This result is due to the independence between location choice Y and productivity Z: after firms choose their locations and regimes, the shape parameter of the productivity distribution among firms located in $l(m)$, captured by θ, is unchanged.

Second, the *new-firm margin* increases with γ, and the *export-regime margin* increases with ρ. Since γ and ρ take values between 0 and 1, the *new-firm margin* and *export-regime margin* can take any arbitrary non-negative values which offer flexibility to match the empirical regularity. [23] Third, equation (17) guides our parameter restrictions to decompose China's aggregate export growth into four different margins of adjustments using a general equilibrium model. For example, the *new-firm* and *export-regime margins* are absent when $\rho = \gamma = 0$.[24]

[23] $\Big(1 - \frac{M_{l,s}}{M_s}\Big)$ and $\Big(1 - \frac{M_{l(m),s}}{M_{l,s}}\Big)$ take values between 0 and 1.

[24] Our counterfactual experiments that involve internal migration shocks or import tariff reductions would affect firms' costs of production, $c_{l(m),s}$. Since $c_{l(m),s}$ and $d_{l(m),n,s}$ are symmetric in our gravity equation, the decomposition results in equation (17) can be applied to analyze these two shocks. Since export tariffs have an asymmetric effect from iceberg costs, export tariffs have an additional elasticity captured by ϑ.

5 Empirical Analysis

We provide empirical validation for the *new-firm* and *export-regime margins* of firm adjustments in our data. In Section 5.1, we validate the *new-firm margin* by estimating the impact of an increase in the supply of migrant workers on the number of firms across provinces and sectors between 1990 and 2005. In Section 5.2, we explore cross-sectoral variation to validate the *export-regime margin* by estimating the impact of changes in production costs (induced by import tariff changes) on the relative number of ordinary to processing exporters. Section 5.3 uses the reduced-form estimates to discipline the values of the structural parameters ρ and γ, using an indirect inference procedure.

5.1 Internal Migration and Firms' Location Choice

We estimate the following reduced-form regression:

$$\Delta M_{l,s} = \beta_0 + \beta_1 \Delta N^m_{l,s} + \gamma x_{l,s} + \epsilon_{l,s}. \tag{18}$$

The dependent variable is the growth in the total number of firms (processing and ordinary) in province l and sector s between 1990 and 2005, $\Delta M_{l,s} = (M_{l,s,2005} - M_{l,s,1990}) / \left(\frac{1}{2} M_{l,s,2005} + \frac{1}{2} M_{l,s,1990}\right)$, where $M_{l,s,t}$ is the number of firms in province l and sector s at year t. This way of defining growth follows from Davis and Haltiwanger (1992) and allows growth rates to lie in the closed interval $[-2, 2]$, which avoids extreme values. We obtain the number of firms in 1990 and 2005 from the Industrial Statistical Yearbook and the Firm Census, respectively. We cluster industries to 16 aggregated manufacturing sectors (see Table 8). The independent variable is the changes in the migrant share in province l and sector s between 1990 and 2005, computed as $\Delta N^m_{l,s} = (N^m_{l,s,2005} - N^m_{l,s,1990}) / \left(\frac{1}{2} N_{l,s,2005} + \frac{1}{2} N_{l,s,1990}\right)$. Here $N^m_{l,s,t}$ and $N_{l,s,t}$ are the number of migrant workers and the total number of workers in province l and sector s at year t, respectively. We obtain these variables from China's Population Census in 1990 and 2005. $x_{l,s}$ is the province and sector control variables.

The OLS regression in equation (18) tends to be biased because an unobserved local productivity or policy shock could attract more firms and migrant workers. To deal with this endogeneity issue, we construct a Card-type instrument to predict exogenous labor supply shifts as follows

$$\Delta \widetilde{N}^m_{l,s} = \sum_g \Delta N_g^{-l,-s} \times \Lambda_{g,l,s,t_0}, \tag{19}$$

where $\Delta N_g^{-l,-s}$ is the change in the total number of group g migrants between 1990 and 2005, excluding those who migrated to province l and sector s, g denotes the province of *Hukou*

Table 1: The Impact of Internal Migration on the Number of Firms

	OLS (1)	**2SLS** (2)	**2SLS** (3)	**2SLS** (4)
	Dep Var: Growth in Num of Firms, 90–05			
Δmigrant share	1.018***	0.987***	0.957***	0.750***
	(0.225)	(0.327)	(0.274)	(0.182)
Controls	No	No	Yes	Yes
Sector FE	No	No	No	Yes
First-stage F		76.42	58.29	63.24
Obs	420	420	420	420
R-squared	0.233	0.232	0.457	0.544

Notes: This table presents the results from estimating regression (18) across provinces and sectors. The instrument is the Card-type instrument to predict exogenous labor supply shifts, as specified in the main text. The controls include: 1) log average output per worker in 1990; 2) changes in non-tariff barriers, FDI restrictions, and input and output tariffs between 1990 and 2005, from Brandt et al. (2017). Regressions are weighted by firm numbers in each province-sector pair in 1990. Standard errors are in parenthesis and clustered by province. Significance levels: 10% * 5% ** 1% ***.

registration, and Λ_{g,l,s,t_0} is the share of group-g workers choosing province l and sector s in the year t_0 among those who migrated.[25] We find that the instrument $\Delta\widetilde{N}^m_{l,s}$ strongly predicts the actual migration pattern $\Delta N^m_{l,s}$, with the coefficient of 0.525 and the standard error of 0.046.[26] Table 1 also reports that the first-stage F values are larger than 10 for all cases.

Recent papers by Adao, Kolesár and Morales (2019) and Borusyak, Hull and Jaravel (2018) study the identification of shift-share instrumentals in the form of equation (19) which can be obtained if either the shifts or the shares are randomly assigned. In our case, the identification holds if $N_g^{-l,-s}$ or Λ_{g,l,s,t_0} is orthogonal to the initial province-sector productivity in year 1990. The orthogonality between $N_g^{-l,-s}$ and the initial province-sector productivity is likely to hold because each province-sector cell we consider is small which means that it has little power in driving national-level migration pattern in aggregate.[27]

Column (1) of Table 1 presents the estimate based on the OLS regression. We find a strong and positive association: provinces and sectors that experienced faster growth in the number of migrants also experienced a rapid growth in the number of firms. The IV regression in Column (2) reports a slightly lower β_1 estimate than the OLS result. The upward bias in the OLS regression likely reflects that fast-growing regions or sectors attracted more migrants and firms. Column (3) shows that our IV estimate is robust to adding control variables including: 1) log average output per worker in 1990; 2) changes in non-tariff barriers, FDI restrictions, and input and output tariffs between 1990 and 2005. Column (4) further controls for sector

[25] We use the 1990 Population Census to measure internal migration in the initial year, using workers' current province of residence and province of residence in the year 1985.

[26] For all regressions results, we cluster standard errors by province.

[27] Despite coastal provinces being the major destinations of internal migrants, each specific coastal province and sector cell is small in accounting for the overall migrants as we consider 30 provinces and 29 sectors.

fixed effects,[28] and the within-sector variation delivers a smaller estimate.

5.2 Import Tariffs and Firms' Export-Regime Choices

Because imported materials for processing exports are duty-free, we expect ordinary exporters to benefit more from import tariff reductions due to China's WTO accession compared to processing exporters. Thus, we estimate the following reduced-form regression:

$$\Delta M_{l(m),s} = b_0 + (b_1 + b_2 \mathbf{1}_{\mathcal{O}}) \sum_k \lambda_{l,s}^k IP_{l,k} \left(\frac{1 + t_{k,2005}}{1 + t_{k,2000}} - 1 \right) + \gamma x_{l,s} + \epsilon_{l,s}, \tag{20}$$

where the dependent variable is the changes in the number of exporters in province l and sector s between 2000 and 2005, $\Delta M_{l(m),s} = (M_{l(m),s,2005} - M_{l(m),s,2000}) / \left(\frac{1}{2} M_{l(m),s,2005} + \frac{1}{2} M_{l(m),s,2000}\right)$, separately for ordinary and processing regimes $m \in \{\mathcal{O}, \mathcal{P}\}$. We obtain the number of processing and ordinary exporters across provinces and manufacturing sectors by linking the China's Annual Survey of Industrial Firms with Customs Database for 2000 and 2005.[29]

The independent variable measures province-sector-level changes in production costs resulting from import tariff reductions. $IP_{l,k}$ is the share of imports in the total expenditure of sector k in province l.[30] t_k is China's tariff rate imposed on imports in sector k, therefore $\left(\frac{1+t_{k,2005}}{1+t_{k,2000}} - 1\right) < 0$ captures changes in import costs due to tariff reductions. The tariffs are drawn from the UNCTAD Trade Analysis and Information System (TRAINS).[31] $\lambda_{l,s}^k$ is the share of sector s's production costs spent on materials from sector k, obtained from the input-output tables in 2005. In our independent variable, reductions in production costs were larger if the province intensively used foreign inputs (high $IP_{l,k}$) or that sector intensively used materials that had large tariff reductions (high $\lambda_{l,s}^k$ or low $\frac{1+t_{k,2005}}{1+t_{k,2000}}$). $\mathbf{1}_{\mathcal{O}}$ is a dummy variable for ordinary exporters. The parameter of interest is β_2, with $\beta_2 < 0$ capturing that ordinary exporters would benefit more from tariff reductions relative to processing exporters.

Tariff changes between 2000 and 2005 may have been endogenous, as policymakers could change import tariffs selectively in favor of less competitive domestic industries. We construct an instrument for the changes in applied tariffs by using the maximum tariff levels

[28]We do not control province fixed effects because changes in the migrant share mainly came from between-province variation, as a result of different *Hukou* policies (Kinnan, Wang and Wang, 2018).

[29]We follow Yu (2015) and Dai, Maitra and Yu (2016) to match these two datasets. The match is based on variables such as firm name, telephone number, and zip code. We compute the number of ordinary (processing) exporters as the total number of firms that perform ordinary (processing) exports, weighted by the share of ordinary (processing) exports in their sales.

[30]We compute import shares using the trade matrix in 2005.

[31]The raw data on tariffs are based on 6-digit HS products from each origin country to China. We use the trade volume as weights to aggregate China's import tariffs into our 16 manufacturing sectors (Table 8).

Table 2: The Impact of WTO on the Number of Ordinary and Processing Exporters

	OLS (1)	2SLS (2)	2SLS (3)	2SLS (4)
	Dep Var: Growth in Num of Firms, 00–05			
Δcosts due to import tariffs	-0.619	-1.545	3.127	-8.719**
	(9.118)	(9.617)	(9.577)	(3.766)
Δcosts due to import tariffs $\times$ 1{ordinary exporters}	-13.517	-12.741	-18.211**	-18.928*
	(10.383)	(9.945)	(7.829)	(9.857)
Controls	No	No	Yes	Yes
Province FE	No	No	No	Yes
First-stage F		2126.46	3423.86	1901.03
Obs	751	751	751	751
R-squared	0.354	0.354	0.426	0.664

Notes: This table presents the results from estimating regression (20) across provinces, sectors and export regimes. All regressions include a dummy variable for export regimes. The instruments are the change in maximum tariffs (as specified in the main text) and its interaction with the ordinary regime. The controls include: 1) changes in non-tariff barriers, FDI restrictions, and output tariffs between 2000 and 2005, from Brandt et al. (2017); 2) initial openness levels measured by the ratio of exports to output in 2000. Regressions are weighted by firm numbers in each province-sector-regime pair in 2000. Standard errors are in parenthesis and clustered by province. Significance levels: 10% * 5% ** 1% ***.

under the WTO agreement, following Brandt et al. (2017),

$$x^*_{l,s} = \sum_k \lambda^k_{l,s} IP_{l,k} \left(\frac{1 + t^{WTO}_{k,2005}}{1 + t^{WTO}_{k,2000}} - 1 \right), \tag{21}$$

where $t^{WTO}_{k,2000}$ and $t^{WTO}_{k,2005}$ refer to specified maximum tariff levels in the WTO agreement, which were mostly agreed in 1999. This instrument is relevant because the agreed tariff rates strongly predict the actual rates. We find that this instrument strongly predicts actual production cost changes due to tariff reductions, with the coefficient of 1.161 and the standard error of 0.038. In Table 2, we also show that the first-stage F values are sizable.

The exclusion restrictions of this instrument require two premises: 1) the actual tariffs deviate from the agreed rates which we do observe in the data, and 2) the agreed maximum tariff rates are uncorrelated with $\epsilon_{l,s}$, the unobserved future factors that affect the relative provincial-sector number of ordinary and processing firms. For 2) to hold, there needs to be the likely policy and economic uncertainties in each province l and sector s so that policymakers' anticipation on $\epsilon_{l,s}$ is not formed by the agreed maximum tariff rates.[32]

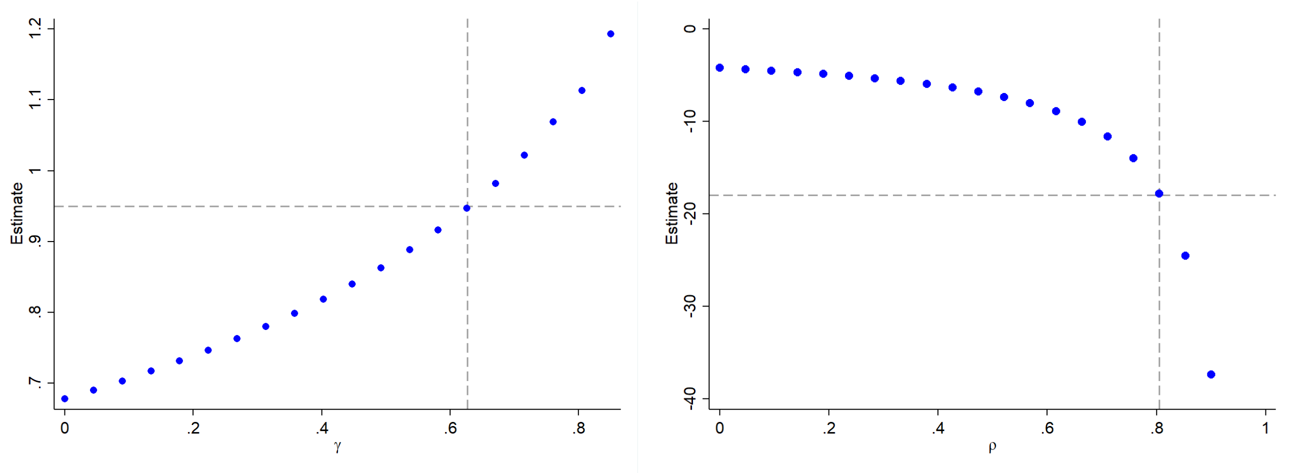
Our OLS and IV regressions in Columns (1)–(2) of Table 2 find that, for sectors that enjoyed larger cost reductions after WTO, the number of ordinary exporters grew faster relative

[32] As mentioned in Brandt et al. (2017), this instrument cannot address the endogeneity problem if the policymakers can correctly anticipate $\epsilon_{l,s}$. Moreover, in line with Brandt et al. (2017), we also find suggestive evidence that the tariff cut is less likely to be driven by the past firm or industry performance: our instrument is uncorrelated with the number of processing and ordinary exporters across provinces, industries in the past.

to the number of processing exporters. Column (3) also controls for: 1) changes in non-tariff barriers, FDI restrictions, and output tariffs between 2000 and 2005; and 2) initial openness levels measured by the ratio of exports to output in 2000. After including controls, the results are quantitatively similar and become statistically significant. Column (4) further controls for province fixed effects, and the within-province variation delivers a similar estimate.

5.3 Linking Reduced-Form Estimates to Structural Productivity Correlation Parameters

We use an indirect inference approach (Gouriéroux and Monfort, 1996) to jointly search structural parameters ρ and γ to target our reduced-form estimates in Column (3) of Tables 1 and 2. We provide the details of the procedure in Appendix D.



(a) Estimate of β_1 in in Regression (18)

(b) Estimate of b_2 in Regression (20)

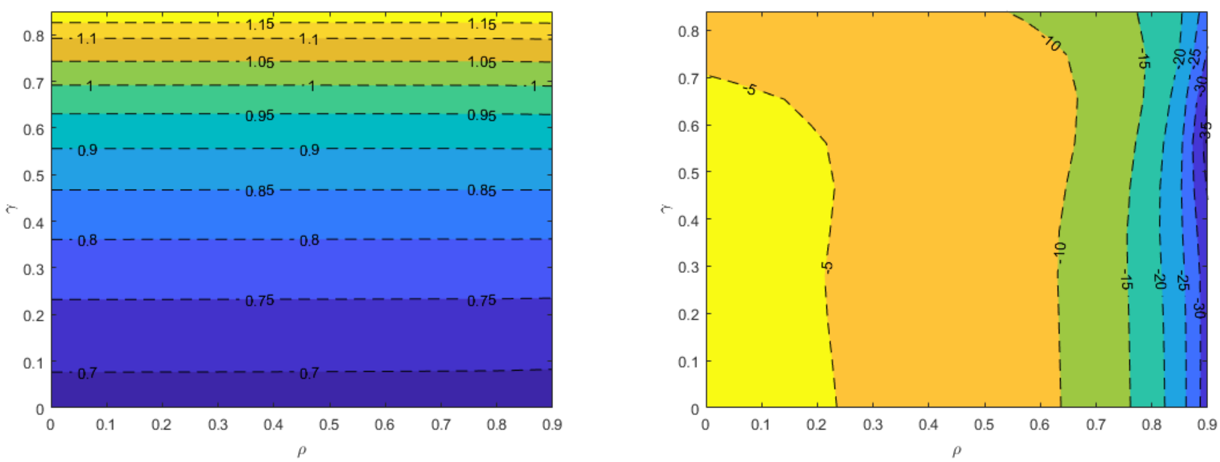
Figure 3: Estimates from Migration and Tariff Regressions using Model-Generated Data

This graph replicates Column (3) of Tables 1 and 2. The left-hand figure varies γ from 0 to 0.85 in the counterfactual exercise with changes in migration barriers, holding all other parameters at their baseline levels. The vertical line represents the value of $\gamma = 0.63$, in which the estimate produced by the model-generated data (0.95) matches the estimate in Column (3) of Table 1. The right-hand figure varies ρ from 0 to 0.9 in the counterfactual exercise with changes in import tariffs, holding all other parameters at their baseline levels. The vertical line represents the baseline value of $\rho = 0.81$, in which the estimate produced by the model-generated data (-17.8) matches the estimate in Column (3) of Table 2.

Figure 3 plots the one-dimensional relationship between the reduced-form estimates (using model-generated data) and the structural parameters, namely β_1 and γ on the left-hand panel and b_2 and ρ on the right-hand panel. Both panels show a monotonic relationship which corroborates the trade elasticity decomposition given in equation (17): a higher γ corresponds to greater firms' location adjustments when a province-sector receives more migrants; and a higher ρ indicates that firms switch more towards ordinary regime when import tariffs decrease. Our indirect inference approach yields estimates of $\gamma = 0.63$ and $\rho = 0.81$, both of which are comparable to those in the previous literature.[33]

[33]Brandt et al. (2018) find the correlation of productivity draws between export regimes to be 0.71. ARRY

We show further evidence that each structural parameter is indeed identified from the related margins of firm adjustments discussed in Section 4, i.e., the *new-firm margin* for γ and the *export-regime margin* for ρ. Figure 4 plots the structural parameters ρ and γ on the horizontal and vertical axes, respectively. The value of each contour line, in the left-hand panel, is the reduced-form estimate of firm responses to migration, and in the right-hand panel, is the reduced-form estimate on the responses of the relative number of ordinary to processing exporters to the import tariff reductions. All reduced-form estimates are based on model-generated data. The pattern in the left-hand panel shows that the reduced-form estimate on firm responses to migration is only responsive to γ but not to ρ. We find an opposite pattern on the right-hand panel—the estimate on the relative number of exporters is mostly responsive to ρ but not to γ.



(a) Estimate of β_1 in Regression (18)

(b) Estimate of b_2 in Regression (20)

Figure 4: Estimates from Migration and Tariff Regressions using Model-Generated Data

6 Quantitative Analysis

China's manufacturing exports increased by a factor of 11.8 in real terms between 1990 and 2005, equaling an annual growth rate of 17.8%. The growth rate was faster in coastal provinces (see Appendix Figure 12). We decompose this observed export increase into four sources including: 1) changes in the costs of intermediate inputs due to import tariff changes; 2) changes in export tariffs; 3) changes in labor costs ($w_{l(m),s}$) due to internal migration; and 4) the composite of changes in TFP ($\bar{A}_{l(m),s}$) and iceberg trade costs ($d_{l(m),n,s}$), which we match to the residual of the observed export increase.

We calibrate our model to 29 sectors, 30 Chinese provinces, 35 foreign countries and a

find the correlation of productivity draws across countries to be 0.55.

constructed rest of the world. Our 29 sector categories are aggregated based on the 2-digit International Standard Industrial Classification (ISIC Rev 3), including 16 tradable sectors and 13 non-tradable sectors. We express the equilibrium system in proportional changes (see Appendix A.6) and solve the model using the "Exact Hat Algebra" approach. Noting that the Exact Hat Algebra approach can compare between any two equilibria, we match our model to the year 2005, for which we have high-quality data to measure provincial imports from and exports to foreign countries.[34] Our counterfactual exercise is to quantify what the level of China's exports in 2005 would be if the tariffs and migration frictions were to stay at the level in 1990.

Given parameter values of $\{\theta, \rho, \gamma, \kappa, \sigma, \alpha, \beta_s, \lambda^L_{r,s}, \lambda^k_{r,s}\}$, we introduce China's import and export tariff changes, and changes in migration frictions into the model, individually. We set $\widehat{\bar{A}}_{r,s} = \widehat{f}_{n,s} = \widehat{M}_s = \widehat{d}_{r,n,s} = \widehat{L}_g = \widehat{L}_n = 1$ and solve $\{\widehat{\Pi}_{l(m),n,s}, \widehat{\Pi}_{j,n,s}, \widehat{P}_{r,s}, \widehat{\Lambda}_{g,l,s}, \widehat{E}_{r,s}, \widehat{w}_{l,s}, \widehat{w}_n\}$ from the system of equations in changes, $r \in \{l(m), j\}$. We treat the U.S. GDP as the numeraire, and trade is balanced for all counterfactual exercises.[35] In the rest of this section, we discuss the data sources, measurement of three policy shocks, and other model parameters.

6.1 Data

Our counterfactual exercises require data on: intranational and international trade flows; firms' location probability $\{\frac{M_{l(m),s}}{M_s}\}$; inter-provincial migration rates $\{\Lambda_{g,l,s}\}$; sectoral output $\{X_{r,s}\}$; and labor income in both China $\{w_{l,s}L_{g,l,s}\}$ and foreign countries $\{w_n L_n\}$. We summarize the data sources we use below and provide detailed descriptions in Appendix C.

Provincial Imports and Exports by Sectors and Regimes: China's Customs Transactions Database has information on whether a firm is engaged in exporting processing activities. We aggregate firms' transaction-level import and export volume to the provincial level by processing and ordinary regimes and by 29 sectors. We thus obtain trade flows between China's provinces and foreign countries by processing and ordinary regimes in the year 2005.

Provincial Gross Output by Sectors and Regimes: Since processing production is not allowed to be sold domestically, we use the total amount of processing exports from China's Customs Transactions Database to measure processing output. We then measure province-sector gross output from input-output tables in the year 2007 (the closest available year to 2005), and deflate output using the growth rate of China's sectoral output between 2005 to

[34] Previous papers mostly calibrate models to the initial year (e.g., Caliendo and Parro, 2015, among others). See Adao, Costinot and Donaldson (2017) who calibrated their model to the final year of their study. The interpretation of the counterfactual results differs by the choice of the year used to calibrate the model.

[35] Instead of assuming balanced trade, an alternative approach is to assume the aggregate trade deficit as a fixed share of the world GDP (Caliendo and Parro, 2015).

2007. The difference between gross output and the overall processing exports (which also equal processing output) reflects the gross output in ordinary production.[36]

Inter-provincial Trade Flows by Sectors and Regimes: Again, since processing production is not allowed to be sold domestically, sectoral inter-provincial trade flows from regional input-output tables reflect domestic sales from ordinary producers. We compute the amount of domestic sales to processing producers at each destination and sector, by using data from input-output tables, processing exports, and processing imports. The rest of domestic sales are sold to ordinary final-good producers. We further assume that processing and ordinary final-good producers at each destination and sector have identical expenditure shares on goods from each domestic origin.[37] This assumption allows us to construct trade flows between province-regime-sectors.

Trade Flows Between Foreign Countries and the Allocation of Firms: We measure bilateral trade flows between foreign countries using the STAN Bilateral Trade Database and measure sectoral gross output of each foreign country using OECD Input-Output Database. We also measure imports from the rest of the world by subtracting the imports from each country that we consider from the total import volume from the world.[38] For the distribution of firms, we obtain firms' choice probability according to equilibrium conditions on firms' choice probability and trade shares given in equations (6) – (11).

Labor Market Variables: We use the 2005 Chinese Population Survey to measure China's internal migration flows, wages, and sectoral employment. For the year 2005, we define China's internal migrants as those who work in a province other than the place of their *Hukou* registration. Since the variable on the province of *Hukou* registration is unavailable in the 1990 data, we define a worker as a migrant if their province of residence 5 years ago differs from their current province of residence.[39] We have a total of 30 groups defined by province of origin and measure the migration stock for each origin-destination-sector pair. We consider one aggregate labor group for each foreign country, and extract data from the IPUMS–International and Luxembourg Income Study (LIS) to measure employment and

[36]China's regional input-output tables in 2007 are obtained from Liu, Chen, Tang, Liu, Han and Li (2012). We match the 2-digit Chinese Standard Industrial Classification Code (CSIC) used in China's regional input-output tables with the 2-digit ISIC code, using the concordance in Dean and Lovely (2010).

[37]This is because we do not have details on whether each trade flow (from an origin) is sold to ordinary or processing producers in the destination. The assumption of proportionality is typical in the trade literature (e.g., Johnson and Noguera, 2016).

[38]Similarly, we measure exports to the rest of the world by subtracting the exports to each country that we consider from the total export volume to the world.

[39]Given that internal migration was under strict control before 1990, respondents' province of residence in 1985 tended to be their home province. Moving out of the *Hukou* area was initially tightly controlled by the government. According to China's 1982 Population Census, only 0.6% of China's total population in 1982 resided out of their *Hukou* county.

wages in foreign countries.

6.2 Measuring Policy Shocks

Measuring Import and Export Tariff Changes: We obtain China's nominal import tariff rates and export tariff rates levied by each country in 1990 and 2005 at each sector, from the UNCTAD TRAINS database.[40] We use the trade volume as weights to aggregate the reported tariffs based on 6-digit HS products into our 29 sector categories. We apply changes in export tariffs between 1990 and 2005 to both processing and ordinary firms and apply changes in import tariffs only to ordinary firms. We keep the tariff structure between foreign countries unchanged. Therefore, our accounting exercises are only based on the realized China-related tariff structure changes.

Calibrating Migration Friction Changes: Following exactly from Tombe and Zhu (2019), we calibrate changes in migration costs to match changes in origin-destination-sector migration shares:

$$\widehat{\tau}_{g,l,s} = \frac{\widehat{V}_{l_g,s}}{\widehat{V}_{l,s}}\Big(\frac{\widehat{\Lambda}_{g,l,s}}{\widehat{\Lambda}_{g,l_g,s}}\Big)^{\frac{1}{\kappa}}.$$

The calculation assumes that the costs of staying in home province (denoted as l_g) remain unchanged, and we measure $\widehat{V}_{l,s}$ as changes in province-sector real wages from the China Labor Statistical Yearbook. Calibrating migration costs requires a value of migration elasticity. We assign $\kappa = 1.5$ following Tombe and Zhu (2019).[41] Using the calibrated migration cost changes, we present the migrant-population-weighted average over all origin provinces, for the aggregate manufacturing sector in Appendix Figure 13 and for all sectors in Appendix Figure 14. Unsurprisingly, the migration costs were reduced more if the destinations were the coastal provinces and major cities, such as Beijing, but reduced less if the destinations were inland provinces.

The calibrated change in migration costs reflects several sources. First, it picks up the changes in the institutional barriers (*Hukou* system) on labor mobility in China. China assigns a *Hukou* to each household to regulate the geographic area in which a Chinese citizen is eligible to reside, work, and obtain public benefits. Moving out of the *Hukou* area was initially tightly controlled by the government and the regulation began to relax in the 1980s. The effect of the *Hukou* reform was more dramatic in coastal destinations and major cities (Tombe

[40] When the data are missing in the year 1990 or 2005, we use the data in the nearest available year to supplement the missing value.

[41] In an earlier version of this paper, we estimate κ by relating changes in migration shares of each origin-destination-sector pair between 1990 and 2005 to changes in wage rates. To address workers' non-random location and sector choices, we construct a model-based instrument following Allen, Arkolakis and Takahashi (2014) and Adao, Arkolakis and Esposito (2018). We find a value of κ around 2.8.

and Zhu, 2019), which is consistent with our calculation where the migration costs changed more for coastal destinations. Until 2003, many cities had eliminated the requirement for temporary residence certificates, but migrants were still denied most of the access to social welfare in the destination city. Second, the emergence of China's railway has significantly reduced travel costs, and our calibrated cost changes also capture the changes in travel costs.

6.3 Other Parameter Values

There are nine additional sets of parameter values we need to calibrate to solve the model. We calculate β_s, the share of income spent on sector s, as the ratio of total consumption on goods from sector s across all countries and provinces to the world total income. We match the 2005 China's Annual Survey of Industrial Firms (ASIF) with the 2005 Customs Database to compute sectoral value added shares $\lambda^L_{l(m),s}$ for processing and ordinary firms. We draw cost shares of inputs $\lambda^k_{l(m),s}$ from China's input-output tables, and rescale value added shares for processing and ordinary firms such that the export-weighted average of value added shares in each sector matches the one in the input-output tables. We obtain foreign countries' value added shares $\lambda^L_{n,s}$ and cost shares of intermediate inputs $\lambda^k_{n,s}$ from OECD input-output tables.[42] We summarize the values and sources of other parameters in Table 3.

Table 3: Other Parameter Values

Parameter	Definition	Source	Value
σ	Elasticity of substitution across varieties	Head and Mayer (2014)	4
θ	Trade elasticity	Simonovska and Waugh (2014)	4
$\lambda^L_{l(m),s}$	Value added share (China)	ASIF, Customs, China I/O Table	
$\lambda^k_{l(m),s}$	Intermediate input share (China)	ASIF, Customs, China I/O Table	
$\lambda^L_{n,s}$	Value added share (foreign)	OECD I/O Table	
$\lambda^k_{n,s}$	Intermediate input share (foreign)	OECD I/O Table	
β_s	Sector consumption share	OECD I/O Table	
α	Agglomeration elasticity	Combes and Gobillon (2015)	0.05
κ	Labor supply elasticity	Tombe and Zhu (2019)	1.5

6.4 Model Fit

Before taking our model to perform counterfactual exercises, we compare our model-predicted changes in province-sector employment by processing and ordinary regimes to those in the

[42]We calculate $\lambda^k_{n,s}$ as the ratio of intermediate inputs from sector k to total output in sector s for each country, and then take the average over all countries. We calculate the value added share as $\lambda^L_{n,s} = 1 - \sum_k \lambda^k_{n,s}$.

data. We introduce the changes in China's export and import tariffs between 2000 and 2005 into our model and calculate the changes in employment resulting from the tariff changes. Using the merged ASIF-Customs data for 2000 and 2005, we measure the actual changes in the overall province-sector employment by processing and ordinary exporters.[43]

Table 4 reports the regression results of the model-generated and actual changes in province-sector employment on tariff changes separately by processing and ordinary exporters. Although all coefficients only reflect the raw correlation between tariff and employment changes, we take the similarity between the model and the data as suggestive evidence that our model is able to capture the heterogeneity in province-sector employment changes.

Table 4: Province-Sector-Level Employment and Tariff Changes between 2000 and 2005

Dependent variable	Changes in employment ordinary exporters		Changes in employment processing exporters	
	data	model	data	model
Panel A: import tariff changes between 2000–2005				
import tariff changes	-1.680*	-2.133***	-3.971***	-3.311***
	(0.854)	(0.346)	(1.397)	(0.548)
Obs	380	380	306	299
R-squared	0.012	0.113	0.044	0.111
Panel B: export tariff changes between 2000–2005				
export tariff changes	-7.054***	-10.375***	-10.403**	-11.788***
	(2.530)	(0.425)	(3.990)	(0.884)
Obs	380	380	306	299
R-squared	0.012	0.243	0.029	0.137

Notes: Changes in tariffs are defined as $\frac{1+t_{k,2005}}{1+t_{k,2000}}$, where $t_{k,t}$ is the tariff rate at time t for sector k. As changes in export tariffs are destination-specific, we use the average change of export tariffs across all destination markets as independent variables in the regression. Changes in employment are defined following Davis and Haltiwanger (1992). We perform the regressions across 30 provinces and 16 manufacturing sectors. Regressions are weighted by the initial employment size in year 2000. Standard errors are in parenthesis and clustered by province. Significance levels: 10% * 5% ** 1% ***.

7 Quantitative Effects of Trade and Migration Policies in China

We first show the extent to which each policy promoted China's export surge between 1990 and 2005. After that, we decompose the impact of the policies into four different margins of trade, and we present the quantitative results on how each policy affected the number of China's exporting firms. Finally, we show that our model predictions align with empirical

[43] We compute firms' ordinary (processing) employment using their total employment and the share of ordinary (processing) exports in their total sales.

evidence on firm relocation. Appendix E presents additional quantitative results using an alternative model with firm entry.

7.1 China's Export Surge

We introduce the three measured policy changes (tariffs on imports, tariffs on exports, and internal migration barriers) to our model individually and attribute the residual of the observed export growth to changes in $\bar{A}_{l(m),s}$ and $d_{l(m),n,s}$.

Aggregate Impact on Exports: Panel A of Table 5 shows the impact of each shock on annual export growth rates in percentage points. The last column shows the average annual growth rate between 1990–2005. On the national level, reductions in migration barriers led to a 1.29 p.p. increase in annual export growth rate and accounted for $\frac{1.29}{17.8} \approx 7.2\%$ of the overall export growth during this period. Reductions in import tariffs caused a 2.30 p.p. increase in annual export growth rate and accounted for $\frac{2.30}{17.8} \approx 12.9\%$ of the overall export growth. Changes in export tariffs resulted in a 1.48 p.p. increase in annual export growth rate and accounted for $\frac{1.48}{17.8} \approx 8.3\%$ of the overall export growth. $\frac{12.73}{17.8} \approx 71.5\%$ of China's export surge was explained by changes in $\bar{A}_{l(m),s}$ and $d_{l(m),n,s}$.

Panel B of Table 5 reports the results for China's three major exporting provinces, Guangdong, Shanghai, and Jiangsu. These three provinces combined accounted for about 70 percent of China's overall exports in 2005. Reductions in migration barriers led to the most notable export increases in Guangdong and Shanghai, causing an increase of 4.00 p.p. in annual export growth in Guangdong and of 2.36 p.p. in Shanghai. They explained $\frac{4.00}{17.1} \approx 23.4\%$ and $\frac{2.36}{18.4} \approx 12.8\%$ of the entire export growth between 1990 and 2005 for these two provinces respectively. These results are consistent with the fact documented in Section 2 that a large fraction of manufacturing employment in Guangdong and Shanghai were supplied by internal migrants in 2005.

Table 5: The Impact of Policies on Annual Export Growth Rates, in Percentage Points

	Migration	**Import Tariff**	**Export Tariff**	**Residual**	**Annual Growth Rate**
			Panel A: Impact on national exports		
China	1.29	2.30	1.48	12.73	17.8
			Panel B: Impact on provincial exports		
Guangdong	4.00	2.34	1.90	8.86	17.1
Shanghai	2.36	1.75	1.26	13.03	18.4
Jiangsu	0.38	1.83	1.63	22.86	26.7

Notes: In each counterfactual, we obtain proportional changes of exports denoted as $\widehat{\text{export}} = \frac{\text{export volume observed in 2005}}{\text{export volume in counterfactual}}$. We then calculate each value in columns 2–4 as $\left(\widehat{\text{export}}^{\frac{1}{15}} - 1\right) \times 100$.

Because provinces differed in their sector composition, the impact of reductions in import and export tariffs varied systematically across provinces in each case. We find that the impact of changes in import and export tariffs was slightly larger in Guangdong, where these changes caused an increase of $2.34 + 1.90 = 4.24$ p.p. in annual export growth. In Shanghai and Jiangsu, changes in import and export tariffs led to an increase of $1.75 + 1.26 = 3.01$ and $1.83 + 1.63 = 3.46$ p.p. in annual export growth respectively.

Processing and Ordinary Exports: We break down China's export increases by processing and ordinary regimes and display the results in Table 6. We highlight three findings below.

First, changes in migration barriers had a larger impact on processing exports than on ordinary exports at the national level. Reductions in migration barriers caused a 1.48 p.p. increase in annual growth of processing exports, in comparison with a 1.05 p.p. increase in annual growth of ordinary exports. Although the domestic value added share was higher in ordinary production than in processing production (Kee and Tang, 2016), the larger impact on processing exports was primarily driven by the fact that migrants' employment shares were much larger in processing-oriented sectors than in sectors that were less concentrated in export processing. Driven by this fact, we find that reductions in migration barriers had a larger impact on processing exports than on ordinary exports in Guangdong, in line with Guangdong's large migrant employment in processing-oriented sectors (documented in Section 2.1). However, in Jiangsu and Shanghai, we find that the impact on ordinary exports was larger than on processing exports.[44]

[44]This result is driven by higher value added shares in ordinary production than in processing production.

Table 6: The Impact of Policies on Annual Export Growth Rates by Processing and Ordinary Trade, in Percentage Points

	Processing Trade Share in 2005	Migration		Import Tariff		Export Tariff	
		Ordinary	Processing	Ordinary	Processing	Ordinary	Processing
		Panel A: Impact on national exports					
China	54.7%	1.05	1.48	2.67	2.03	0.55	2.32
		Panel B: Impact on provincial exports					
Guangdong	73.5%	3.51	4.20	2.90	2.13	0.38	2.59
Shanghai	57.2%	2.93	2.02	3.26	0.93	0.42	1.89
Jiangsu	66.7%	0.43	0.35	2.55	1.51	0.38	2.35

Notes: We calculate percentage points as $(\widehat{\text{export}}^{\frac{1}{15}} - 1) \times 100$, where $\widehat{\text{export}}$ is the proportional changes of export volume between the observed equilibrium and the counterfactual.

Second, import tariff reductions had a larger impact on ordinary exports than on processing exports at both the national and provincial levels. This is consistent with the fact that ordinary production was impacted by reductions in nominal tariffs, whereas the imported materials for processing exporters were previously duty-free and thus unaffected by these reductions in nominal tariffs. On the national level, import tariff reductions caused a 2.67 p.p increase in annual growth rate of ordinary exports. Differing from the partial equilibrium approach in Brandt and Morrow (2017), our general equilibrium approach also predicts a 2.03 p.p. increase in annual growth of processing exports due to reductions in import tariffs. This difference is due to input-output linkages and equilibrium wage changes in response to import tariff reductions (similar to Ossa, 2014).

Third, the impact of export tariff reductions operated mostly through promoting processing exports. On the national level, export tariff reductions caused a 2.32 p.p. annual growth rate of processing exports, in comparison to a 0.55 p.p. annual growth rate of ordinary exports. We find similar patterns in Guangdong, Shanghai, and Jiangsu. The results are driven by the fact that relative to ordinary producers, processing producers were more concentrated in sectors that experienced large export tariff reductions.

7.2 The Margins of Trade

We next break down the impact of each policy into four margins. In Table 3, we introduce three different sets of parameters for θ, γ, and ρ to isolate the effect of these margins of trade, while holding all other parameter values at their baseline levels. We calibrate all the versions of our model to the year 2005. We first set $\theta \equiv \sigma - 1 = 3$, $\gamma = 0$, and $\rho = 0$ and introduce each shock individually. This exercise examines the impact of policies on exports due to the *intensive margin* of trade. We then use the second set of parameters of $\theta = 4$, $\gamma = 0$ and $\rho = 0$ and introduce shocks individually. This exercise is used to quantify the *intensive* and *extensive margins* of trade. Note that the results from this exercise are equivalent to the ones predicted by a multi-sector Melitz-Chaney model with exogenous entry. Comparing the results under the second set of parameters ($\theta = 4$) with the results under the first set of parameters ($\theta = 3$), we isolate the *extensive margin* of trade. We then implement the third set of parameters $\theta = 4$, $\rho = 0.81$, and $\gamma = 0$. By changing ρ to 0.81 from 0, we isolate the effect of the *export-regime margin*. Finally, comparing the results of the third set of counterfactuals with our baseline results shown in Table 5, we isolate the impact on exports due to the *new-firm margin*.

For each set of parameters, Table 7 reports the impact of each policy on annual export growth rates in terms of percentage points. The first three rows report the impact of migration shocks, import tariff reductions, and export tariff reductions, respectively. The last row reports the combined impact of all three policies, by simply presenting a sum of the values in each column. A noteworthy result is that comparing column (3) with column (4), the *new-firm margin* of the three policies combined triggered a $5.07 - 2.87 \approx 2.20$ p.p. annual increase in China's exports and accounted for $\frac{2.20}{17.8} \approx 12.4\%$ of the overall national export growth. In other words, holding the number of firms constant in each province, the combined contribution of the three policies to China's export growth would drop from 28.5% to 16.1%. We present provincial results in Appendix Table 11.

Table 7: The Impact of Policies on National Annual Export Growth Rates by Different Margins of Trade, in Percentage Points

Policy Shock	**Intensive Margin** $\theta = 3, \gamma = 0,$ $\rho = 0$ (1)	**Intensive & Extensive Margin** $\theta = 4, \gamma = 0,$ $\rho = 0$ (2)	**Intensive, Extensive & Regime Margin** $\theta = 4, \rho = 0.81,$ $\gamma = 0$ (3)	**Benchmark Model with Four Margins** $\theta = 4, \rho = 0.81,$ $\gamma = 0.63$ (4)
Migration Shock	0.77	0.95	0.91	1.29
Import Tariff	0.87	1.19	1.08	2.30
Export Tariff	0.65	0.83	0.88	1.48
Combined Policies	2.29	2.97	2.87	5.07

Notes: We calculate percentage points as $\left(\widehat{\text{export}}^{\frac{1}{15}} - 1\right) \times 100$, where $\widehat{\text{export}}$ is the proportional changes of export volume between the observed equilibrium and the counterfactual. Each value in the last row adds up the values of the first three rows along its column.

Next, in Figure 5, we decompose the impact of each policy on exports into four margins of trade. On the national level, presented in the upper left-hand Panel, the *new-firm margin* of trade (in red) had a pronounced impact on exports. This margin had the strongest impact in the case of import tariff reductions and caused a 1.22 p.p. annual increase in China's export growth. The migration-induced *new-firm margin* of trade was the smallest across all three policies, causing a 0.38 p.p. annual increase in national exports. The small impact of the *new-firm margin* resulting from internal migration suggests a strong offsetting effect due to firms' switching across provinces.[45]

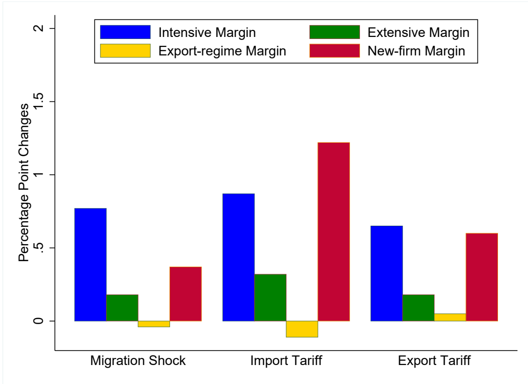
For provinces, we find strong effects of the migration-induced *new-firm margin* in Guangdong, causing a 1.55 p.p. increase in annual export growth. The effect of the migration-induced *new-firm margin* was also substantial in Shanghai, leading to a 0.55 p.p. increase in annual export growth. However, we find small effects of the migration-induced *new-firm margin* in Jiangsu. As for import tariff reductions, the effects of the *new-firm margin* were substantial in all of Guangdong, Shanghai, and Jiangsu, causing a 1.33, 0.80, and 0.93 p.p. increase in annual export growth, respectively.

7.3 The New-firm Margin

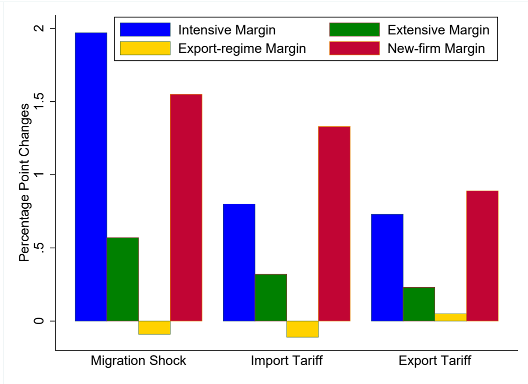
We further explore the extent to which each policy affected the number of exporting firms in China's coastal provinces. Figure 6 plots the histograms of $\widehat{P}\Big(Y = l(m)\Big)$, which are the proportional changes in firm's probability of choosing China's provinces and export regimes, across all foreign destinations and sectors. We plot the impact of migration shocks in green, the impact of import tariff reductions in blue, and the impact of export tariff reductions in red. Panels (a) and (b) show firms' likelihood of choosing ordinary and processing regimes in Guangdong respectively, while Panels (c) and (d) are for ordinary and processing regimes in Shanghai respectively. The vertical black dashed line indicates $\widehat{P}\Big(Y = l(m)\Big) = 1$.

One evident feature is that most areas of the histogram are located to the right of the vertical line, indicating that the policy changes attracted more exporting firms into China. We highlight some findings below. First, in both Guangdong and Shanghai, import tariff reductions had a stronger impact on attracting ordinary firms than processing firms, as the blue bars are more skewed to the right in Panels (a) and (c) in comparison with those in Panels (b) and (d), respectively. Second, reductions in migration barriers substantially attracted firms to relocate to Guangdong Province, and the impact was strong on both ordinary and processing exporters. Import tariff reductions appeared to be important in attracting ordinary firms to be located in Shanghai. Finally, export tariff changes had a relatively small impact on attracting firms to relocate to Guangdong and Shanghai. We plot the results for Zhejiang and Jiangsu provinces in Appendix Table 15.

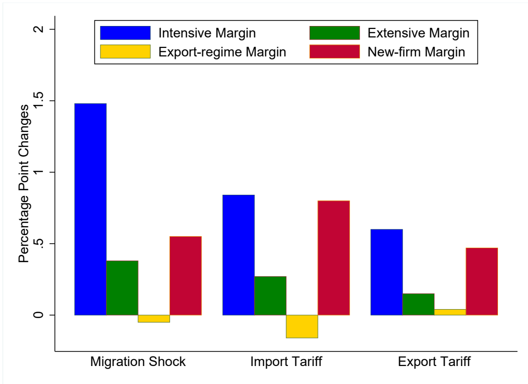
[45]We find that provinces which experienced a migration outflow or a relatively small migration inflow suffered a net outflow of firms.



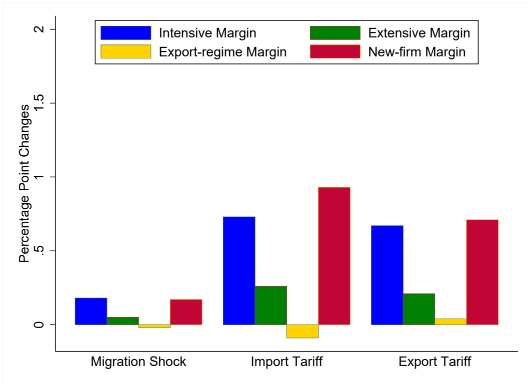
(a) China



(b) Guangdong



(c) Shanghai



(d) Jiangsu

Figure 5: The Impact of Policies on Annual Export Growth Rates by Different Margins of Trade, in Percentage Points

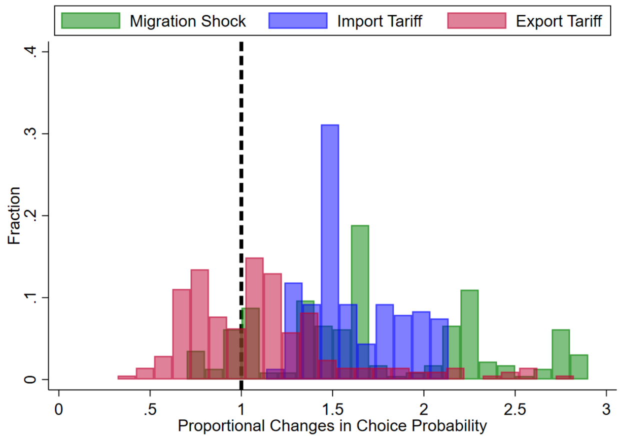
Notes: The intensive margin is obtained from Column (1) of Table 7. The extensive margin is obtained from the difference between Columns (2) and (1); the export-regime margin is obtained from the difference between Columns (3) and (2), and the new-firm margin is obtained from the difference between Columns (4) and (3).

7.4 Evidence on Firms' Relocation

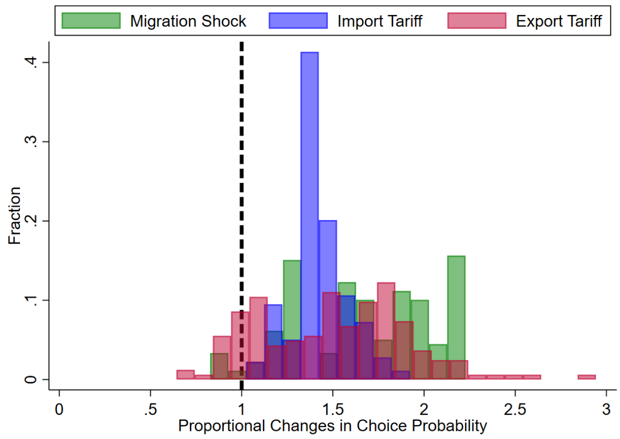
Although China has experienced a dramatic increase in foreign investments and inflows of production factories over the past 30 years, it is a challenge to distinguish between firm relocation and entry from our data. This section shows that our model-predicted origins of new firms align well with the data, which we take as suggestive evidence that our model can capture variation in the origin of new firms' majority owner.

We draw data from Chinese Ministry of Commerce to measure the number of new registered foreign-invested firms. Before 2016, all foreign-invested firms in China were required to obtain approval for registry and changes of business, and these requests were then publicized on the website. We collect all these raw data and use text analysis to identify information on firms' name, industry, and ownership structure.[46] Between 1990 and 2005, there

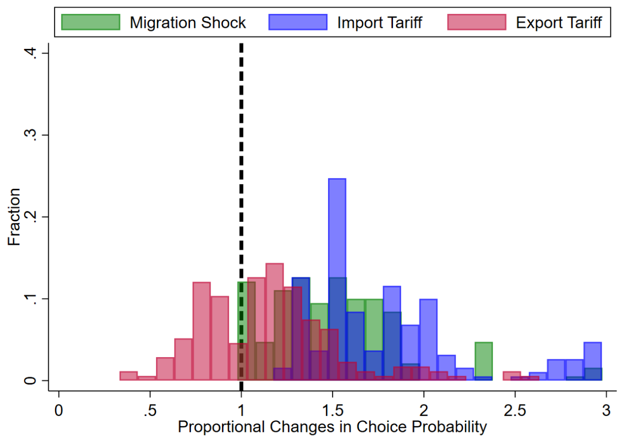
[46]We keep manufacturing firms registered between 1990 and 2005 and define foreign-invested firms as firms with at least 30% foreign ownership. Our results are robust if we use thresholds of 0% or 50% to define foreign ownership. We do not use 50% as a threshold in the baseline results because for a long time, China requested



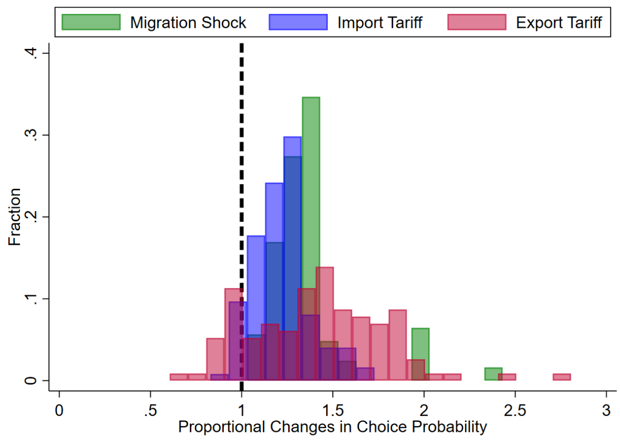
(a) Guangdong Ordinary Exporters



(b) Guangdong Processing Exporters



(c) Shanghai Ordinary Exporters



(d) Shanghai Processing Exporters

Figure 6: Changes in Firms' Probability to Choose China's Provinces and Export Regimes

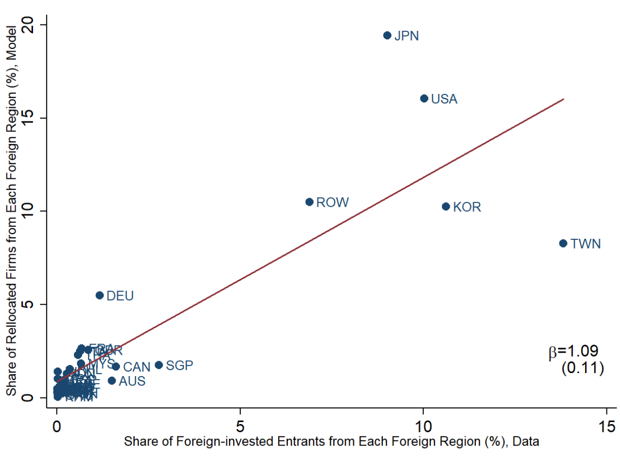
Notes: The histogram is plotted across all foreign destinations and sectors where China's export volume was greater than 30 million US dollars. For the case of export tariffs, there are destination-sector pairs where $\widehat{P}\left(Y = l(m)\right)$ takes very large values (with probability density smaller than 0.05). We truncate the distribution such that $\widehat{P}\left(Y = l(m)\right)$ takes values smaller than 3.

were 102,072 new registrations of foreign-invested firms, which is similar to the 91,047 existing manufacturing foreign-invested firms in the Firm Census 2004.[47] Appendix Table 12 presents the number of new foreign-invested firms between 1990 and 2005, ranked by sectors and places of origin. We identify the places of origin by the nationality of firms' majority owner.

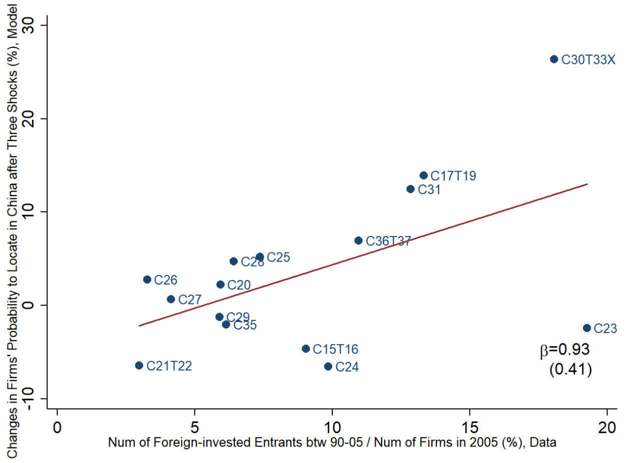
We use our model to calculate the reduction in number of firms in each foreign region as a share of the increase in overall number of firms in China resulting from the reduction in trade and migration barriers. Panel (a) plots the model-predicted shares against the actual

individual firms' foreign ownership to be lower than 50% in many industries (e.g., automobile industry), especially before WTO accession.

[47] Across our 16 manufacturing sectors, the correlation between the number of foreign-invested entrants between 1990 and 2005 and the number of existing foreign-invested firms in 2004 is 0.95.



(a) Across Origins



(b) Across Sectors

Figure 7: Comparison of Model Predictions with Data on Foreign-invested Firms

share of foreign-invested firms in China by origin between 1990–2005.[48] Panel (b) plots the model-predicted percentage changes in the number of firms by sectors against the observed changes.[49] Both plots show that our model can capture a reasonable amount of heterogeneity in terms of the origin of foreign firms, as well as at the sector level.

8 Conclusion

This paper quantifies how three policy reforms affected Chinese exports between 1990 and 2005. The rapidly increasing number of firms, which accompanied reductions in Chinese tariffs and internal migration costs, suggests that the entry of new firms induced by reductions in trade and migration barriers was an important source of China's export growth. We find that, together, the three policies explained around 29% of China's export surge between 1990 and 2005; holding the number of firms unchanged, the portion of Chinese export growth explained by the three policies combined would drop to 16%. In other words, overlooking the *new-firm margin* would cause substantial underestimation on the impact of these policy changes on China's export surge.

Differing from the standard Melitz model with endogenous firm entry, our model has an analytic trade elasticity decomposition for each margin of firm adjustment. While our empirical analysis validates that both the *new-firm* and *export-regime margins* exist in the data, it is our quantitative exercise and analytic trade elasticity decomposition that allow us to

[48] We omit Hong Kong in the graph, as it invested hugely in mainland China because of its well-developed financial markets and shared border.

[49] We compute the change in firms' probability to locate in China for each destination-sector, normalized by the initial probability to locate in China. We use China's output sold to each destination-sector as weights to aggregate the changes to sectors. The negative change means that the sector experienced relocation of production from China to overseas resulting from the shocks.

quantify the extent to which each policy reform impacted aggregate exports through each margin of firm adjustment. Because of the presence of the *new-firm* and *export-regime margins*, our model predicts a larger trade elasticity in response to trade costs than the standard trade model. The additional *new-firm margin* we analyze provides a potential channel to reconcile the small effects of trade liberalization predicted by standard trade models with the empirical evidence (e.g., Khandelwal et al., 2013; Feyrer, 2019).

While our paper emphasizes the role played by the new firms in China's export surge, our decomposition results can be applied to several other questions in which the *new-firm margin* has the potential of playing an important role (e.g., transportation infrastructure). We look forward to address some of these questions in our future research.

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Online Appendix

A Proofs

A.1 Proof of Lemma

To prove the lemma, we first establish the following results regarding the joint distribution of Y and Z.

$$P\Big(Y = l(m) \;\&\; Z = z\Big) = \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}} \times \frac{\Psi_{l,n,s}}{\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}} \times \left(\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\right)^{1-\gamma} \theta z^{-\theta-1},$$

$$P\Big(Y = j \;\&\; Z = z\Big) = \frac{\psi_{j,n,s}}{\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}} \times \left(\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\right)^{1-\gamma} \theta z^{-\theta-1}.$$

The proof follows closely from ARRY. For ease of notations, we omit n and s in the proof and denote $\xi = cd\tilde{t}$.

$$\begin{aligned} P\Big(\widetilde{\phi}_{l(m)} \leq x_{l(m)}, \widetilde{\phi}_j \leq x_j, \forall l, m, j\Big) &= P\Big(\phi_{l(m)} \leq \xi_{l(m)} x_{l(m)}, \phi_j \leq \xi_j x_j, \;\; \forall l, m, j\Big) \\ &= 1 - \left[\sum_l \left(\sum_m A_{l(m)} \xi_{l(m)}^{-\frac{\theta}{1-\rho}} x_{l(m)}^{-\frac{\theta}{1-\rho}}\right)^{\frac{1-\rho}{1-\gamma}} + \sum_j A_{j,s} \xi_j^{-\frac{\theta}{1-\gamma}} x_j^{-\frac{\theta}{1-\gamma}}\right]^{1-\gamma}. \end{aligned}$$

The first equality holds since by definition, $\widetilde{\phi} = \frac{\phi}{\xi}$. The derivative of the CDF with respect to an arbitrary element $x_{k(o)}$ is

$$P\Big(\widetilde{\phi}_1 \leq x_1, ..., \widetilde{\phi}_{k(o)} = x_{k(o)}, ..., \widetilde{\phi}_N \leq x_N\Big) = \frac{\partial P\Big(\widetilde{\phi}_1 \leq x_1, ..., \widetilde{\phi}_{k(o)} = x_{k(o)}, ..., \widetilde{\phi}_N \leq x_N\Big)}{\partial x_{k(o)}}.$$

Using our multivariate Pareto CDF function, this derivative further equals

$$\theta \left[\sum_l \left(\sum_m A_{l(m)} \xi_{l(m)}^{-\frac{\theta}{1-\rho}} x_{l(m)}^{-\frac{\theta}{1-\rho}}\right)^{\frac{1-\rho}{1-\gamma}} + \sum_j A_j \xi_j^{-\frac{\theta}{1-\gamma}} x_j^{-\frac{\theta}{1-\gamma}}\right]^{-\gamma} \left(\sum_m A_{l(m)} \xi_{l(m)}^{-\frac{\theta}{1-\rho}} x_{l(m)}^{-\frac{\theta}{1-\rho}}\right)^{\frac{1-\rho}{1-\gamma}-1} \frac{A_{k(o)} \xi_{k(o)}^{-\frac{\theta}{1-\rho}} x_{k(o)}^{-\frac{\theta}{1-\rho}}}{x_{k(o)}}. \tag{22}$$

Evaluating the derivative of the CDF at a common productivity level z gives the joint probability for firms to choose k and n at that productivity level, which equals

$$\begin{aligned} P\Big(Y = k(o) \;\&\; Z = z\Big) &= P\Big(\widetilde{\phi}_1 \leq z, ..., \widetilde{\phi}_{k(o)} = z, ..., \widetilde{\phi}_{l(m)} \leq z\Big) \\ &= \frac{\psi_{k(o),n,s}}{\sum_m \psi_{k(m),n,s}} \times \Psi_{k,n,s} \times \left[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\right]^{-\gamma} \theta z^{-\theta-1}. \end{aligned}$$

The second equality holds by plugging z into formula (22).

$$\psi_{k(o),n,s} = A_{k(o),s}\Big(c_{k(o),s}d_{k(o),n,s}\tilde{t}_{i,n,s}\Big)^{-\frac{\theta}{1-\rho}}, \qquad \psi_{j,n,s} = A_{j,s}\Big(c_{j,s}d_{j,n,s}\tilde{t}_{j,n,s}\Big)^{-\frac{\theta}{1-\gamma}},$$

and $\Psi_{k,n,s} = \Big[\sum_m \psi_{k(m),n,s}\Big]^{\frac{1-\rho}{1-\gamma}}$.

Analogously, the derivative of the CDF with respect to an arbitrary element x_j is

$$\theta\left[\sum_l\left(\sum_m A_{l(m)}\xi_{l(m)}^{-\frac{\theta}{1-\rho}}x_{l(m)}^{-\frac{\theta}{1-\rho}}\right)^{\frac{1-\rho}{1-\gamma}} + \sum_j A_j\xi_j^{-\frac{\theta}{1-\gamma}}x_j^{-\frac{\theta}{1-\gamma}}\right]^{-\gamma}\frac{A_j\xi_j^{-\frac{\theta}{1-\gamma}}x_j^{-\frac{\theta}{1-\gamma}}}{x_j}.$$

Evaluating the derivative of CDF at a common productivity level z, we have

$$P\Big(Y=j \;\&\; Z=z\Big) = \psi_{j,n,s}\times\Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big]^{-\gamma}\theta z^{-\theta-1}.$$

The probability density function of the maximum productivity is

$$\begin{aligned}P\Big(Z=z\Big) &= \sum_{l,m}P\Big(Y=k(o)\;\&\;Z=z\Big) + \sum_j P\Big(Y=j\;\&\;Z=z\Big)\\ &= \Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big]^{1-\gamma}\theta z^{-\theta-1}.\end{aligned}$$

By the definition of conditional probability,

$$P\Big(Y=l(m)|Z=z\Big) = \frac{P\Big(Y=l(m)\;\&\;Z=z\Big)}{P\Big(Z=z\Big)} = \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}}\times\frac{\Psi_{l,n,s}}{\sum_l \Psi_{l,n,s}+\sum_j \psi_{j,n,s}}.$$

Note that $P\Big(Y=l(m)|Z=z\Big)$ is not a function of z, implying that firms' location choices and the productivity distribution conditional on location choices are independent (Y and Z are independent). Thus

$$P\Big(Y=l(m)\Big) = \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}}\times\frac{\Psi_{l,n,s}}{\sum_l \Psi_{l,n,s}+\sum_j \psi_{j,n,s}}.$$

In addition,

$$P\Big(Y=l\Big) = \sum_m P\Big(Y=l(m)\Big) = \frac{\Psi_{l,n,s}}{\sum_l \Psi_{l,n,s}+\sum_j \psi_{j,n,s}},$$

and by conditional probability again,

$$P\Big(Y = m|l\Big) = \frac{P\Big(Y = l(m)\Big)}{P\Big(Y = l\Big)} = \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}}.$$

One implication is that $P\Big(Y = l(m)\Big)$ reflects not only the probability of locations among exporting firms, but also the probability of locations among all firms, since independence property implies $P\Big(Y = l(m) \mid Z > \min Z\Big) = P\Big(Y = l(m) \mid Z > \widetilde{\phi}^*_{l(m),n,s}\Big)$. Denote $P\Big(Z = z \mid Y = l(m)\Big)$ as the productivity distribution conditional on locating in China's province l and regime m, and $P\Big(Z = z \mid Y = j\Big)$ as the productivity distribution in foreign country j. The independence implies that these two conditional productivity distributions have the following density function (same as $P\Big(Z = z\Big)$)

$$\Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big]^{1-\gamma} \theta z^{-\theta-1}.$$

This implies a CDF function for cost-adjusted productivity in each location as

$$1 - \left(\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\right)^{1-\gamma} z^{-\theta}.$$

Using this, we can obtain the conditional distribution of unadjusted productivity as in equation (9).

A.2 Decomposing the Aggregate Trade Elasticity

Recall that the derivative of trade flows with regard to trade costs has three terms as follows

$$
\begin{aligned}
-\frac{\partial X_{l(m),n,s}}{\partial d_{l(m),n,s}} = & \underbrace{-M_s R \int_{\phi^*}^{+\infty} \frac{\partial x_{l(m),n,s}(\phi)}{\partial d_{l(m),n,s}} \, \mathrm{d}G(\phi)}_{\text{Intensive Margin}} + \underbrace{M_s R \, x_{l(m),n,s}(\phi^*) G'(\phi^*) \frac{\partial \phi^*}{\partial d_{l(m),n,s}}}_{\text{Extensive Margin}} \\
& \underbrace{- \frac{\partial R}{\partial d_{l(m),n,s}} M_s \left[\int_{\phi^*}^{+\infty} x_{l(m),n,s}(\phi) \, \mathrm{d}G(\phi) \right]}_{\text{New-firm and Export-regime Margins}}.
\end{aligned}
$$

1) The *Intensive Margin* of Trade Elasticity: recall that $x_{l(m),n,s}(\phi)$ is the sales from $l(m)$ to n in sector s for firms which have productivity ϕ, and is equal to

$$
x_{l(m),n,s}(\phi) = \Big(\frac{\sigma}{\sigma - 1} \frac{\tilde{t}_{i,n,s} c_{l(m),s} d_{l(m),n,s}}{\phi_{l(m),n,s}} \Big)^{1-\sigma} E_{n,s} P_{n,s}^{\sigma-1}.
$$

The first term can be rewritten as

$$
M_s R \int_{\phi^*}^{+\infty} \frac{\partial x_{l(m),n,s}(\phi)}{\partial d_{l(m),n,s}} \, \mathrm{d}G(\phi) = \frac{1-\sigma}{d_{l(m),n,s}} M_s R \left[\int_{\phi^*}^{+\infty} x_{l(m),n,s}(\phi) \, \mathrm{d}G(\phi) \right].
$$

Then the *intensive margin* of trade elasticity is

$$
\begin{aligned}
-M_s R \int_{\phi^*}^{+\infty} \frac{\partial x_{l(m),n,s}(\phi)}{\partial d_{l(m),n,s}} \, \mathrm{d}G(\phi) \Bigg/ \frac{X_{l(m),n,s}}{d_{l(m),n,s}} &= -\frac{1-\sigma}{d_{l(m),n,s}} M_s R \left[\int_{\phi^*}^{+\infty} x_{l(m),n,s}(\phi) \, \mathrm{d}G(\phi) \right] \Bigg/ \frac{X_{l(m),n,s}}{d_{l(m),n,s}} \\
&= \sigma - 1.
\end{aligned}
$$

2) The *Extensive Margin* of Trade Elasticity: The second term can be rewritten as

$$
\begin{aligned}
M_s R \, x_{l(m),n,s}(\phi^*) G'(\phi^*) \frac{\partial \phi^*}{\partial d_{l(m),n,s}} &= M_s R \, x_{l(m),n,s}(\phi^*) \, \phi^* \, G'(\phi^*) \, \frac{1}{d_{l(m),n,s}} \\
&= \theta M_s R \Big(\frac{\sigma}{\sigma - 1} \tilde{t}_{i,n,s} c_{l(m),s} d_{l(m),n,s} \Big)^{1-\sigma} E_{n,s} P_{n,s}^{\sigma-1} \Big(\phi^* \Big)^{\sigma-1-\theta} \, \frac{1}{d_{l(m),n,s}}.
\end{aligned}
$$

The first equality holds since $\frac{\partial \phi^*}{\partial d_{l(m),n,s}} = \frac{\phi^*}{d_{l(m),n,s}}$. The *extensive margin* of trade elasticity is:

$$\frac{M_s R\, x_{l(m),n,s}(\phi^*) G'(\phi^*) \frac{\partial \phi^*}{\partial d_{l(m),n,s}}}{\frac{X_{l(m),n,s}}{d_{l(m),n,s}}} = \frac{M_s R\Big(\frac{\sigma}{\sigma-1}\tilde{t}_{i,n,s} c_{l(m),s} d_{l(m),n,s}\Big)^{1-\sigma} E_{n,s} P_{n,s}^{\sigma-1}\Big(\phi^*\Big)^{\sigma-1-\theta}}{M_s R\Big(\frac{\sigma}{\sigma-1}\tilde{t}_{i,n,s} c_{l(m),s} d_{l(m),n,s}\Big)^{1-\sigma} E_{n,s} P_{n,s}^{\sigma-1}\int_{\phi^*}^{+\infty}\phi^{\sigma-2-\theta}\mathrm{d}\phi}$$
$$= \frac{\Big(\phi^*\Big)^{\sigma-1-\theta}}{\Big(\phi^*\Big)^{\sigma-1-\theta}\Big/\Big(\theta-\sigma+1\Big)}$$
$$= \theta - \sigma + 1.$$

3) The *Export-regime* and *New-firm margins* of Trade Elasticity: Recall that R can be written as

$$R = \frac{M_{l(m),s}}{M_{l,s}}\frac{M_{l,s}}{M_s}\Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big]^{1-\gamma}\Big(\tilde{t}_{i,n,s} c_{l(m),s} d_{l(m),n,s}\Big)^{\theta},$$

where $\frac{M_{l(m),s}}{M_{l,s}} = \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}}$ is the share of firms that are engaged in regime m, conditional on those that export to n and are located in province l; $\frac{M_{l,s}}{M_s} = \frac{\Psi_{l,n,s}}{\sum_l \Psi_{l,n,s}+\sum_j \psi_{j,n,s}}$is the share of firms that are located in province l, conditional on those that export to n. According to the chain rule, $\frac{\partial R}{\partial d_{l(m),n,s}}$ is the summation of four terms. We derive each term as follows.

The derivative of the first term can be derived as

$$\frac{\partial \frac{M_{l(m),s}}{M_{l,s}}}{\partial d_{l(m),n,s}} = \frac{-\frac{\theta}{1-\rho}\psi_{l(m),n,s}\frac{1}{d_{l(m),n,s}}\Big[\sum_m \psi_{l(m),n,s}\Big] + \frac{\theta}{1-\rho}\psi_{l(m),n,s}\psi_{l(m),n,s}\frac{1}{d_{l(m),n,s}}}{\Big(\sum_m \psi_{l(m),n,s}\Big)^2}$$
$$= -\frac{\theta}{1-\rho}\frac{\Big[\sum_m \psi_{l(m),n,s} - \psi_{l(m),n,s}\Big]\psi_{l(m),n,s}\frac{1}{d_{l(m),n,s}}}{\Big(\sum_m \psi_{l(m),n,s}\Big)^2}$$
$$= -\frac{\theta}{1-\rho}\frac{1}{d_{l(m),n,s}}\Big[1-\frac{M_{l(m),s}}{M_{l,s}}\Big]\frac{M_{l(m),s}}{M_{l,s}},$$

where $\psi_{l(m),n,s} = A_{l(m),s}\Big(c_{l(m),s} d_{l(m),n,s}\Big)^{-\frac{\theta}{1-\rho}}$. The implied elasticity is

$$-\frac{\partial \frac{M_{l(m),s}}{M_{l,s}}}{\partial d_{l(m),n,s}}\Bigg/\frac{\frac{M_{l(m),s}}{M_{l,s}}}{d_{l(m),n,s}} = \frac{\theta}{1-\rho}\Big(1-\frac{M_{l(m),s}}{M_{l,s}}\Big). \tag{23}$$

The derivative of the second term can be derived as

$$\frac{\partial \frac{M_{l,s}}{M_s}}{\partial d_{l(m),n,s}} = \frac{-\frac{\theta}{1-\gamma}\Big[\sum_m \psi_{l(m),n,s}\Big]^{\frac{1-\rho}{1-\gamma}-1}\frac{\psi_{l(m),n,s}}{d_{l(m),n,s}}\Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big] + \frac{\theta}{1-\gamma}\Psi_{l,n,s}\Big[\sum_m \psi_{l(m),n,s}\Big]^{\frac{1-\rho}{1-\gamma}-1}\frac{\psi_{l(m),n,s}}{d_{l(m),n,s}}}{\Big(\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big)^2}$$

$$= -\frac{\theta}{1-\gamma}\frac{1}{d_{l(m),n,s}}\frac{\Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s} - \Psi_{l,n,s}\Big]\Big[\sum_m \psi_{l(m),n,s}\Big]^{\frac{1-\rho}{1-\gamma}-1}\psi_{l(m),n,s}}{\Big(\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big)^2}$$

$$= -\frac{\theta}{1-\gamma}\frac{1}{d_{l(m),n,s}}\frac{\Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s} - \Psi_{l,n,s}\Big]\Psi_{l,n,s}\frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}}}{\Big(\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big)^2}$$

$$= -\frac{\theta}{1-\gamma}\frac{1}{d_{l(m),n,s}}\Big[1-\frac{M_{l,s}}{M_s}\Big]\frac{M_{l(m),s}}{M_{l,s}}\frac{M_{l,s}}{M_s},$$

where $\Psi_{l,n,s} = \Big[\sum_m \psi_{l(m),n,s}\Big]^{\frac{1-\rho}{1-\gamma}}$. The implied elasticity is

$$-\frac{\partial \frac{M_{l,s}}{M_s}}{\partial d_{l(m),n,s}} \Big/ \frac{\frac{M_{l,s}}{M_s}}{d_{l(m),n,s}} = \frac{\theta}{1-\gamma}\Big(1-\frac{M_{l,s}}{M_s}\Big)\frac{M_{l(m),s}}{M_{l,s}}. \tag{24}$$

The derivative of the third term can be derived as

$$\frac{\partial \Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big]^{1-\gamma}}{\partial d_{l(m),n,s}} = -\theta\Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big]^{-\gamma}\Big[\sum_m \psi_{l(m),n,s}\Big]^{\frac{1-\rho}{1-\gamma}-1}\psi_{l(m),n,s}\frac{1}{d_{l(m),n,s}}$$

$$= -\theta\frac{1}{d_{l(m),n,s}}\Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big]^{-\gamma}\Psi_{l,n,s}\frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}}$$

$$= -\theta\frac{1}{d_{l(m),n,s}}\Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big]^{1-\gamma}\frac{\Psi_{l,n,s}}{\sum_l \Psi_{l,n,s}}\frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}}$$

$$= -\frac{\theta}{d_{l(m),n,s}}\frac{M_{l(m),s}}{M_{l,s}}\frac{M_{l,s}}{M_s}\Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big]^{1-\gamma}.$$

The implied elasticity is

$$-\frac{\partial \Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big]^{1-\gamma}}{\partial d_{l(m),n,s}} \Big/ \frac{\Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\Big]^{1-\gamma}}{d_{l(m),n,s}} = \theta\frac{M_{l(m),s}}{M_{l,s}}\frac{M_{l,s}}{M_s}. \tag{25}$$

The implied elasticity for the fourth term is

$$-\frac{\partial \Big(c_{l(m),s}d_{l(m),n,s}\tilde{t}_{i,n,s}\Big)^{\theta}}{\partial d_{l(m),n,s}} \Big/ \frac{\Big(c_{l(m),s}d_{l(m),n,s}\tilde{t}_{i,n,s}\Big)^{\theta}}{d_{l(m),n,s}} = -\theta. \tag{26}$$

Finally, we add up the elasticity in (23), (24), (25) and (26) to have

$$
\begin{aligned}
&\frac{\theta}{1-\rho}\Big(1-\frac{M_{l(m),s}}{M_{l,s}}\Big)+\frac{\theta}{1-\gamma}\Big(1-\frac{M_{l,s}}{M_s}\Big)\frac{M_{l(m),s}}{M_{l,s}}+\theta\frac{M_{l(m),s}}{M_{l,s}}\frac{M_{l,s}}{M_s}-\theta\\
=&\frac{\theta}{1-\rho}\Big(1-\frac{M_{l(m),s}}{M_{l,s}}\Big)+\frac{\theta}{1-\gamma}\Big(1-\frac{M_{l,s}}{M_s}\Big)\frac{M_{l(m),s}}{M_{l,s}}-\theta\Big(1-\frac{M_{l(m),s}}{M_{l,s}}\frac{M_{l,s}}{M_s}\Big)\\
=&\frac{\theta}{1-\rho}\Big(1-\frac{M_{l(m),s}}{M_{l,s}}\Big)+\frac{\theta}{1-\gamma}\Big(1-\frac{M_{l,s}}{M_s}\Big)\frac{M_{l(m),s}}{M_{l,s}}-\theta\Big(1-\frac{M_{l(m),s}}{M_{l,s}}+\frac{M_{l(m),s}}{M_{l,s}}-\frac{M_{l(m),s}}{M_{l,s}}\frac{M_{l,s}}{M_s}\Big)\\
=&\frac{\theta}{1-\rho}\Big(1-\frac{M_{l(m),s}}{M_{l,s}}\Big)+\frac{\theta}{1-\gamma}\Big(1-\frac{M_{l,s}}{M_s}\Big)\frac{M_{l(m),s}}{M_{l,s}}-\theta\Big(1-\frac{M_{l(m),s}}{M_{l,s}}\Big)-\theta\Big(1-\frac{M_{l,s}}{M_s}\Big)\frac{M_{l(m),s}}{M_{l,s}}\\
=&\Big(\frac{\theta}{1-\rho}-\theta\Big)\Big(1-\frac{M_{l(m),s}}{M_{l,s}}\Big)+\Big(\frac{\theta}{1-\gamma}-\theta\Big)\Big(1-\frac{M_{l,s}}{M_s}\Big)\frac{M_{l(m),s}}{M_{l,s}}\\
=&\frac{\theta\rho}{1-\rho}\Big(1-\frac{M_{l(m),s}}{M_{l,s}}\Big)+\frac{\theta\gamma}{1-\gamma}\Big(1-\frac{M_{l,s}}{M_s}\Big)\frac{M_{l(m),s}}{M_{l,s}}.
\end{aligned}
$$

A.3 The Derivation of Trade Shares and Price Index

The trade flows from $l(m)$ to n can be written as (we drop subscripts n and s for most variables to simplify the notation)

$$
\begin{aligned}
X_{l(m),n,s}&=M_sP\Big(Y=\{l,m\}\Big)\int_{\widetilde{\phi}^*}^{+\infty}x_{l(m),n,s}(\widetilde{\phi})P\Big(Z=\widetilde{\phi}\mid Y=\{l,m\}\Big)\mathrm{d}\widetilde{\phi}\\
&=\theta M_s\frac{\psi_{l(m)}}{\sum_m\psi_{l(m)}}\Psi_l\Big[\sum_l\Psi_l+\sum_j\psi_j\Big]^{-\gamma}\Big(\frac{\sigma}{\sigma-1}\Big)^{1-\sigma}\Bigg[\int_{\widetilde{\phi}^*}^{+\infty}\Big(\widetilde{\phi}\Big)^{\sigma-\theta-2}\mathrm{d}\widetilde{\phi}\Bigg]E_{n,s}P_{n,s}^{\sigma-1}\\
&=\frac{\theta\big(\frac{\sigma}{\sigma-1}\big)^{1-\sigma}}{\theta-\sigma+1}M_s\frac{\psi_{l(m)}}{\sum_m\psi_{l(m)}}\Psi_l\Big[\sum_l\Psi_l+\sum_j\psi_j\Big]^{-\gamma}\Big(\widetilde{\phi}^*\Big)^{\sigma-\theta-1}E_{n,s}P_{n,s}^{\sigma-1}\\
&=\Theta M_s\frac{\psi_{l(m)}}{\sum_m\psi_{l(m)}}\Psi_l\Big[\sum_l\Psi_l+\sum_j\psi_j\Big]^{-\gamma}\tilde{t}_i^{\vartheta}\Big(c_{n,s}f_{n,s}\Big)^{\vartheta}E_{n,s}^{\frac{\theta}{\sigma-1}}P_{n,s}^{\theta},
\end{aligned}
$$

where $\Theta=\sigma^{\frac{\sigma-\theta-1}{\sigma-1}}\Big(\frac{\theta}{\theta-\sigma+1}\Big)\Big(\frac{\sigma}{\sigma-1}\Big)^{-\theta}$, and $\vartheta=\frac{\sigma-1-\theta}{\sigma-1}$. The second equality holds by plugging in $P\Big(Y=\{l,m\}\Big)$ as in (6), $x_{l(m),n,s}(\widetilde{\phi})$ as in (22), and $P\Big(Z=\widetilde{\phi}\mid Y=\{l,m\}\Big)$ as in (9).

Analogously, one can derive the trade flows from country j to n as

$$
\begin{aligned}
X_{j,n,s}&=M_sP\Big(Y=\{j\}\Big)\int_{\widetilde{\phi}^*}^{+\infty}x_{j,n,s}(\widetilde{\phi})P\Big(Z=\widetilde{\phi}\mid Y=\{j\}\Big)\mathrm{d}\widetilde{\phi}\\
&=\Theta M_s\psi_j\Big[\sum_l\Psi_l+\sum_j\psi_j\Big]^{-\gamma}\tilde{t}_j^{\vartheta}\Big(c_{n,s}f_{n,s}\Big)^{\vartheta}E_{n,s}^{\frac{\theta}{\sigma-1}}P_{n,s}^{\theta}.
\end{aligned}
$$

The aggregate price index is

$$
\begin{aligned}
P_{n,s} = & \Bigg[M_s P\Big(Y = \{l,m\}\Big) \sum_{l,m} \int_{\widetilde{\phi}^*_{i,n,s}}^{+\infty} p(\widetilde{\phi})^{1-\sigma} P\Big(Z = \widetilde{\phi} \mid Y = \{l,m\}\Big) \mathrm{d}\widetilde{\phi} \\
& + M_s P\Big(Y = \{j\}\Big) \sum_{j} \int_{\widetilde{\phi}^*_{j,n,s}}^{+\infty} p(\widetilde{\phi})^{1-\sigma} P\Big(Z = \widetilde{\phi} \mid Y = \{j\}\Big) \mathrm{d}\widetilde{\phi} \Bigg]^{\frac{1}{1-\sigma}} \\
= & \Bigg[M_s \theta \sum_{l,m} \frac{\psi_{l(m)}}{\sum_m \psi_{l(m)}} \Psi_l \Big[\sum_l \Psi_l + \sum_j \psi_j \Big]^{-\gamma} \Big(\frac{\sigma}{\sigma - 1} \Big)^{1-\sigma} \Big[\int_{\widetilde{\phi}^*_{i,n,s}}^{+\infty} \widetilde{\phi}^{\sigma-\theta-2} \mathrm{d}\widetilde{\phi} \Big] \\
& + M_s \theta \sum_j \psi_j \Big[\sum_l \Psi_l + \sum_j \psi_j \Big]^{-\gamma} \Big(\frac{\sigma}{\sigma - 1} \Big)^{1-\sigma} \Big[\int_{\widetilde{\phi}^*_{j,n,s}}^{+\infty} \widetilde{\phi}^{\sigma-\theta-2} \mathrm{d}\widetilde{\phi} \Big] \Bigg]^{\frac{1}{1-\sigma}} \\
= & \Bigg[\Theta M_s \Big(\frac{c_{n,s} f_{n,s}}{E_{n,s}} \Big)^{\vartheta} P_{n,s}^{\theta-\sigma+1} \Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s} \Big]^{-\gamma} \Big(\sum_l \Psi_l \tilde{t}^{\vartheta}_{i,n,s} + \sum_j \psi_j \tilde{t}^{\vartheta}_{j,n,s} \Big) \Bigg]^{\frac{1}{1-\sigma}}
\end{aligned}
$$

$\Longleftrightarrow$

$$
P^{\theta}_{n,s} = \Bigg[\Theta M_s \Big(\frac{c_{n,s} f_{n,s}}{E_{n,s}} \Big)^{\vartheta} \Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s} \Big]^{-\gamma} \Big(\sum_l \Psi_l \tilde{t}^{\vartheta}_{i,n,s} + \sum_j \psi_j \tilde{t}^{\vartheta}_{j,n,s} \Big) \Bigg]^{-1},
$$

where the second equality holds because $p(\widetilde{\phi})^{1-\sigma} = \widetilde{\phi}^{\sigma-1} \Big(\frac{\sigma}{\sigma-1} \Big)^{1-\sigma}$. The third equality is obtained by noting that $\widetilde{\phi}^* = \frac{\sigma}{\sigma-1} \Big(\tilde{t}_{i,n,s} \Big)^{\frac{1}{\sigma-1}} \Big(\frac{\sigma c_{n,s} f_{n,s}}{E_{n,s}} \Big)^{\frac{1}{\sigma-1}} \frac{1}{P_{n,s}}$ and $\sum_m \frac{\psi_{l(m)}}{\sum_m \psi_{l(m)}} = 1$.

Plugging the price index into trade flows, we have the trade share from $l(m)$ to n as

$$
\Pi_{l(m),n,s} = \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}} \times \frac{\Psi_{l,n,s}}{\sum_l \Psi_{l,n,s}} \times \frac{\Big[\sum_l \Psi_{l,n,s} \Big] \tilde{t}^{\vartheta}_{i,n,s}}{\Big[\sum_l \Psi_{l,n,s} \Big] \tilde{t}^{\vartheta}_{i,n,s} + \sum_j \psi_{j,n,s} \tau^{\vartheta}_{j,n,s}}.
$$

The price index is

$$
P_{n,s} = \Bigg[\Theta M_s \Big(\frac{c_{n,s} f_{n,s}}{E_{n,s}} \Big)^{\vartheta} \Big[\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s} \Big]^{-\gamma} \Big(\sum_l \Psi_l \tilde{t}^{\vartheta}_{i,n,s} + \sum_j \psi_j \tilde{t}^{\vartheta}_{j,n,s} \Big) \Bigg]^{-\frac{1}{\theta}}.
$$

where $\Theta = \sigma^{\frac{\sigma-\theta-1}{\sigma-1}} \Big(\frac{\theta}{\theta-\sigma+1} \Big) \Big(\frac{\sigma}{\sigma-1} \Big)^{-\theta}$, and $\vartheta = \frac{\sigma-1-\theta}{\sigma-1}$. As a simple representation, we can express trade shares as

$$
\begin{aligned}
\Pi_{l(m),n,s} &= \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}} \times \frac{\Psi_{l,n,s}\tilde{t}^{\vartheta}_{i,n,s}}{\left[\sum_l \Psi_{l,n,s}\right]\tilde{t}^{\vartheta}_{i,n,s} + \sum_j \psi_{j,n,s}\tilde{t}^{\vartheta}_{j,n,s}} \\
&= \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}} \times \frac{\Psi_{l,n,s}}{\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}} \times \frac{\tilde{t}^{\vartheta}_{i,n,s}}{\frac{\sum_l \Psi_{l,n,s}}{\sum_l \Psi_{l,n,s}+\sum_j \psi_{j,n,s}}\tilde{t}^{\vartheta}_{i,n,s} + \frac{\sum_j \psi_{j,n,s}}{\sum_l \Psi_{l,n,s}+\sum_j \psi_{j,n,s}}\tilde{t}^{\vartheta}_{j,n,s}} \\
&= \frac{P\big(Y=\{l,m\}\big)\tilde{t}^{\vartheta}_{i,n,s}}{\sum_{l,m} P\big(Y=\{l,m\}\big)\tilde{t}^{\vartheta}_{i,n,s} + \sum_j P\big(Y=\{j\}\big)\tilde{t}^{\vartheta}_{j,n,s}} \\
&= \frac{M_{l(m)}\tilde{t}_{i,n,s}^{\frac{\sigma-1-\theta}{\sigma-1}}}{\sum_{l,m} M_{l(m)}\tilde{t}_{i,n,s}^{\frac{\sigma-1-\theta}{\sigma-1}} + \sum_j M_j\tilde{t}_{j,n,s}^{\frac{\sigma-1-\theta}{\sigma-1}}},
\end{aligned}
$$

and

$$
\Pi_{j,n,s} = \frac{M_j\tilde{t}^{\vartheta}_{j,n,s}}{\sum_{l,m} M_{l(m)}\tilde{t}^{\vartheta}_{i,n,s} + \sum_j M_j\tilde{t}^{\vartheta}_{j,n,s}}.
$$

A.4 The Derivation of Labor Market Variables

Migration Share: Workers choose to work in the region-sector pair that brings them the highest utility. If a worker from labor group g chooses to work in province l and sector s, it implies $x_{g,l,s} \geq \frac{\tau_{g,l',s'}x_{g,l',s'}V_{l',s'}}{\tau_{g,l,s}V_{l,s}}$. Note that $x_{g,l,s}$ is drawn from $G_{g,l,s}(x) = \exp(-x^{-\kappa})$ independently across all regions and sectors. Denote $g_{g,l,s}$ as the probability density function of the location preference distribution. Then we have:

$$
\begin{aligned}
\Lambda_{g,l,s} &= \int_0^{\infty} \prod_{l'\neq l \text{ or } s'\neq s} G_{g,l',s'}\left(\frac{\tau_{g,l,s}V_{l,s}x}{\tau_{g,l',s'}V_{l',s'}}\right) g_{g,l,s}(x)dx \\
&= \int_0^{\infty} \kappa x^{-\kappa-1}\exp\left(-\sum_{l',s'}(\tau_{g,l',s'}V_{l',s'}/\tau_{g,l,s}V_{l,s})^{\kappa}x^{-\kappa}\right)dx \\
&= \frac{(\tau_{g,l,s}V_{l,s})^{\kappa}}{\sum_{l',s'}(\tau_{g,l',s'}V_{l',s'})^{\kappa}}.
\end{aligned}
$$

The second equality is obtained by using the functional form of $G_{g,l,s}(x)$. The third equality is derived by taking the integral.

A.5 Model Extension

We relax the distribution in equation (2) to allow for the correlation of productivity draws across Chinese provinces to differ from the correlation of productivity draws across countries. Assume that the productivity vector is drawn from

$$F\Big(\vec{\phi}_{l(m),s}, \vec{\phi}_{j,s}\Big) = 1 - \left\{ \left[\sum_l \Big(\sum_m A_{l(m),s} \phi_{l(m),s}^{-\frac{\theta}{1-\rho}} \Big)^{\frac{1-\rho}{1-\gamma}} \right]^{\frac{1-\gamma}{1-\delta}} + \sum_j A_{j,s} \phi_{j,s}^{-\frac{\theta}{1-\delta}} \right\}^{1-\delta},$$

with the support being defined on $\phi_{l(m),s} > \left\{ \left[\sum_l \Big(\sum_m A_{l(m),s} \Big)^{\frac{1-\rho}{1-\gamma}} \right]^{\frac{1-\gamma}{1-\delta}} + \sum_j A_{j,s} \right\}^{\frac{1-\delta}{\theta}}$, for all l, m, and j. This multivariate Pareto distribution has an additional correlation parameter δ, which captures firms' correlation of productivity draws across countries. It is worth mentioning that δ not only captures the correlation of productivity draws between any two foreign countries, but also captures the correlation between any China's province and a foreign country. To see this, the joint distribution between an arbitrary province-regime $l(m)$ in China, and a foreign country j is

$$F\Big(+ \infty, ..., \phi_{l(m),s}, ... + \infty, ...\phi_{j,s} ... + \infty \Big) = 1 - \left[A_{l(m),s}^{\frac{1-\rho}{1-\delta}} \phi_{l(m),s}^{-\frac{\theta}{1-\delta}} + A_{j,s} \phi_{j,s}^{-\frac{\theta}{1-\delta}} \right]^{1-\delta}.$$

Following similar steps as in the previous proof, one can obtain the share of country n's expenditure in sector s that is spent on goods produced by province l and regime m as

$$\Pi_{l(m),n,s} = \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}} \times \frac{\Psi_{l,n,s}}{\sum_l \Psi_{l,n,s}} \times \frac{\Big[\sum_l \Psi_{l,n,s} \Big]^{\frac{1-\gamma}{1-\delta}} \tilde{t}_{i,n,s}^{\vartheta}}{\Big[\sum_l \Psi_{l,n,s} \Big]^{\frac{1-\gamma}{1-\delta}} \tilde{t}_{i,n,s}^{\vartheta} + \sum_j \psi_{j,n,s} \tilde{t}_{j,n,s}^{\vartheta}}.$$

where $\psi_{l(m),n,s} = A_{l(m),s} \Big(c_{l(m),s} d_{l(m),n,s} \tilde{t}_{l(m),n,s} \Big)^{-\frac{\theta}{1-\rho}}$, $\Psi_{l,n,s} = \Big[\sum_m \psi_{l(m),n,s} \Big]^{\frac{1-\rho}{1-\gamma}}$, and $\psi_{j,n,s} = A_{j,s} \Big(c_{j,s} d_{j,n,s} \tilde{t}_{j,n,s} \Big)^{-\frac{\theta}{1-\delta}}$.

A.6 Variables in Proportional Changes

Denote the proportional change for variable x as $\widehat{x} = \frac{x'}{x}$, where x' represents variables in the counterfactual equilibrium, and x refers to variables in the observed equilibrium. The proportional changes of the equilibrium system can be expressed as

$$\widehat{\Pi}_{r,n,s} = \frac{\widehat{M}_{r,n,s} \widehat{\tilde{t}}_{r,n,s}^{\vartheta}}{\sum_{r'} \widehat{M}_{r',n,s} \widehat{\tilde{t}}_{r',n,s}^{\vartheta} \Pi_{r',n,s}}, \tag{27}$$

where $\widehat{M}_{r,n,s} = \widehat{P}\Big(Y = r\Big)$. When r refers to a province-regime combination in China, then

$$\widehat{P}\Big(Y = \{l, m\} \,|\, Y = \{l\}\Big) = \frac{\widehat{\psi}_{l(m),n,s}}{\sum_m \widehat{\psi}_{l(m),n,s} \frac{M_{l(m),n,s}}{M_{l,n,s}}}, \quad \widehat{P}\Big(Y = \{l\}\Big) = \frac{\widehat{\Psi}_{l,n,s}}{\sum_l \widehat{\Psi}_{l,n,s} \frac{M_{l,n,s}}{M_s} + \sum_j \widehat{\psi}_{j,n,s} \frac{M_{j,n,s}}{M_s}}.$$

Analogously, when r refers to a foreign country j, then

$$\widehat{M}_{r,n,s} = \widehat{P}\Big(Y = \{j\}\Big) = \frac{\widehat{\psi}_{j,n,s}}{\sum_l \widehat{\Psi}_{l,n,s} \frac{M_{l,n,s}}{M_s} + \sum_j \widehat{\psi}_{j,n,s} \frac{M_{j,n,s}}{M_s}},$$

where $\widehat{\psi}_{l(m),n,s} = \widehat{A}_{l(m),s}\Big(\widehat{c}_{l(m),s}\widehat{d}_{l(m),n,s}\widehat{\tilde{t}}_{i,n,s}\Big)^{-\frac{\theta}{1-\rho}}$, $\widehat{\psi}_{j,n,s} = \widehat{A}_{j,s}\Big(\widehat{c}_{j,s}\widehat{d}_{j,n,s}\widehat{\tilde{t}}_{j,n,s}\Big)^{-\frac{\theta}{1-\gamma}}$, and $\widehat{\Psi}_{l,n,s} = \Big[\sum_m \widehat{\psi}_{l(m),n,s} \frac{M_{l(m),n,s}}{M_{l,n,s}}\Big]^{\frac{1-\rho}{1-\gamma}}$.[50]

We also have the proportional change of the aggregate price index as

$$\widehat{P}_{n,s} = \left[\Big(\frac{\widehat{c}_{n,s}\widehat{f}_{n,s}}{\widehat{E}_{n,s}}\Big)^{\vartheta} \frac{\Big[\sum_l \widehat{\Psi}_{l,n,s} \frac{M_{l,n,s}}{\sum_l M_{l,n,s}}\Big]\widehat{\tilde{t}}^{\vartheta}_{i,n,s}\Pi_{i,n,s} + \sum_j \widehat{\psi}_{j,n,s}\widehat{\tilde{t}}^{\vartheta}_{j,n,s}\Pi_{j,n,s}}{\Big(\sum_l \widehat{\Psi}_{l,n,s} \frac{M_{l,n,s}}{M_s} + \sum_j \widehat{\psi}_{j,n,s} \frac{M_{j,n,s}}{M_s}\Big)^{\gamma}} \right]^{-\frac{1}{\theta}}. \tag{28}$$

The proportional changes of migration flows are

$$\widehat{\Lambda}_{g,l,s} = \frac{\widehat{\tau}^{\kappa}_{g,l,s}\widehat{V}^{\kappa}_{l,s}}{\sum_{l',s'} \widehat{\tau}^{\kappa}_{g,l',s'}\widehat{V}^{\kappa}_{l',s'}\Lambda_{g,l',s'}}. \tag{29}$$

The final-good market clearing conditions can be written in proportional changes as

$$E_{r,s}\widehat{E}_{r,s} = \beta_s I_r \widehat{I}_r + \sum_k \lambda^s_{r,k} \left((1-\eta) \sum_u \frac{\Pi_{r,u,k} E_{u,k} \widehat{\Pi}_{r,u,k} \widehat{E}_{u,k}}{\tilde{t}_{r,u,k}\widehat{\tilde{t}}_{r,u,k}} + \eta \sum_u \frac{\Pi_{u,r,k} E_{r,k} \widehat{\Pi}_{u,r,k} \widehat{E}_{r,k}}{\tilde{t}_{u,r,k}\widehat{\tilde{t}}_{u,r,k}} \right), \tag{30}$$

where $\widehat{\tilde{t}}_{r,u,s} = \frac{1+t'_{r,u,s}}{1+t_{r,u,s}}$.

The labor market equilibrium for China can be written in proportional changes as:

$$\begin{aligned} &\sum_m \lambda^L_{l(m),s} \left((1-\eta) \sum_u \frac{\Pi_{l(m),u,s} E_{u,s} \widehat{\Pi}_{l(m),u,s} \widehat{E}_{u,s}}{\tilde{t}_{l(m),u,s}\widehat{\tilde{t}}_{l(m),u,s}} + \eta \sum_u \frac{\Pi_{u,l(m),s} E_{l(m),s} \widehat{\Pi}_{u,l(m),s} \widehat{E}_{l(m),s}}{\tilde{t}_{u,l(m),s}\widehat{\tilde{t}}_{u,l(m),s}} \right) \\ &= \sum_g w_{l,s}\widehat{w}_{l,s} L_{g,l,s} \widehat{L}_{g,l,s} \end{aligned} \tag{31}$$

[50]The proportional change of unit costs is given by $\widehat{c}_{l(m),s} = \widehat{w}_{l(m),s}^{\lambda^L_{l(m),s}} \prod_k \widehat{P}_{l(m),k}^{\lambda^k_{l(m),s}}$. $\widehat{A}_{l(m),s} = \widehat{\bar{A}}_{l(m),s}\widehat{L}^{\alpha}_{l(m),s}$ contains both changes in fundamental productivity $\bar{A}_{l(m),s}$ and agglomeration effects that are induced through $L_{l(m),s}$.

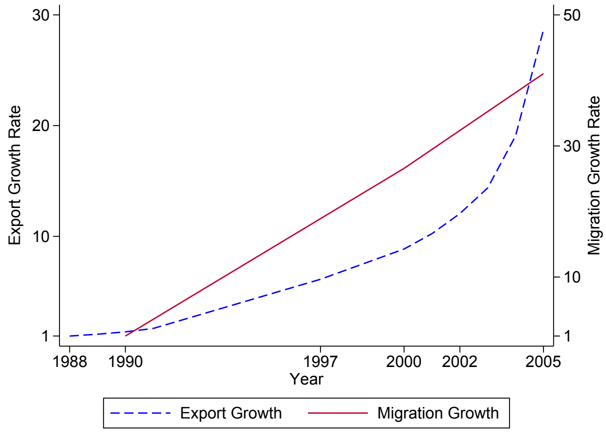
And the labor market equilibrium for foreign countries is written similarly as:

$$\sum_s \lambda_{n,s}^L \left((1-\eta) \sum_u \frac{\Pi_{n,u,s} E_{u,s} \widehat{\Pi}_{n,u,s} \widehat{E}_{u,s}}{\tilde{t}_{n,u,s} \widehat{\tilde{t}}_{n,u,s}} + \eta \sum_u \frac{\Pi_{u,n,s} E_{n,s} \widehat{\Pi}_{u,n,s} \widehat{E}_{n,s}}{\tilde{t}_{u,n,s} \widehat{\tilde{t}}_{u,n,s}} \right) = w_n \widehat{w}_n L_n \widehat{L}_n. \quad (32)$$

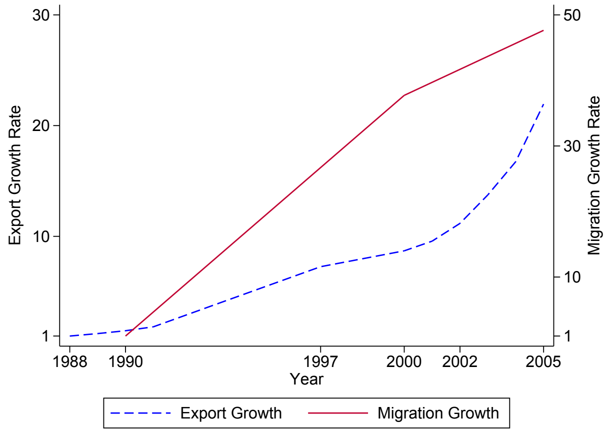
B Additional Evidence on Internal Migrants

B.1 The Timing of Migration and Trade

We explore the time trend of provincial manufacturing exports and manufacturing migrant employment stock for coastal provinces. Panel (a) of Figure 8 is for all five provinces, and Panel (b) is for Guangdong Province only. We normalize both variables by their initial year values. Exports are plotted in blue dashed lines and migration in red solid lines. The left-hand panel shows that China's exports grew steadily from the late 1980s to 2000, and accelerated after China's accession into WTO in 2001. The red solid line suggests that the massive rise in migrant workers appeared before 2000, prior to the turning point of China's export surge. Among the coastal provinces considered in Panel (a), manufacturing migrant employment grew steadily in both the period of 1990–2000 and the period of 2000–2005. Panel (b) shows that in Guangdong Province, the epic rise in migrant employment of manufacturing took place prior to 2000, and migrant employment grew relatively slowly after 2000. The time-series evidence of migration and export growth shows that massive relocation of workers to coastal provinces started, if not prior to, no later than the surge in Chinese exports to the global market. The timing is consistent with the agglomeration at coastal provinces resulting from internal migrants.



(a) Five Coastal Provinces



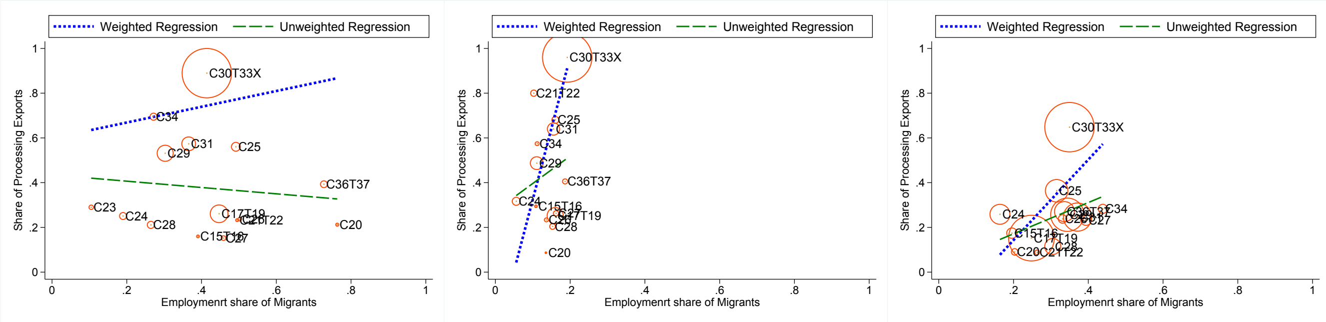
(b) Guangdong

Figure 8: Growth in Exports and Manufacturing Migrant Employment for Coastal Provinces, 1990–2005

Notes: The migration data have three time points drawn from China's Population Survey (1990, 2000, and 2005). The export data are based on China's Customs Transactions Database in the years 1988-1991, 1997, 2000, and 2005. The five coastal provinces include Guangdong, Shanghai, Fujian, Zhejiang, and Jiangsu. We deflate the export volume using inflation rates.

B.2 Sector's Processing-export Specialization and Migrant Employment

We show that the fact—that sectors which had higher migrants' employment shares were more specialized in processing exports—holds in other coastal provinces including Shanghai, Jiangsu, and Zhejiang Provinces. Figure 9 plots migrant employment shares against the share of processing exports across manufacturing sectors for China's coastal provinces. We find a strong positive association between sector's migrant employment shares and specialization in processing exports. The size of the circle reflects provincial processing export volume in a given sector, and the blue dashed line is the linear regression fit (observations are weighted by processing export volume).



(a) Shanghai (b) Jiangsu (c) Zhejiang

Figure 9: Provincial and Sectoral Migrant Employment Share vs. Share of Processing Exports

Notes: The blue dashed line is the linear fit weighted by province-sector processing export volume. The circle size reflects provincial processing export volume in each sector.

C Data Description

Dimensions of the Model: We calibrate our model to 29 sectors, 30 Chinese provinces, 35 foreign countries and a constructed rest of the world. We exclude Tibet from our analysis due to the lack of data on Tibet's inter-provincial migration and trade. Our choice of the 35 countries is fully driven by the availability of both bilateral trade flow data and labor market data. The 35 foreign countries and regions are: Argentina, Australia, Austria, Brazil, Cambodia, Canada, Chile, Denmark, France, Finland, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Italy, Japan, Korea, Malaysia, Mexico, Norway, Philippines, Portugal, Singapore, South Africa, Spain, Sweden, Taiwan, Thailand, Turkey, UK, US, and Viet Nam.

China's Provincial Imports and Exports by Regimes: China's Customs Transactions Database is collected by China's General Administration of Customs. It covers very dis-aggregated information on imports and exports at the transaction level. For each transaction, it records the trading price, quantity, firms' name, identification number, zip code, and whether a transaction was processing or ordinary. We aggregate firm-level transactions into the provincial level to obtain provincial imports and exports by processing and ordinary regimes with each foreign country. The product type is reported using 8-digit Harmonized System (HS) classification.

China's Inter-provincial Trade: We measure China's inter-provincial bilateral trade flows and provincial sectoral output using China's regional input-output table. China's National Bureau of Statistics collected its first regional input-output survey in the year 1987. After

1987, the survey has been collected for every five years. We use China's input-output table of the year 2007, which is the closest available year to the year 2005. We deflate these trade flows and output to the year 2005 by the growth rate of China's sectoral output between 2005 to 2007. China's input-output table reports industries using 2-digit China's Standard Industrial Classification Code (CSIC), and contains 42 industries.

China Labor Market: We use China's Population Survey 2005 and restrict the sample to individuals who were between 20 and 60 years old and not attending schools to measure China's internal migration flows, wages, and sectoral employment. China's Population Survey 2005 is a mini version of the population census. Our sample covers about 0.2% of overall population, with roughly 2.6 million observations. The data provide detailed information on individual's provinces of *Hukou* registration, the current province of residence, sectors and occupations of employment, and earnings. For the year 2005, we define China's internal migrants as those who work in a province other than the place of their *Hukou* registration. The set of migrant population we measure reflects the effect of China's *Hukou* reform on the "floating population". Our measure slightly differs from the previous literature. Tombe and Zhu (2019) consider both inter-provincial migrants and rural-urban migrants during 2000–2005; they define rural-urban migrants as those whose *Hukou* is in rural agriculture sector but work in industrial sectors. Fan (2019) examines pre-2000 internal migrants who are defined as the mismatch between workers' place of residence and birthplace.

We use the survey data to construct the labor stock by each group $\{L_g\}$ and origin-destination-sector-level migration rates $\{\Lambda_{g,l,s}\}$ for each of our 30 labor groups based on provinces of *Hukou* registration, g, at each destination province, l, and at each sector, s. We also measure the average income earned by each labor group at each destination and sector, which is denoted as $\{w_{g,m,s}\}$. For groups which have insufficient observations at a given origin-destination-sector cell, we assign the average destination-sector wage to that group.

Industrial Aggregation and Crosswalks: China's Customs Transactions Database reports product types using 8-digit Harmonized System (HS) classification, China's input-output table reports industries using 2-digit China's Standard Industrial Classification Code (CSIC) for 42 industries, and China's Population Census uses China's Standard Industrial Classification Code (CSIC) for 96 industries. In addition, we extract bilateral trade flows between foreign countries using STAN Bilateral Trade Database and draw tariff data from the TRAINS data. The former one uses ISIC industry codes, whereas the latter one uses 6-digit HS product codes. The OECD database provides input-output tables for 48 countries for the years 1995, 2000, and 2005, and contains information for 37 ISIC Rev 3 industries.

Our strategy is to map HS codes or CSIC industry codes to the 2-digit ISIC code, and after that we group the 2-digit ISIC code to our 29 industry aggregations as shown by Table 8. Specifically, we map 8-digit and 6-digit HS codes to the 4-digit ISIC Rev 3 code based on the concordance which is provided by the World Integrated Trade Solution (WITS). The concordance is available on the WITS website.[51] The 4-digit ISIC code has 145 unique industries. We aggregate the 4-digit ISIC code to the 2-digit ISIC code where the cluster can be simply done based on the first two digits of the 4-digits ISIC code. We also map China's CSIC code to the 2-digit ISIC code using the concordance in Dean and Lovely (2010).

Table 8: Tradable and Non-tradable Industries by International Standard Industrial Classification (ISIC) Revision 3

Industry	ISIC, Rev 3
Panel A: 16 Tradable Industries	
Food products, beverages and tobacco	C15T16
Textiles, textile products, leather and footwear	C17T19
Wood and products of wood and cork	C20
Pulp, paper, paper products, printing and publishing	C21T22
Coke, refined petroleum products and nuclear fuel	C23
Chemicals and chemical products	C24
Rubber and plastics products	C25
Other non-metallic mineral products	C26
Basic metals	C27
Fabricated metal products	C28
Machinery and equipment, nec	C29
Computer, Electronic and optical equipment	C30T33X
Electrical machinery and apparatus, nec	C31
Motor vehicles, trailers and semi-trailers	C34
Other transport equipment	C35
Manufacturing nec; recycling	C36T37
Panel B: 13 Non-tradable Industries	
Agriculture	C01T05
Mining	C10T14
Utility supply	C40T41
Construction	C45
Retail	C50T52
Hotels and restaurants	C55
Transportation and communications	C60T64
Financial intermediation	C65T67
Real estate and business services	C70T74
Public administration and defence; compulsory social security	C75
Education	C80
Health and social work	C85
Other services	C90T95

[51] See https://wits.worldbank.org/product_concordance.html.

Foreign Labor Markets: We only consider one aggregate labor group for each of the foreign countries that we included. Therefore, the information required for each of the foreign labor markets is a vector of shares of sectoral employment, $\{\Lambda_{g,i,s}\}$, and a vector of sectoral average wages, $\{w_{g,i,s}\}$. We extract data from IPUMS–International and Luxembourg income study (LIS) to construct these variables. The ISIC code is available in both datasets, however manufacturing industries are reported as a single aggregation. For each country, we thus divide the share of manufacturing employment into 16 detailed (tradable) manufacturing sectors by using proportions of countries' sectoral output. When wage variables are missing in IPUM-International or LIS, we supplement sectoral wages with the Occupational Wages around the World (OWW) Database. We assume that within each country, the average wage is the same across all 16 detailed manufacturing sectors. Then we assign the average sectoral wage at the broad manufacturing sector into detailed categories. Details of the data sources used for foreign countries are provided by the table below.

Table 9: Data Sources to Measure Foreign Labor Markets

Data Source	$w_{g,i,s}$	$\Lambda_{g,i,s}$
IPUMS-International	Brazil, Canada, India, Mexico, South Africa, Spain, United States	Argentina, Austria, Brazil, Canada, Chile, Denmark, Greece, Hungary, India, Indonesia, Ireland, Malaysia, Mexico, Philippines, Portugal, South Africa, Spain, Thailand, Turkey, United Kingdom, United States, Vietnam
Luxembourg Income Study	Austria, Chile, Denmark, Finland, Greece, Germany, Hong Kong, Italy, Ireland, Japan, Korea, Malaysia, Norway, Philippines, Portugal, United Kingdom	Finland, Germany, Hong Kong, Italy, Japan, Korea, Norway, Singapore
Occupational Wages around the World	Thailand, Turkey, Vietnam	N/A

Measuring the Location Choice Probability of Firms: We first use equilibrium conditions (6) – (11) to pin down the relative probability between any two locations (including any foreign country and China's provinces). Second, we divide provincial firms into processing and ordinary regimes using equilibrium conditions which imply the provincial share of firms in each regime equals the share of exports. Combining equations (6) – (11), one can have

$$\frac{P\Big(Y=l\Big)}{P\Big(Y=j\Big)}=\frac{\Big[\sum_m \Pi_{l(m),n,s}\Big]\tilde{t}_{i,n,s}^{-\vartheta}}{\Pi_{j,n,s}\tilde{t}_{j,n,s}^{-\vartheta}}, \tag{33}$$

where $\tilde{t}_{i,n,s}$ denotes China's export tariff. $\Pi_{l(m),n,s}$ and $\Pi_{j,n,s}$ are n's expenditure share in sector s on goods produced by $l(m)$ and j respectively. We also know that

$$\sum_l P\Big(Y=l\Big)+\sum_j P\Big(Y=j\Big)=1. \tag{34}$$

We solve $P\Big(Y=l\Big)$ and $P\Big(Y=j\Big)$ for all l and j from the system of equations (33) and (34). Next, the share of provincial firms in each regime m equals the share of exports, such that

$$P\Big(Y=l(m)\mid Y=l\Big)=\frac{\Pi_{l(m),u,s}}{\sum_m \Pi_{l(m),u,s}}.$$

D Indirect Inference of Structural Parameters

Below we describe the procedure we used to jointly search for the value of $\{\gamma,\rho\}$:

1. We start with an initial guess of $\{\gamma_0,\rho_0\}$.

2. Given ρ_0, we choose γ to target the extent to which the number of firms responded to migration shocks, targeting the estimate of Columns (3) in Table 1. We introduce changes in migration costs between 1990 and 2005 to our quantitative model which is calibrated to the year 2005. We search for a value of γ such that the model-generated data can produce the same estimate of β_1 as in Column (3) of Table 1. We compute the model-generated changes in the number of firms in a province-sector as the weighted average of changes in firms' location probability (in that province-sector) across destination markets. The weights are the output sold to each destination market. We use the same instrument and controls as in Table 1.

3. Given γ_0, we choose ρ to target the extent to which the number of ordinary exporters responded to import tariff reductions, targeting the estimate of Columns (3) in Table 2. We introduce China's import tariff reductions between 2000 and 2005 to our model. Again, we calibrate our model to the year 2005 and search for a value of ρ such that the model-generated data can produce the same estimate of b_2 as in Column (3) in Table 2. Again, we compute the model-generated changes in the number of firms for a province-sector-regime as the weighted average of changes in firms' location probability (in that

province-sector-regime) across destination markets. The weights are the output sold to each destination market. We use the same instrument and controls as in Table 2.

4. We update $\{\gamma_0, \rho_0\}$ with $\{\gamma_1, \rho_1\}$ and iterate Steps 1–3 until the convergence of $\{\gamma, \rho\}$.

E Quantitative Results of Alternative Model with Firm Entry

We provide quantitative results using an alternative model with firm entry. The model assumes that to establish a firm in region r and sector s, entrepreneurs need to hire $f^e_{r,s}$ units of labor. In the equilibrium, the number of firms in a region-sector is determined by the free-entry condition, which requires firms' average profits to equal entry costs. We suppress firm's location choices and we maintain other settings of productivity distributions to be consistent with the baseline model. For a Chinese firm in province l and sector s, its productivity is Pareto-distributed with substitution between two export regimes:

$$F\left(\vec{\phi}_{l(m),s}\right) = 1 - \left(\sum_m A_{l(m),s}\phi_{l(m),s}^{-\frac{\theta}{1-\rho}}\right)^{1-\rho}. \tag{35}$$

The foreign firm's productivity is Pareto-distributed as $F\left(\phi_{j,s}\right) = 1 - A_{j,s}\phi_{j,s}^{-\theta}$. We calibrate the model with firm entry to the observed economy in 2005 and still apply the Exact Hat Algebra to perform counterfactual exercises without needing the estimates of entry costs. For ease of comparison, we use the same parameter values in the model with firm entry as in our baseline model, except for the absence of relocation parameter γ.

Table 10: Comparison of Baseline Model and Model with Firm Entry

Policy shock	baseline model (no relocation, $\gamma = 0$)	baseline model (with relocation, $\gamma = 0.63$)	alternative model (with firm entry)
Migration shock	0.91	1.29	1.58
Import tariff	1.08	2.30	1.31
Export tariff	0.88	1.48	0.98
Combined policies	2.87	5.07	3.87

Notes: We calculate percentage points as $\left(\widehat{\text{export}}^{\frac{1}{15}} - 1\right) \times 100$, where $\widehat{\text{export}}$ is the proportional changes of export volume between the observed equilibrium and the counterfactual.

Table 10 presents the effects of three policy changes on export growth, for the model with firm entry and our baseline model with and without firm relocation. We highlight two findings. First, the export effects of migration shocks were much stronger in the model with firm entry than in our baseline model with relocation. In the model with firm entry, the large export effect of migration is because the free-entry condition implies the number of firms is proportional to employment size. In contrast, in our model, local employment growth indirectly affects firms' location choices through lowering the labor costs. Second, the effects of tariff reductions were smaller in the model with firm entry than in our model with relocation. In the model with firm entry, the total measure of firms in a region-sector is determined by firms' total revenues. Because exports only accounted for a small fraction of firms' revenues, the changes in firm entry tended to be small. In contrast, in our model, firms choose production locations by minimizing the unit cost of exports, which is directly affected by the tariff changes.

The rest of this section presents the equilibrium conditions for the alternative model with firm entry. First, the trade share becomes:

$$\Pi_{l(m),n,s} = \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}} \times \frac{M_{l,s}\Psi_{l,n,s}\tilde{t}^{\vartheta}_{i,n,s}}{\left[\sum_l M_{l,s}\Psi_{l,n,s}\right]\tilde{t}^{\vartheta}_{i,n,s} + \sum_j M_{j,s}\psi_{j,n,s}\tilde{t}^{\vartheta}_{j,n,s}}, \tag{36}$$

where $M_{l,s}$ is the number of firms in province l and sector s, and $M_{j,s}$ is the number of firms in country j and sector s. Analogously, the share of country n's expenditure in sector s that is spent on goods produced by foreign country j is

$$\Pi_{j,n,s} = \frac{M_{j,s}\psi_{j,n,s}\tilde{t}^{\vartheta}_{j,n,s}}{\left[\sum_l M_{l,s}\Psi_{l,n,s}\right]\tilde{t}^{\vartheta}_{i,n,s} + \sum_j M_{j,s}\psi_{j,n,s}\tilde{t}^{\vartheta}_{j,n,s}}, \tag{37}$$

where $\psi_{l(m),n,s}$, $\Psi_{l,n,s}$, and $\Psi_{j,s}$ are still identically defined as in the main text except for $\gamma = 0$. The aggregate price index in country n and sector s is now as

$$P_{n,s} = \left[\Theta M_s \Big(\frac{c_{n,s}f_{n,s}}{E_{n,s}}\Big)^{\vartheta}\Big(\Big[\sum_l M_{l,s}\Psi_{l,n,s}\Big]\tilde{t}^{\vartheta}_{i,n,s} + \sum_j M_{j,s}\psi_{j,n,s}\tilde{t}^{\vartheta}_{j,n,s}\Big)\right]^{-\frac{1}{\theta}}. \tag{38}$$

Second, in the equilibrium, free-entry conditions in province l and sector s require:

$$M_{l,s}f^{e}_{l,s}w_{l,s} = \frac{\sigma-1}{\sigma\theta}\sum_m\sum_r \frac{\Pi_{l(m),r,s}E_{r,s}}{\tilde{t}_{l(m),r,s}}. \tag{39}$$

The left-hand side is the total costs of entry, whereas the right-hand side represents the total profits, where $\frac{\sigma-1}{\sigma\theta} = \frac{1}{\sigma} - \eta$ is the profit ratio after taking into account marketing costs. The free-entry condition for foreign countries can be obtained analogously.

Third, because entrepreneurs' profits now accrue to workers that they hire for entry, the market clearing condition for final goods in Chinese provinces is

$$E_{l(m),s} = \beta_s I_{l(m)} + \sum_k \lambda^s_{l(m),k} \left(\frac{\sigma - 1}{\sigma} \sum_r \frac{\Pi_{l(m),r,k} E_{r,k}}{\tilde{t}_{l(m),r,k}} + \eta \sum_r \frac{\Pi_{r,l(m),k} E_{l(m),k}}{\tilde{t}_{r,l(m),k}} \right). \tag{40}$$

Workers' income is $I_{l(\mathcal{O})} = \sum_g \sum_s w_{l,s} L_{g,l,s} + \sum_s \sum_r \frac{t_{r,l(\mathcal{O}),s}}{\tilde{t}_{r,l(\mathcal{O}),s}} \Pi_{r,l(\mathcal{O}),s} E_{l(\mathcal{O}),s}$ and $I_{l(\mathcal{P})} = 0$.

Finally, because a portion of labor is used for entry, the labor-market clearing condition for each China's province l and sector s can be obtained as:

$$w_{l,s} M_{l,s} f^e_{l,s} + \sum_m \lambda^L_{l(m),s} \left(\frac{\sigma - 1}{\sigma} \sum_r \frac{\Pi_{l(m),r,s} E_{r,s}}{\tilde{t}_{l(m),r,s}} + \eta \sum_r \frac{\Pi_{r,l(m),s} E_{l(m),s}}{\tilde{t}_{r,l(m),s}} \right) = \sum_g w_{l,s} L_{g,l,s}. \tag{41}$$

The left-hand side now includes entry costs.

F Additional Tables and Figures

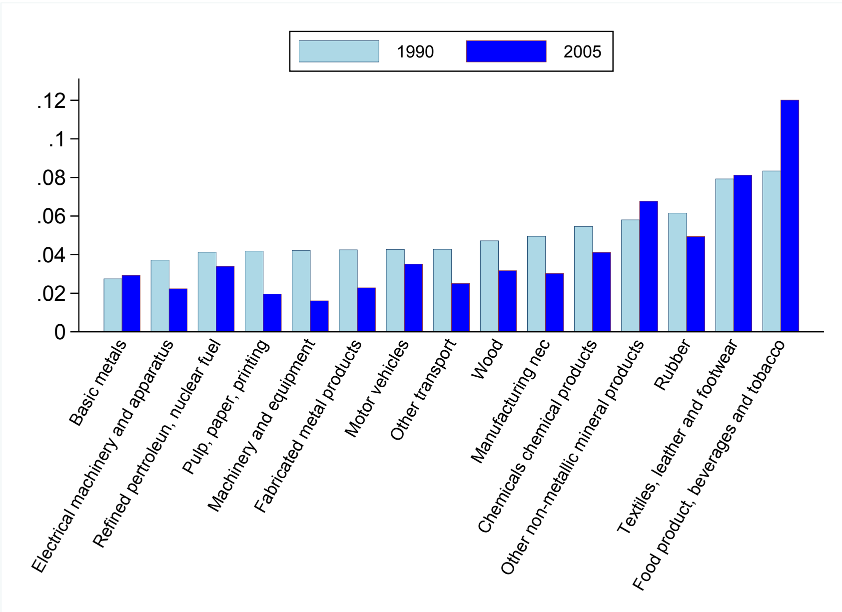


Figure 10: China's Average Export Tariffs across Foreign Countries by Sectors, in 1990 and 2005

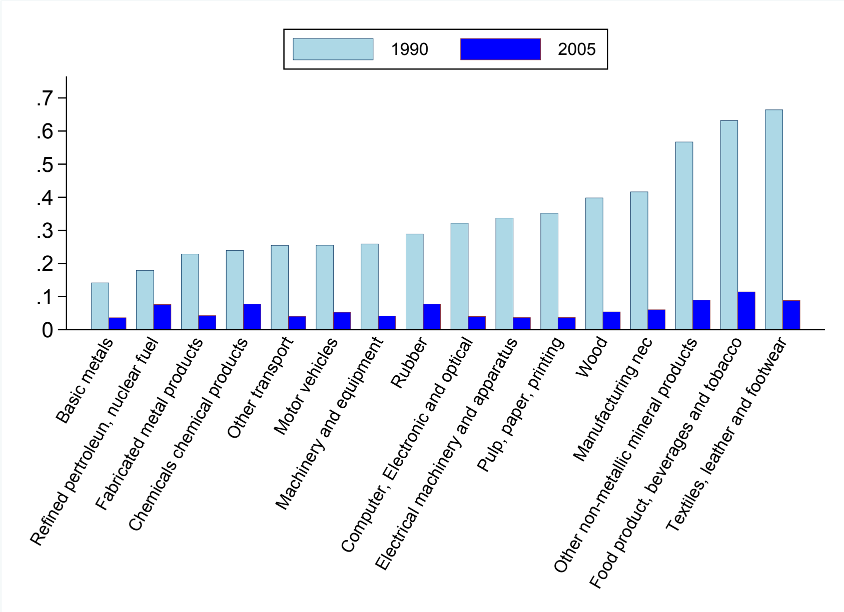


Figure 11: China's Import Tariff by Sectors, in 1990 and 2005

Figure 12: Provincial Annual Export Growth Rate Between 1990 and 2005

Notes: the black dots are four Special Economic Zones (SEZs) in 1980; the red dots are 14 national Economic and Technological Development Zones (ETDZs) in 1984; and the pink dots are 18 national ETDZs added in the year 1992.

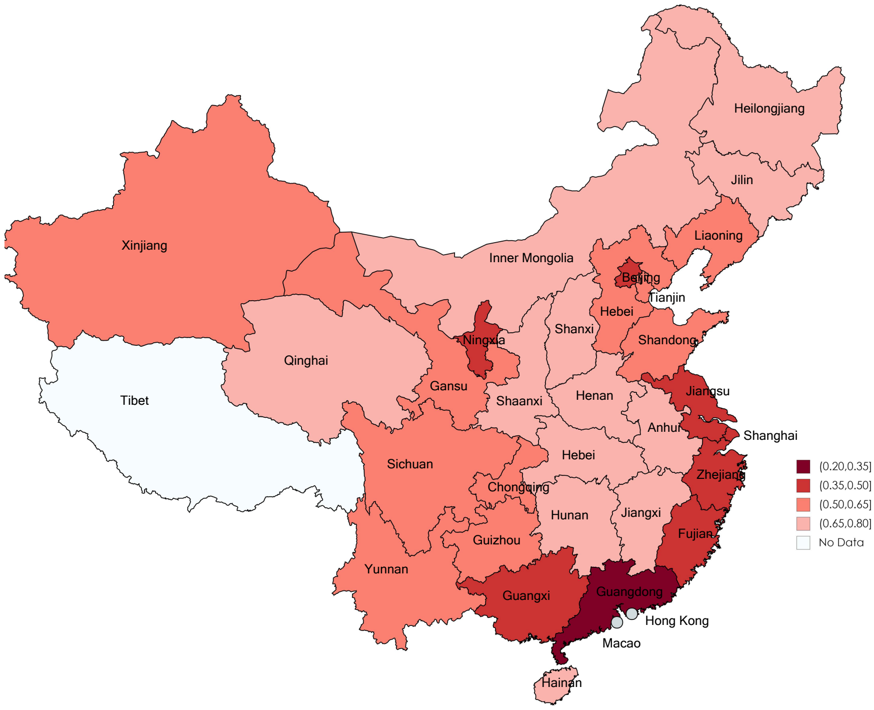


Figure 13: Provincial Changes in Migration Frictions $\frac{\tau_{l,s,1990}}{\tau_{l,s,2005}}$ (Manufacturing Sector)

Notes: Here we show the changes in migration costs by destination provinces for manufacturing sector, which are the migrant-population weighted average across origin provinces and sectors.

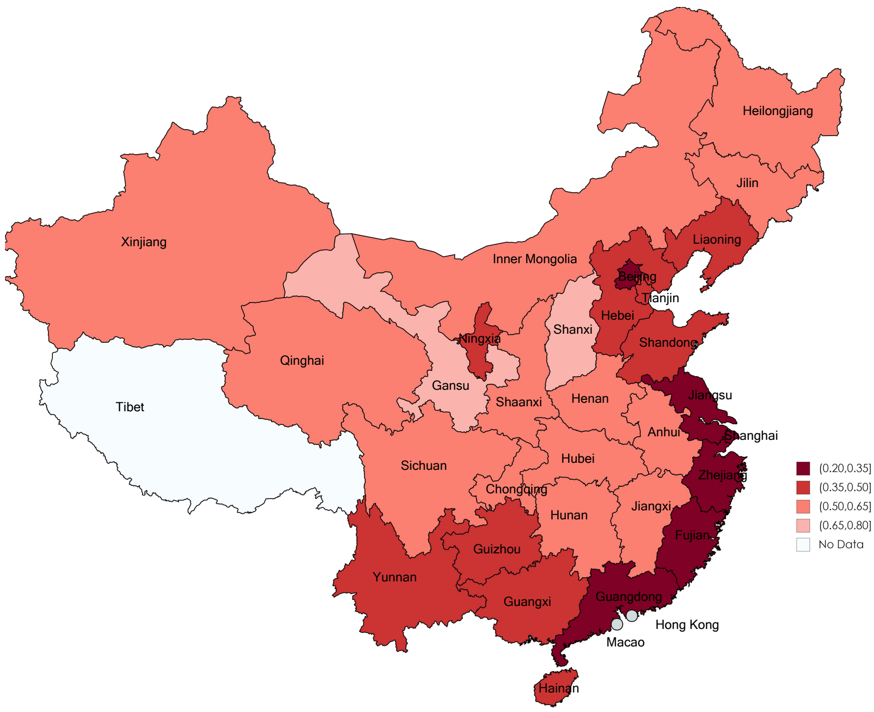
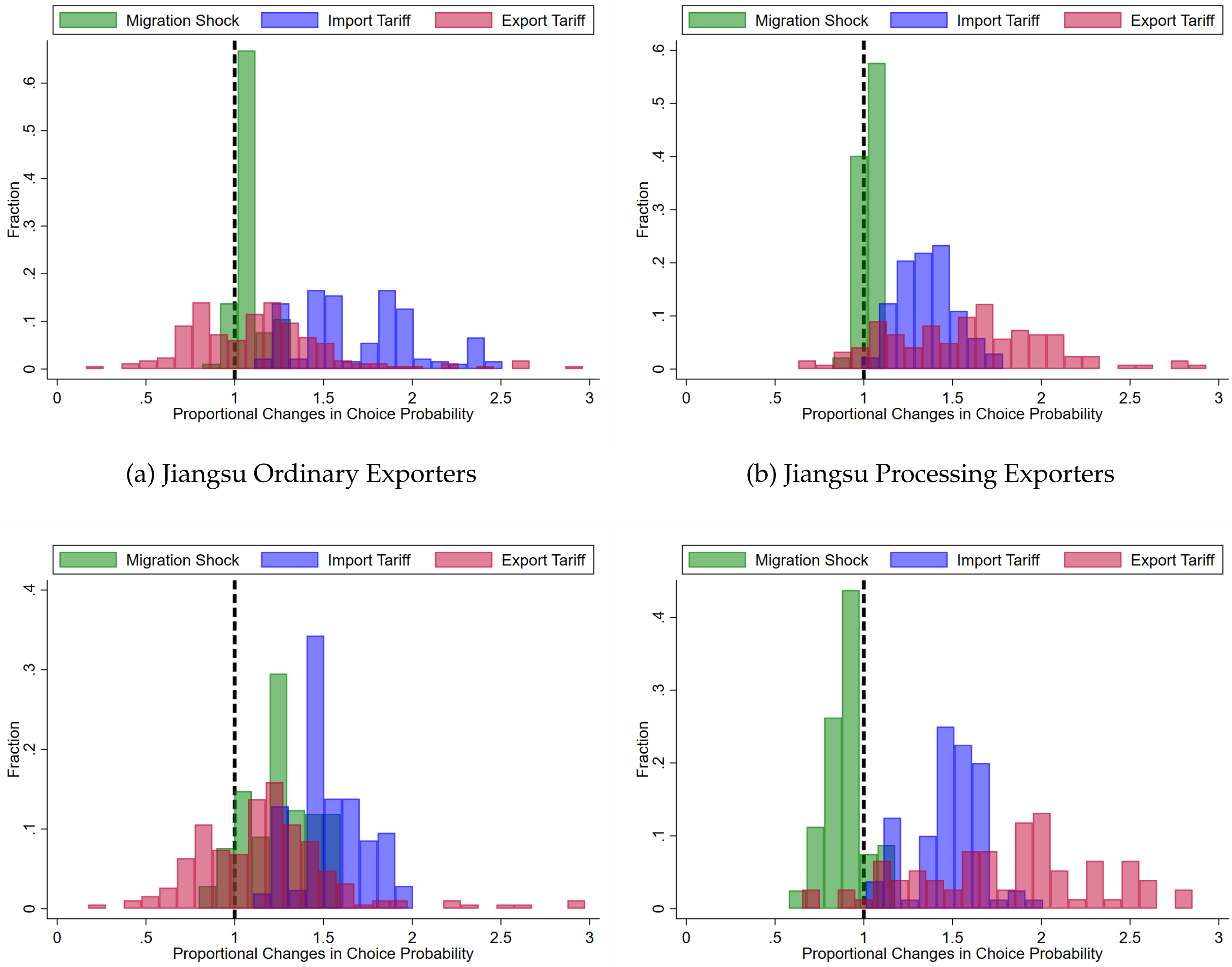


Figure 14: Provincial Changes in Migration Frictions $\frac{\sum_s \tau_{l,s,1990}}{\sum_s \tau_{l,s,2005}}$ (All Sectors)

Notes: Here we show the changes in migration costs by destination provinces for all sectors, which are the migrant-population weighted average across origin provinces and sectors.



(a) Jiangsu Ordinary Exporters

(b) Jiangsu Processing Exporters

(c) Zhejiang Ordinary Exporters

(d) Zhejiang Processing Exporters

Figure 15: The Histogram of Changes in Firms' Probability to Choose China's Province and Export-regime, $\widehat{P}\Big(Y = l(m)\Big)$

Notes: The histogram is plotted across all foreign destinations and sectors, where China's export volume was greater than 30 million US dollars in 2005. For the case of export tariffs, there is a probability mass of around 0.05 for which $\widehat{P}\Big(Y = l(m)\Big)$ takes values greater than 3. We truncate the distribution such that $\widehat{P}\Big(Y = l(m)\Big)$ takes values smaller than 3.

Table 11: The Provincial Export Impact by Different Margins of Trade, in Percentage Points

Policy Shock	**Intensive Margin** $\theta = 3, \gamma = 0, \rho = 0$ (1)	**Intensive & Extensive Margin** $\theta = 4, \gamma = 0, \rho = 0$ (2)	**Intensive, Extensive & Regime Margin** $\theta = 4, \rho = 0.81, \gamma = 0$ (3)	**Benchmark Model with Four Margins** $\theta = 4, \rho = 0.81, \gamma = 0.63$ (4)
		Guangdong Province		
Migration Shock	1.97	2.54	2.45	4.00
Import Tariff	0.80	1.12	1.01	2.34
Export Tariff	0.73	0.96	1.01	1.90
		Shanghai		
Migration Shock	1.48	1.86	1.81	2.36
Import Tariff	0.84	1.11	0.95	1.75
Export Tariff	0.60	0.75	0.79	1.26
		Jiangsu		
Migration Shock	0.18	0.23	0.21	0.38
Import Tariff	0.73	0.99	0.90	1.83
Export Tariff	0.67	0.88	0.92	1.63

Notes: the values are in units of percentage points. They are calculated in the same way as described in Table 5.

Table 12: Statistics of Manufacturing Foreign-invested Firms Registered between 1990–2005

By sector			By place of origin		
ISIC code	#entrants, 90–05	share	region	#entrants, 90–05	share
C17T19	20,526	20.1%	Hong Kong	37,767	37.0%
C15T16	11,329	11.1%	Taiwan	14,054	13.8%
C29	9,949	9.7%	Korea	10,802	10.6%
C24	8,854	8.7%	United States	10,186	10.0%
C36T37	8,184	8.0%	Japan	9,171	9.0%
C30T33X	7,965	7.8%	Singapore	2,827	2.8%
C31	7,728	7.6%	British Virgin Isds	2,540	2.5%
C25	6,254	6.1%	Canada	1,638	1.6%
C28	5,196	5.1%	Australia	1,523	1.5%
C26	5,152	5.0%	Germany	1,184	1.2%
C35	3,307	3.2%	Macau	1,072	1.1%
C21T22	2,410	2.4%	United Kingdom	858	0.8%
C20	2,366	2.3%	France	682	0.7%
C27	1,475	1.4%	Malaysia	667	0.7%
C23	1,377	1.3%	Italy	644	0.6%