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Migration, Tariffs, and China's Export Surge*

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Abstract

We built a multi-sector spatial general equilibrium model, featuring heterogeneous firms' and workers' location choices, to account for China's export surge between 1990 and 2005 from three policy changes: China's import tariffs, tariffs imposed against China's exports, and barriers to internal migration in China. We found that tariff and migration policies jointly accounted for 30% of China's export growth. We also found a positive spillover effect of tariff and migration policies, which arose entirely from processing export growth. As migration reform prepared the country to become more export oriented, China enjoyed a faster export growth from opening up trade than if it had done otherwise. This spillover effect of tariff and migration policies would have been overlooked if tariff and migration had been analyzed separately, or if processing and ordinary exports had not been distinguished in the model.

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

We build a multi-sector spatial general equilibrium model and combine rich data sources to account for China's export surge between 1990 and 2005 from three policy changes: China's import tariffs, tariffs imposed against China's exports, and barriers to internal migration in China. In the model, workers choose which provinces and sectors to work in. Firms choose their production locations and whether to engage in processing or ordinary export regimes.[1] We explore provincial and sectoral variations of the changes in firm mass, migrant employment, and tariff exposure to discipline the model parameters. Finally, we analyze the effects of tariff and migration policies on China's export surge collectively, as well as the importance of equilibrium firm and worker adjustments.

We find that the tariff and migration policies jointly accounted for 30% of China's export growth. These joint effects were larger than the result of simply aggregating the effect of individual policy, suggesting a positive spillover of tariff and migration policies. More importantly, the spillover effect, arising entirely from processing export growth and absent for ordinary exports, would have been overlooked had migration and tariff policies been analyzed separately, or had processing and ordinary exports not been distinguished in the model.

The policy spillover is a consequence of migrants' spatial and sectoral movements. Recent literature has emphasized that China's rural-to-urban migrants caused a substantial aggregate productivity gain (Tombe and Zhu, 2019; Hao, Sun, Tombe and Zhu, 2020). We document that migrant employment was prominent in export-intensive and processing-oriented industries, which reinforced the comparative advantages of China's export and improved the country's aggregate export-output ratio. As migration policy reform prepared the country to become more export oriented, China enjoyed a faster export growth when opening up trade than it would have had otherwise.

Accompanying China's substantial reductions in tariffs and internal migration costs were the massive entry of new firms (Brandt, Van Biesebroeck and Zhang, 2012) and the structural changes in export regimes (Brandt and Morrow, 2017). To motivate our quantitative model,

[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 their output domestically.

we show—using reduced-form specifications—that firm location and regime decisions are sensitive to migration and tariff changes. First, we demonstrate that provinces and sectors that experienced larger expansions in migrant employment also faced faster increases in the number of firms between 1990 and 2005. To address the endogeneity issues, we construct a Card-type instrument for changes in migrant employment by exploiting historical patterns of location and sector sorting for workers from different provinces of origin. Second, we explore the variation across sectors to show that the decreased import tariffs led to a rise in the number of ordinary firms relative to that of the processing firms.[2] We use provincial import penetration and sectoral input-output tables to construct changes in the production costs resulting from import tariff reductions (WTO), and instrument potentially endogenous tariff changes with maximum tariff levels under the WTO agreement following Brandt, Van Biesebroeck, Wang and Zhang (2017). These reduced-form estimates will be targeted to discipline the key parameters that govern firm adjustments.

Our model has three key components. First, we build upon Arkolakis, Ramondo, Rodríguez-Clare and Yeaple (2018) (hereafter referred to as ARRY) to model firm location and ordinary and processing regime choices, with correlated productivity draws from a multivariate Pareto distribution (Arkolakis, Rodríguez-Clare and Su, 2016). The second is the intersectoral input-output linkages (Caliendo and Parro, 2015). Third, Chinese workers with heterogeneous location preferences and migration costs are sorted by provinces and sectors. A policy shock could impact the aggregate exports not only by affecting the firms' decisions on whether and how much to export (Chaney, 2008), but also by changing firms' decisions on where to produce and their processing or ordinary regime choices. The aggregate trade elasticity, therefore, depends on the two structural parameters of productivity correlation across locations and across regimes, which govern firm location and regime responses to policy shocks, respectively.

We use an indirect inference approach to discipline these productivity correlation parameters that match our reduced-form estimates on firm location and regime responses. Specifically, we obtain the productivity correlation across locations to target our reduced-form estimate on the response of the number of firms to migration shocks, and we obtain the productivity correlation between ordinary and processing regimes to target our reduced-form estimate on the effects of import tariff changes on the number of ordinary firms, relative to processing ones. We provide additional evidence that each correlation parameter is indeed identified from the associated firm adjustment, but is insensitive to changes in other model components.

[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.

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. We measure the changes in internal migration costs following Head and Ries (2001)'s approach to match the changes in migration flows, and present tariff and migration shocks in a model of 29 sectors, two export regimes (processing and ordinary), 30 Chinese provinces, and 35 foreign countries. First, taking individual policy into the model one at a time, we find that the reductions in China's import tariffs explained 12.6% of the overall export growth, while changes in foreign tariffs on China's exports and reductions in internal migration barriers each accounted for 7.7% and 7.2%, respectively. The major portion of China's export growth arose from three coastal provinces, namely Guangdong, Shanghai, and Jiangsu. We also observe that while import tariff reductions favored ordinary exports, the reductions in migration barriers and in foreign tariffs on China's exports both favored processing exports.

Next, in simultaneously applying the three policy changes to the model, we find that they jointly accounted for 30% of China's export growth. This joint effect is 9% larger than the aggregation of individual effects (12.6%+7.7%+7.2%=27.5%), suggesting a positive spillover between trade and migration policies. We also discover that because migrant employment was prominent among processing-oriented sectors, the spillover arose entirely from processing exports.

In our final exercise, we study the role of firm and worker adjustments in China's export growth. We find that in a model where firms' locations and regimes do not respond to policy changes, the joint effects of policies on export growth drop by nearly half; and in a model where workers do not adjust across locations or sectors, the export impacts of tariffs drop by 12%. Accounting for equilibrium adjustments of workers and firms is quantitatively important for evaluating China's export growth.

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) and its export structures (Brandt and Morrow, 2017). Brandt, Li and Morrow (2019) built an Eaton-Kortum model with ordinary and processing regimes to quantify the welfare losses incurred by restricting domestic sales of processing output. Differing from these studies, we analyze migration and trade collectively to illustrate that the policy spillover is overlooked when only one policy is analyzed at a time. Tombe and Zhu (2019), Fan (2019), Ma and Tang (2020) and Zi (2020) model migration and trade collectively in China's context. Our main departure from these studies is in distinguishing the processing and ordinary export regimes, and showing that the policy spillover is only present for processing export growth. Finally, Brandt and Lim (2019) account 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 policies collectively. Second, they calibrate their model to analyze the 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.

Our paper also relates to the quantitative trade and spatial equilibrium literature that studies the impact of goods and labor market integration (Allen and Arkolakis, 2014; Redding and Rossi-Hansberg, 2017, among others). International trade theory widely emphasizes how opening up international trade causes factor relocation and the associated consequences on productivity (Melitz, 2003), and yet labor mobility in China used to be banned. In a well-studied area, researchers have shown that reducing the internal migration frictions can generate sizable aggregate output gains in developing countries (Bryan and Morten, 2019; Tombe and Zhu, 2019). Relative to the studies on the aggregate productivity impact of migration friction, less attention has been paid to the migrants' choices of sectors and their associated impacts on exports. We show that China's internal migration favored the productivity growth of export-intensive industries and reinforced China's comparative advantages—this is the source of the policy spillovers we emphasize.

This paper proceeds as follows: Section 2 presents facts that motivate our analysis, Section 3 presents our model, Section 4 calibrates the model parameters, Section 5 presents the quantitative results, and Section 6 concludes.

2 Motivating Facts

This section presents facts demonstrating that China's internal migration expanded employment in export-oriented provinces and industries, thereby causing an aggregate productivity gain and improving China's export-output ratio. We also provide reduced-form evidence on firm location and regime responses to migration and tariff changes. Our data sources are described below.

2.1 Data

Our analysis includes 29 sectors, 30 Chinese provinces, 35 foreign countries, and the rest of the world.[3] We aggregate the 2-digit International Standard Industrial Classification (ISIC Rev 3) industries into 16 tradable sectors and 13 non-tradable sectors (see Table C.2). We summarize the data sources below and provide the full details in Appendix C.

[3]We exclude Tibet due to the lack of data.

Migration. We use China's Population Census in 1990 (1%) and China's Population Survey 2005 (0.2% mini census) to measure China's inter-provincial migration flows, wages, and sectoral employment. We study inter-provincial migrants—individuals whose *Hukou* is not registered in the province they are currently working.

Firms. We measure the total number of firms in 1990 and 2005 by province and sector, using the 2004 Firm Census (for 2005) and the Industrial Statistical Yearbook (for 1990). Both sources provide full coverage of manufacturing firms.[4] This variable is used to measure the dependent variable in equation (2). Additionally, in merging China's Annual Survey of Industrial Firms with China's customs Transactions Database, we obtain the numbers of processing and ordinary firms by province and sector for the dependent variable in equation (4).

Output. We obtain province-sector-level output from China's regional input-output tables in 2007 (Liu, Chen, Tang, Liu, Han and Li, 2012). Since domestic sales of the output of processing firms are prohibited, we measure the provincial and sectoral output of processing firms using the total amount of processing exports obtained from China's Customs Transactions Database. We measure ordinary production as the difference between gross province-sector-level output and the processing output. The output variables are used in the quantitative analysis.

Trade. We measure inter-provincial trade flows primarily based on inter-provincial input-output tables, and measure trade between foreign countries using the STAN Bilateral Trade Database. We measure trade flows (classified into processing and ordinary) between China's provinces and foreign countries using China's Customs Transactions Database.

2.2 Migrants' Employment and Manufacturing Exports

China's internal migrants make up an important portion of manufacturing employment. For the broad manufacturing sector, Figure 1 plots the migrants' employment shares against export-output ratios across provinces in 2005. Provinces where migrants comprised larger portions of manufacturing employment were more export-oriented and had higher export volumes (reflected by the circle size). Notably, in Guangdong and Shanghai, migrants accounted for 60% and 45% of the provincial manufacturing employment, respectively. This spatial movement of labor expanded the manufacturing employment at export-oriented provinces, improving the country's export-output ratio.[5]

[4]Because Firm Census is not available in the year 1990, we obtain the number of firms in each province and sector from the Industrial Statistical Yearbook.

[5]To verify that internal migration increased the manufacturing employment size relative to the overall employment, Appendix B shows that internal migrants were over-represented in manufacturing sectors at desti-

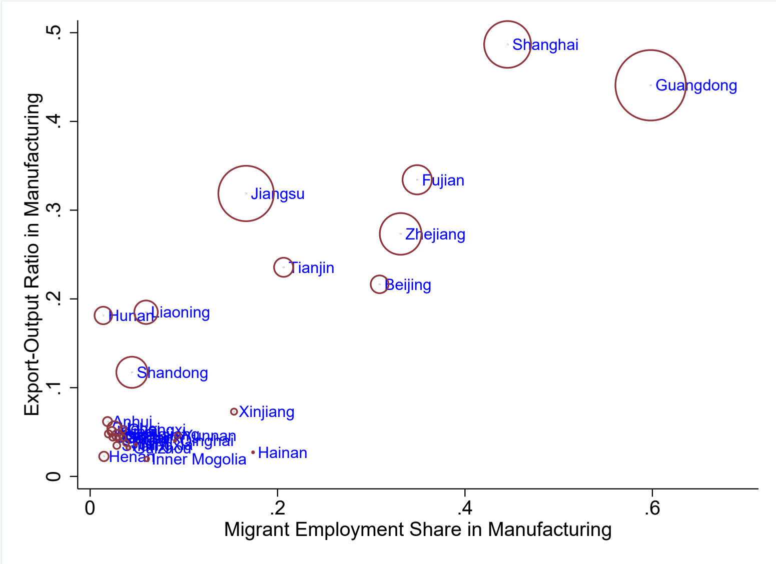


Figure 1: Migrants' Manufacturing Employment Shares against Provincial Export-Output Ratios. The Circle Size Measures Provincial Export Volume.

We next focus on five coastal provinces (Guangdong, Jiangsu, Shanghai, Zhejiang, and Fujian), and examine the migrant sorting across 16 specified manufacturing sectors. The five provinces combined accounted for 73% of the inter-provincial migrants, 79% of China's manufacturing exports, and 84% of the processing exports in 2005. Figure 2 (left) plots export-output ratios against migrant employment shares across 16 specified manufacturing sectors. Migrant employment shares varied dramatically and were higher at more export-oriented sectors. For this reason, we use 16 manufacturing sectors, at a more disaggregated level than the previous literature did.[6] We will return to analyze the productivity and export implications in Section 2.3.

The export-oriented manufacturing sectors (e.g., electronics, electrical machinery) are also highly processing oriented. With the y-axis replaced by the share of processing exports, Figure 2 (right) resembles what we see in Figure 2 (left) closely. In Appendix B, we show that a strong and similar positive correlation holds at Guangdong province, which accounted for 39% of China's processing exports in 2005. There are also positive correlations in Zhejiang and Jiangsu, despite their migrant employment shares being relatively small. The positive correlation holds for Shanghai when weighting industries by export volumes. As the pattern has been proven to hold systematically among China's export provinces, the migrants expanded employment at export-intensive and processing-oriented industries, again improving the country's export-output ratio.

nation provinces relative to other sectors.

[6]Tombe and Zhu (2019) and Hao et al. (2020) distinguish migration sorting into agricultural and non-agricultural sectors. Fan (2019) analyzes three broad sectors, whereas Ma and Tang (2020) analyze two broad sectors.

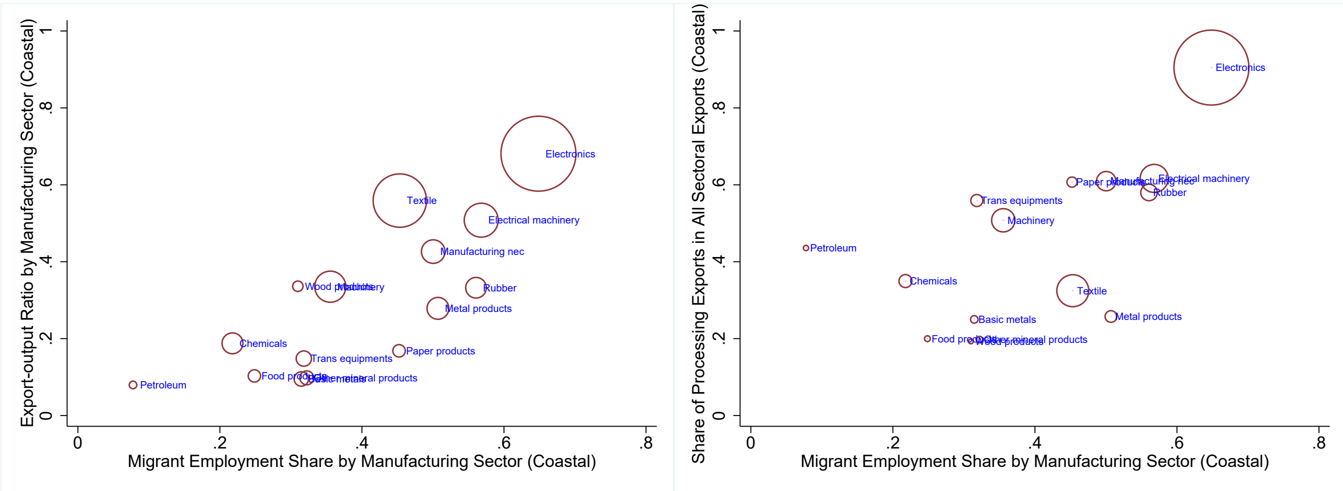


Figure 2: Migrants' Sectoral Employment Shares against Sectoral Export-Output Ratios — Coastal Provinces (left); Migrants' Sectoral Employment Shares against Sectoral Share of Processing Exports — Coastal Provinces (right)

Notes: Both plots use data from five provinces (Guangdong, Jiangsu, Shanghai, Zhejiang, and Fujian). The circle size reflects sectoral export volume on the left, and processing export volume in each sector on the right.

The sectoral sorting pattern of migrants is likely driven by two economic forces. One is that the migrants were less educated compared to the Hukou residents at destination provinces and thus, more likely to work in processing export activities that required few skills (Dai, Maitra and Yu, 2016). Another force is that the reduction in migration regulations was potentially more aggressive at major exporting sectors in coastal areas. In particular, as China's exports boomed after the WTO accession (Feenstra and Wei, 2010), local governments had incentives to relax migration regulations to stimulate the local economy (Tian, 2019).[7] We use the patterns of sectoral sorting to calibrate policy parameters in Section 4.1.

2.3 The Intuition

What are the mechanisms through which China's internal migration promoted export growth? First, migration expanded employment in the more productive provinces and sectors, causing an aggregate productivity gain (Tombe and Zhu, 2019; Hao et al., 2020). Second, internal migration improved productivity to a greater extent in the more export-oriented provinces and sectors, reinforcing the country's comparative advantage.[8] To illustrate, we decompose the export effect of the observed changes in migrant employment in province l and sector s

[7] Tian (2019) collects a dataset that measures the degree of city-level migration regulations. She finds that Chinese cities that faced larger increases in access to export markets had a larger degree of relaxation of migration regulations. Also see Yang (2005), who shows that faced with labor shortage due to reasons such as agricultural reforms, local governments and firms improved access to welfare of migrant workers, especially for export processing activities which had to live with very low pay and abysmal working conditions.

[8] This theoretical insight has been discussed in Cosar and Fajgelbaum (2016).

between 1990 and 2005, $\Delta L_{l,s}$, as

$$\underbrace{\Delta \log \text{Export}}_{2.57 \text{ p.p. annual growth}} = \underbrace{\Delta \log \text{Output}}_{1.07 \text{ p.p. annual growth}} + \underbrace{\Delta \log \frac{\text{Export}}{\text{Output}}}_{1.50 \text{ p.p. annual growth}} . \quad (1)$$

The first term captures the aggregate output effect, and the second term measures the comparative advantage effects using the export-output ratio. We calculate the effect on aggregate export and output growth as

$$\Delta \log \text{Output} \approx \sum_{l,s} \frac{\text{Output}_{l,s}}{L_{l,s}} \Delta L_{l,s} \Big/ \text{Output}, \quad \Delta \log \text{Export} \approx \sum_{l,s} \frac{\text{Export}_{l,s}}{L_{l,s}} \Delta L_{l,s} \Big/ \text{Export}$$

where $\frac{\text{Output}_{l,s}}{L_{l,s}}$ and $\frac{\text{Export}_{l,s}}{L_{l,s}}$ are output and exports per worker in province l and sector s, respectively. Holding sectoral employment of local Hukou residence unchanged over time, we find that internal migration led to a 1.07 p.p. increase in annual output growth and a 1.5 p.p. increase in annual growth of the export-output ratio.[9] Productivity and comparative advantage gains both appear to be important.

The gain in China's overall comparative advantage is due to the faster productivity growth in export-intensive industries. To verify this theory, Figure 3 (left) plots the effects of $\Delta L_{l,s}$ on the aggregate sectoral output growth against the sectoral export-output ratio. We find that more export-oriented sectors experienced faster output growth, and the largest effect is a 3.6 p.p annual growth of the electronics sector.

Employment expansion is not the only cause for the uneven sectoral growth. Figure 3 (right) replaces the y-axis with the effect of $\Delta L_{l,s}$ on annual growth of output per worker. It shows that the output per worker increased in most sectors, but fell in a few industries such as electrical machinery. In China's top two export sectors—electronics and textiles—the output per worker increased by 0.21% and 0.06% annually. Employment expansion and the gain in output per worker in the export sectors both played a role in shaping the country's comparative advantage gain. As the aggregate export-output ratio increased, China enjoyed a faster export growth from the trade liberalization than it would have had without the migration policy reform. This is the source of the export spillovers of migration and trade policies, which we will quantify in Section 5.

[9] We convert the 15-year growth to annual growth by applying the formula $1 + g_{15} = (1 + g)^{15}$, where g_{15} is the 15-year growth rate and g is annual growth rate. We find that inter-provincial migration increased aggregate output (including nontradable sectors not analyzed in this section) by 9.6%. Because we only analyze inter-provincial migration, the aggregate output impact we obtained is smaller than partial-equilibrium gains (10.8%) computed by Tombe and Zhu (2019) who also consider rural-urban migration. The period we focus on also differs from Tombe and Zhu (2019) who focus on 2000-2005.

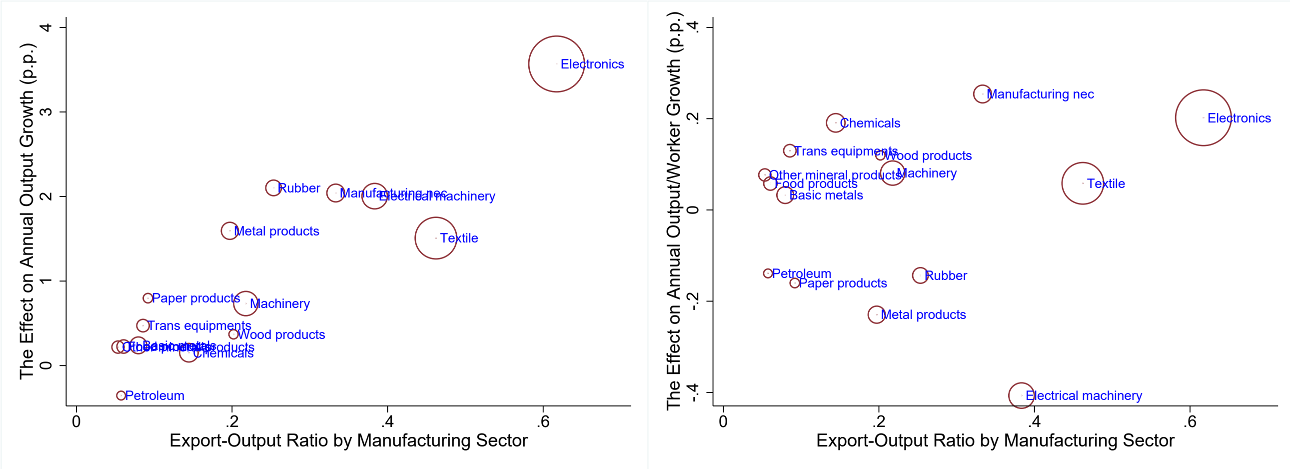


Figure 3: The Effect of Migration on Annual Output Growth against Sectoral Export-Output Ratio (left); The Effect of Migration on Annual Output/Worker Growth against Sectoral Export-Output Ratio (right); The Circle Size Reflects the Sectoral Export Volumes.

Our calculation overlooks several economic forces. First, we ignore the general equilibrium wage adjustments of increasing sectoral labor supply and the consequent adjustments of the province-sector-level export intensity.[10] As an increase in migration labor supply would lower local wages, coastal provinces may become more export-oriented. Second, our calculation treats labor as the only factor and ignores intermediate materials and the input-output linkages across sectors. Third, changes in economic policies (migration and tariff policies) could change firms' market access to consumers and affect firms' decisions of production locations. Previous literature argues that the massive entry of new firms has been an important source of China's productivity (Brandt et al., 2012) and export growth (Khandelwal, Schott and Wei, 2013). Section 3 builds a general equilibrium model that incorporates these forces. However, before expounding that, we first provide reduced-form evidence on firms' adjustments.

2.4 Reduced-form Evidence

We estimate the firm location and regime responses to migration and tariff changes. The exercise serves two purposes. First, they motivate our quantitative model that features the firm location and export regime choices. Second, we use the reduced-form estimates to pin down two key structural parameters in Section 4.2.

[10]Assuming that $\Delta L_{l,s}$ has no impact on wages and foreign income, the province-sector-level export intensity would not change.

2.4.1 Internal Migration and the Number of Firms

We estimate the impact of migrant labor supply on the number of firms between 1990 and 2005, using the following reduced-form specification

$$\Delta M_{l,s} = \beta_0 + \beta_1 \Delta N^m_{l,s} + \gamma x_{l,s} + \epsilon_{l,s}. \tag{2}$$

The dependent variable is growth in the total number of firms in province l and sector s between 1990 and 2005, which is constructed as $(M_{l,s,2005} - M_{l,s,1990})/\frac{1}{2}(M_{l,s,2005} + M_{l,s,1990})$. $M_{l,s,t}$ is the number of firms in province l and sector s at year t.[11] The independent variable is the changes in migrant share in province l and sector s between 1990 and 2005, constructed as $\Delta N^m_{l,s} = (N^m_{l,s,2005} - N^m_{l,s,1990})/\frac{1}{2}(N_{l,s,2005} + N_{l,s,1990})$. Here, $N^m_{l,s,t}$ and $N_{l,s,t}$ are the number of migrant workers and the overall employment in province l and sector s at year t, respectively.

The increase in migrant labor force may attract more firms by lowering the local wages, generating industrial agglomeration, or changing the firms' market access. The reduced-form parameter β_1, therefore, captures the mixture of these effects.[12] $x_{l,s}$ denotes province and sector control variables, including log output per worker in 1990, and changes in non-tariff barriers, FDI restrictions, and input-output tariffs between 1990 and 2005.[13]

The OLS regression in equation (2) would be biased if provinces and sectors that have high unobserved productivity attract more firms and migrant workers. We construct a Card-type instrument as follows

$$\Delta \widetilde{N}^m_{l,s} = \sum_g \Delta N_g^{-l,-s} \times \Lambda_{g,l,s,t_0}, \tag{3}$$

where g indexes for workers whose *Hukou* is registered in province g, and $\Delta N_g^{-l,-s}$ 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. Λ_{g,l,s,t_0} is the share of workers choosing province l and sector s in the year t_0 among those who migrated.[14]

Our instrument aims to capture plausibly exogenous supply-driven variation in migration flows that are orthogonal to the unobserved local demand. The identification of shift-share instrumentals in the form of equation (3) can be obtained if either the shifts or the shares are randomly assigned (Adao, Kolesár and Morales, 2019; Borusyak, Hull and Jar-

[11] 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.

[12] Our specification is similar to the widely adopted reduced-form specification in the immigration literature (e.g, Card, 2001; Borjas, 2003; Olney, 2013). Moreover, with migration labor supply as the independent variable, we can construct an instrumental variable to better identify the parameter.

[13] Output per worker in 1990 is drawn from the Industrial Statistical Yearbook. Non-tariff barriers, FDI restrictions, and input and output tariffs are drawn from Brandt et al. (2017).

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

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, 1990–2005			
Δmigrant share	1.018***	0.987***	0.957***	0.750***
	(0.225)	(0.327)	(0.274)	(0.182)
Controls	No	No	Yes	Yes
Sector Fixed-effects	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 (2) across provinces and sectors. The instrument is the Card-type instrument to predict exogenous labor supply shifts (measured in units of millions of people). 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% ***.

avel, 2022). In our case, the identification holds if $\Delta N_g^{-l,-s}$ or Λ_{g,l,s,t_0} is orthogonal to the initial province-sector-level productivity in the year 1990. These orthogonality conditions tend to hold because each province-sector cell we consider is small and has little power in driving national aggregate migration pattern.

It appears that $\Delta \widetilde{N}_{l,s}^m$ strongly predicts the actual migration pattern $\Delta N_{l,s}^m$, with the coefficient of 0.525 and the standard error of 0.046.[15] The OLS regression shows a strong and positive association, as reported in Column (1) of Table 1. Columns (2) - (4) report the IV estimates under different specifications, where we add local controls in Column (3) and sector fixed effects in Column (4).[16] All IV estimates are smaller than the OLS result, where the upward bias in the OLS regression likely reflects that fast-growing regions or sectors attracted more migrants and firms.

2.4.2 Import Tariffs and Firms' Export-Regime Choices

We estimate the impact of import tariff changes on the relative number of ordinary to processing exporters. Because imported materials for processing exports are duty-free, import tariff reductions benefit ordinary exporters more. In a previous study, Brandt and Morrow (2017) find the share of ordinary exports increases as tariffs fall. We show that a similar relationship holds on the relative number of ordinary and processing exporters.

[15]The Card-type instrument, while widely used, is subject to criticism. One concern is that it may be invalid if regional labor demand shocks are persistent (Borjas, Freeman and Katz, 1997). Helpfully, we find that our instrument $\Delta \widetilde{N}_{l,s}^m$ is uncorrelated with output per worker in 1990 and the growth in output per worker between 1990 and 2005 across provinces and sectors.

[16]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).

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			
b_1	-1.122	-1.873	3.079	-8.368**
	(8.504)	(8.626)	(8.774)	(3.570)
b_2	-11.827	-11.265	-17.383**	-18.692**
	(9.041)	(8.740)	(7.096)	(8.866)
Controls	No	No	Yes	Yes
Province Fix-effects	No	No	No	Yes
First-stage F		8653.43	6839.21	2485.28
Obs	751	751	751	751
R-squared	0.354	0.354	0.426	0.668

Notes: This table presents the results from estimating regression (4) 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% ***.

We estimate the following reduced-form regression:

$$\Delta M_{l(m),s} = b_0 + (b_1 + b_2 \mathbf{1}_{\mathcal{O}}) \sum_k \lambda_{l,s}^k IP_{l,k} \left(\frac{1 + t_{k,2005}}{1 + t_{k,2000}} - 1 \right) + \gamma x_{l,s} + \epsilon_{l,s}, \tag{4}$$

where the dependent variable is the changes in the number of exporters in province l and sector s between 2000 and 2005, constructed as $(M_{l(m),s,2005} - M_{l(m),s,2000}) / \left(\frac{1}{2} M_{l(m),s,2005} + \frac{1}{2} M_{l(m),s,2000}\right)$, separately for ordinary and processing regimes $m \in \{\mathcal{O}, \mathcal{P}\}$. 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. 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 the changes in import costs due to tariff reductions. $\lambda_{l,s}^k$ is the share of sector s's production costs spent on materials from sector k, obtained from the input-output tables in 2005.

Production costs reduced more when the province intensively used foreign inputs (high $IP_{l,k}$) or the 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 b_2, which captures differential responses in the number of ordinary exporters 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 changes in applied tariffs by using the maximum tariff levels under the WTO agreement, following Brandt et al. (2017),

$$x^*_{l,s} = \sum_k \lambda^k_{l,s} IP_{l,k} \left(\frac{1 + t^{WTO}_{k,2005}}{1 + t^{WTO}_{k,2000}} - 1 \right), \tag{5}$$

where $t^{WTO}_{k,2000}$ and $t^{WTO}_{k,2005}$ refer to specified maximum tariff levels in the WTO agreement, which were mostly established in 1999.

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. The justification for (2) is that because of many local policy and economic uncertainties, policymakers' anticipation of $\epsilon_{l,s}$ is not formed by the agreed maximum tariff rates.[17]

Column (1) of Table 1 reports a negative and insignificant OLS estimate. Columns (2)-(4) report the IV estimates under different specifications. All IV estimates show negative values of b_2, where the parameters are precisely estimated when adding local controls in Column (3) and province fixed effects in Column (4). We also find that the instrument strongly predicts the independent variable, with a linear coefficient of 1.161 (standard error of 0.038) and sizable first-stage F values. The evidence shows that provinces and sectors, where production cost reduced more after China's WTO accession, faced a faster growth in the number of ordinary exporters relative to processing exporters.

3 A Spatial Equilibrium Model with Firms' Location Choices

We extend ARRY to a multi-sector spatial general equilibrium model with heterogeneous firms' and workers' location choices, and input-output linkages. We treat each foreign country as a single region. In China, we consider provinces regions. 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. The world has a total number M_s of potential firms in each sector s. We take M_s as exogenous in our benchmark model, but provide a model extension that endogenizes M_s in Appendix D.3.

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

[17] 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 WTO tariff cut was 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 and sectors in the past.

countries, we assume 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 present our model based on China's provinces and export regimes. We discuss the setup for foreign countries when a distinction arises. Math derivations 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 intermediate goods sourced from all foreign countries and domestic ordinary producers in all of China's provinces. $\sigma > 1$ is the elasticity of substitution across varieties. The final good can be either consumed by households or used as a raw material 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 China's processing and ordinary regimes. 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 foreign 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

$$q_{l(m),s} = \phi_{l(m),s} L_{l(m),s}^{\lambda_{l(m),s}^{L}} \prod_{k} Q_{l(m),s,k}^{\lambda_{l(m),s}^{k}}, \tag{6}$$

where $\lambda_{l(m),s}^{L}$ is the share of workers' value added, and $\lambda_{l(m),s}^{k}$ is the share of expenses on raw materials from sector k. We assume $\lambda_{l(m),s}^{L} + \sum_k \lambda_{l(m),s}^{k} = 1$. The implied unit cost of the input bundle is

$$c_{l(m),s} = \left(\frac{w_{l(m),s}}{\lambda_{l(m),s}^{L}}\right)^{\lambda_{l(m),s}^{L}} \prod_{k} \left(\frac{P_{l(m),k}}{\lambda_{l(m),s}^{k}}\right)^{\lambda_{l(m),s}^{k}}.$$ [18]

Two of the three policies we analyze would affect exports directly through the unit cost at provincial and sectoral levels. The reduction in migration costs increases labor supply and lowers wages $w_{l(m),s}$. The decline in import tariffs would change the price $P_{l(m),k}$ for ordinary producers. However, it has no direct impact on the price for processing producers who have faced zero import tariffs since 1987.

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 et al., 2016):

$$F\left(\vec{\phi}_{l(m),s}, \vec{\phi}_{j,s}\right) = 1 - \left[\sum_{l}\left(\sum_{m} A_{l(m),s}\phi_{l(m),s}^{-\frac{\theta}{1-\rho}}\right)^{\frac{1-\rho}{1-\gamma}} + \sum_{j} A_{j,s}\phi_{j,s}^{-\frac{\theta}{1-\gamma}}\right]^{1-\gamma}, \quad \theta > \sigma - 1 \tag{7}$$

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 aggregate trade elasticity resulting from firms' location and regime switching. A larger value of the parameter θ corresponds to a smaller productivity dispersion across firms.

In Appendix B.2, we show that the massive migration to coastal provinces started no later than the surge in Chinese exports, where the timing suggests that agglomeration economies

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

at coastal provinces arose from internal migration. To this end, we model agglomeration forces as external economies of scale (Ethier, 1982). Specifically, we assume $A_{l(m),s} = \bar{A}_{l(m),s} L^{\alpha}_{l(m),s}$ 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). Firms 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, $q_{l(m),n,s} = \left[p_{l(m),n,s}\right]^{-\sigma} E_{n,s} P^{\sigma-1}_{n,s}$, 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 a foreign country n on Chinese goods and is constant across all provinces and regimes. $d_{l(m),n,s}$ denotes the non-tariff trade barriers. Firms also need to pay fixed marketing costs in terms of input bundles of destination n, denoted as $c_{n,s} f_{n,s} > 0$.[19] The optimal price is set with a markup $\frac{\sigma}{\sigma-1}$ over the marginal cost of selling to country n

$$p_{l(m),n,s} = \frac{\sigma}{\sigma-1} \tilde{t}_{i,n,s} \frac{c_{l(m),s} d_{l(m),n,s}}{\phi_{l(m),s}}.\text{[20]} \tag{8}$$

Exporting Decisions: Firms will only export to destination n if the profit is positive. Given the demand and the optimal price in equation (8), the zero-profit productivity cutoff above which the firm would export from $l(m)$ to destination n is

$$\phi^{*}_{l(m),n,s} = \frac{\sigma}{\sigma-1} c_{l(m),s} d_{l(m),n,s} \tilde{t}^{\frac{\sigma}{\sigma-1}}_{i,n,s} \left(\frac{\sigma c_{n,s} f_{n,s}}{E_{n,s}} \right)^{\frac{1}{\sigma-1}} \frac{1}{P_{n,s}}. \tag{9}$$

[19] $f_{n,s}$ 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.

[20] 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 $\tilde{t}_{i,n,s}$. See Bai, Krishna and Ma (2017) for the analysis of direct trading rights. However, this exercise is out of the scope of our paper.

In related papers that model firms' location choices in the spatial equilibrium, Suárez Serrato and Zidar (2016) and Fajgelbaum, Morales, Suárez Serrato and Zidar (2018) assume zero fixed costs. Here, we allow for positive fixed costs, and therefore our model incorporates the *extensive margin* of trade (Chaney, 2008).[21] Another point to note from equation (9) 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: In each sector s, firms choose a location among Chinese province-regimes and foreign countries to serve destination n where the unit cost of export is the lowest

$$\min_{l(m),j} \left\{ \frac{c_{l(m),s} d_{l(m),n,s} \tilde{t}_{i,n,s}}{\phi_{l(m),s}}, \frac{c_{j,s} d_{j,n,s} \tilde{t}_{j,n,s}}{\phi_{j,s}} \right\}.$$

In equilibrium, the number of firms that set up production in Chinese province-regime $l(m)$ is

$$M_{l(m),n,s} = \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}} \times \frac{\Psi_{l,n,s}}{\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}} \times M_s, \tag{10}$$

and the number of firms that set up production in a foreign country j is

$$M_{j,n,s} = \frac{\psi_{j,n,s}}{\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}} \times M_s, \tag{11}$$

where $\psi_{l(m),n,s} = A_{l(m),s} \left(c_{l(m),s} d_{l(m),n,s} \tilde{t}_{i,n,s} \right)^{-\frac{\theta}{1-\rho}}$, $\psi_{j,n,s} = A_{j,s} \left(c_{j,s} d_{j,n,s} \tilde{t}_{j,n,s} \right)^{-\frac{\theta}{1-\gamma}}$, and $\Psi_{l,n,s} = \left[\sum_m \psi_{l(m),n,s} \right]^{\frac{1-\rho}{1-\gamma}}$. $\tilde{t}_{i,n,s}$ and $\tilde{t}_{j,n,s}$ are the tariffs levied by destination n on China's and country j's exports, respectively. Firm location and regime choices are determined by local TFP $A_{l(m),s}$, trade costs, and production costs. The structural parameters, θ, ρ, and γ, govern the elasticity of firm responses to trade or production costs.

3.3 Aggregate Trade Flows and Prices

The aggregate trade flow from $l(m)$ to n in sector s is

$$X_{l(m),n,s} = M_{l(m),n,s} \times \left[\int_{\phi*}^{+\infty} x_{l(m),n,s}(\phi) \, \mathrm{d}G_{\phi|l(m)} \right], \tag{12}$$

[21] Without fixed marketing costs, the *extensive margin* of trade is absent because every firm makes positive profits and exports to every market under monopolistic competition.

where $x_{l(m),n,s}(\phi)$ denotes the sales from $l(m)$ to n in sector s by firms with productivity level ϕ.[22] ϕ^* is the zero-profit productivity cutoff defined in equation (9), and $G_{\phi|l(m)}$ is the equilibrium productivity distribution among firms that choose $l(m)$.[23]

Equation (12) speaks to the key factors that determine China's export growth resulting from changes in $c_{l(m),s}$ or $\tilde{t}_{i,n,s}$. A reduction in $c_{l(m),s}$ would not only promote exports through the intensive and the extensive margin (Chaney, 2008), but also change the number of firms by affecting $M_{l(m),n,s}$. The aggregate trade elasticity also depends on γ and ρ, which govern firm location and regime responses to policy shocks, respectively.

Country n's expenditure share in sector s on goods produced by $l(m)$ is

$$\Pi_{l(m),n,s} = \frac{M_{l(m),n,s}\tilde{t}^{\vartheta}_{i,n,s}}{\sum_{l,m} M_{l(m),n,s}\tilde{t}^{\vartheta}_{i,n,s} + \sum_j M_{j,n,s}\tilde{t}^{\vartheta}_{j,n,s}}. \tag{14}$$

Equation (14) points out the *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. Similarly, the share of country n's expenditure in sector s that is spent on goods produced by foreign country j is

$$\Pi_{j,n,s} = \frac{M_{j,n,s}\tilde{t}^{\vartheta}_{j,n,s}}{\sum_{l,m} M_{l(m),n,s}\tilde{t}^{\vartheta}_{i,n,s} + \sum_j M_{j,n,s}\tilde{t}^{\vartheta}_{j,n,s}}. \tag{15}$$

The aggregate price index in country n and sector s is

$$P_{n,s} = \left[\Theta M_s \left(\frac{c_{n,s} f_{n,s}}{E_{n,s}}\right)^{\vartheta} \left(\sum_l \Psi_{l,n,s} + \sum_j \psi_{j,n,s}\right)^{-\gamma} \left(\left[\sum_l \Psi_{l,n,s}\right]\tilde{t}^{\vartheta}_{i,n,s} + \sum_j \psi_{j,n,s}\tilde{t}^{\vartheta}_{j,n,s}\right)\right]^{-\frac{1}{\theta}}, \tag{16}$$

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 β_s being the expenditure share on the final good produced by sector s and $\sum_s \beta_s = 1$.

Chinese Labor Markets: Chinese workers are grouped by the province of their *Hukou* reg-

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

$$x_{l(m),n,s}(\phi) = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} \left(c_{l(m),s} d_{l(m),n,s} \tilde{t}_{i,n,s}\right)^{1-\sigma} \left(\phi_{l(m),s}\right)^{\sigma-1} E_{n,s} P^{\sigma-1}_{n,s}. \tag{13}$$

[23] As we showed in an early version of this paper, the equilibrium productivity distribution $G_{\phi|l(m)}$ also follows a Pareto distribution. The proof is available upon request.

istration. We index group by g. Workers choose provinces and sectors by maximizing $\tau_{g,l,s} \times a_{g,l,s} \times V_{l,s}$. $\tau_{g,l,s}$ is the migration frictions which act as proportional adjustments to real income. In our baseline model, we assume migration frictions are group-destination-sector-specific, but consider alternative specifications in Appendix D.1.

$V_{l,s} = \frac{w_{l,s}}{P_l}$ is the real wage per efficiency unit in l and s, where P_l is the aggregate price index in province l.[24] $a_{g,l,s}$ is the idiosyncratic preferences, drawn independently across l and s from a Fréchet distribution with CDF $G(a) = \exp\big(- a_{g,l,s}^{-\kappa}\big)$. A larger κ corresponds to a smaller degree of heterogeneity in location preferences across workers.

Each worker supplies one unit of labor, and is perfectly mobile between processing and ordinary firms, $w_{l,s} = w_{l(\mathcal{P}),s} = w_{l(\mathcal{O}),s}$ within a province-sector pair. The Fréchet-distributed location preferences imply the fraction of group g workers in province l and sector s is

$$\Lambda_{g,l,s} = \frac{\tau_{g,l,s}^{\kappa} V_{l,s}^{\kappa}}{\sum_{l',s'} \tau_{g,l',s'}^{\kappa} V_{l',s'}^{\kappa}}. \tag{17}$$

Parameter κ governs the elasticity of labor supply with respect to real wages. We denote $L_{g,l,s} = L_g \Lambda_{g,l,s}$ as total efficiency units supplied 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 on input bundles,[25] and tariff revenues are rebated to local workers, the market clearing condition for final goods in Chinese provinces is:

$$E_{l(m),s} = \beta_s I_{l(m)} + \sum_k \lambda_{l(m),k}^{s} \left((1-\eta) \sum_r \frac{\Pi_{l(m),r,k} E_{r,k}}{\tilde{t}_{l(m),r,k}} + \eta \sum_r \frac{\Pi_{r,l(m),k} E_{l(m),k}}{\tilde{t}_{r,l(m),k}} \right), \tag{18}$$

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.[26] 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

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

[25] This assumption allows us to directly use input-output tables to calibrate input-output parameters $\{\lambda_{l(m),s}^{L}, \lambda_{l(m),s}^{k}\}$.

[26] 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, $E_{l(m),s} = P_{l(m),s} Q_{l(m),s}$.

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:

$$\sum_m \lambda^L_{l(m),s} \left((1-\eta) \sum_r \frac{\Pi_{l(m),r,s} E_{r,s}}{\tilde{t}_{l(m),r,s}} + \eta \sum_r \frac{\Pi_{r,l(m),s} E_{l(m),s}}{\tilde{t}_{r,l(m),s}} \right) = \sum_g w_{l,s} L_{g,l,s}. \tag{19}$$

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

In summary, given model fundamentals and parameters, the endogenous variables for Chinese provinces and sectors $\{\Pi_{l(m),n,s}, P_{l(m),s}, \Lambda_{g,l,s}, E_{l(m),s}, w_{l,s}\}$ satisfy conditions (14), (16), and (17)-(19). The equilibrium conditions for foreign countries can be obtained analogously.

4 Calibration

We calibrate our model to 29 sectors, 30 Chinese provinces, 35 foreign countries, and a constructed rest of the world. We express the equilibrium system in proportional changes (see Appendix A.4) and solve the model using the "Exact Hat Algebra" approach (Dekle, Eaton and Kortum, 2008). We match our model to the year 2005, for which we have better quality data to measure provincial imports and exports. Our counterfactual results inform what the level of China's exports in 2005 would have been if the tariffs and migration frictions had stayed at the level of 1990.[27]

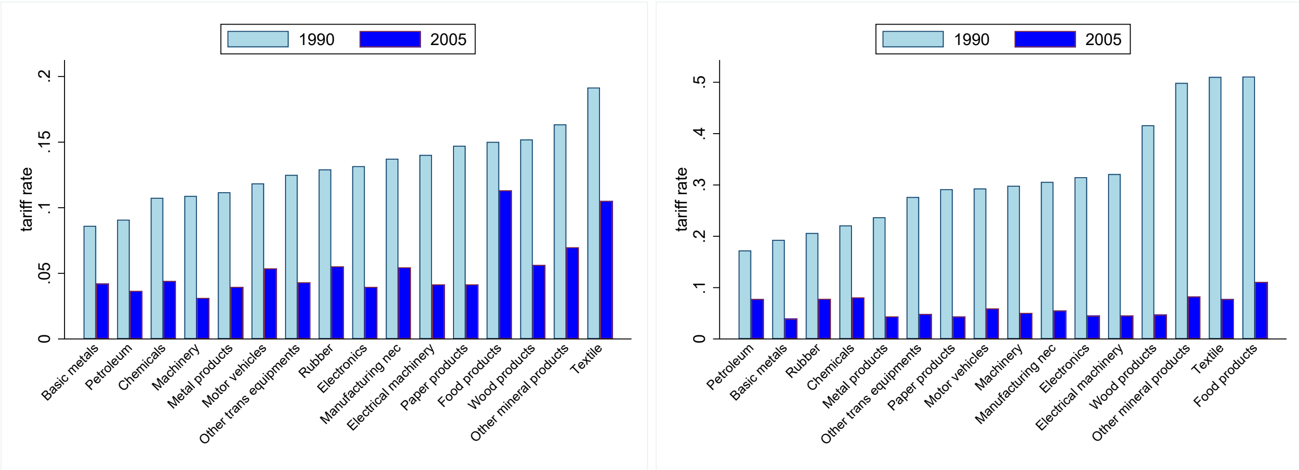
Solving the model requires data on intranational and international trade flows $\{\Pi_{l(m),n,s}\}$, firms' location choices $\{\frac{M_{l(m),s}}{M_s}\}$, inter-provincial migration rates $\{\Lambda_{g,l,s}\}$, sectoral output $\{X_{l(m),s}, X_{j,s}\}$, and labor income in both China $\{w_{l,s} L_{g,l,s}\}$ and foreign countries $\{w_n L_n\}$. We list the data sources used to construct these variables in Appendix C. The rest of the section discusses the measurement of policy shocks, the calibration of model parameters, and the model fit.

4.1 Measuring Policy Shocks

Import and Export Tariff Changes. We draw tariffs from the UNCTAD Trade Analysis and Information System (TRAINS). We use trade volume as weights to aggregate the reported tariffs of 6-digit HS products into 16 tradable sectors. As China joined the WTO and gained

[27] Some previous papers calibrate models to the initial year (e.g., Caliendo and Parro, 2015, among others), while others match the model to the final year (Adao, Costinot and Donaldson, 2017). The choice of the initial equilibrium matters for the state of the economy the counterfactual exercise is conditional on, and thus the counterfactual interpretation differs.

the Most-Favored-Nation (MFN) status, the tariff levied by foreign countries on China's exports, on average, declined from 13% to 5% between 1990 and 2005. The changes also varied across sectors (see Figure 4 [left]) and applied to both processing and ordinary firms. The decline in China's import tariffs was even more prominent, on average declining from over 30% to less than 10%, and varying systematically across sectors (see Figure 4 [right]). However, these changes only applied to ordinary firms.



(a) Export Tariffs

(b) Import Tariffs

Figure 4: China's Average Export Tariffs by Sectors (left); China's Import Tariffs by Sectors, in 1990 and 2005 (right)

Migration Cost Changes. Our baseline allows the migration cost changes to be specific to 29 sectors. Specifically, we calibrate changes in migration costs $\widehat{\tau}_{g,l,s}$ that match the observed changes in sectoral wages and migrant employment relative to home province l_g in the following equation:

$$\widehat{\tau}_{g,l,s} = \frac{\widehat{V}_{l_g,s}}{\widehat{V}_{l,s}} \left(\frac{\widehat{\Lambda}_{g,l,s}}{\widehat{\Lambda}_{g,l_g,s}} \right)^{\frac{1}{\kappa}}. \tag{20}$$

We measure $\widehat{V}_{l,s}$ as changes in province-sector-level real wages from the China Labor Statistical Yearbook. Calibrating migration costs requires a value of migration elasticity, which we set as $\kappa = 1.5$, following Tombe and Zhu (2019).

Column (1) in Table 3 reports the aggregate and provincial changes in migration costs, obtained as the migrant-population weighted average across origin provinces and all sectors. Smaller values mean a larger decline in migration costs between 1990 and 2005. Unsurprisingly, migration costs reduced more among coastal provinces relative to other provinces, and the reduction was more prominent in Guangdong and Zhejiang. It also appears that the reduction in migration costs was more substantial in the broad manufacturing sectors than in the non-manufacturing ones, as shown in Columns (2) and (3). Within the manufacturing sectors, the migration costs decreased more in sectors with higher export-output ratios (see

Appendix Figure G.1).

Table 3: Changes in Migration Frictions $\frac{\tau_{l,s,1990}}{\tau_{l,s,2005}}$

	(1) Overall	(2) Manufacturing	(3) Non-manufacturing
China	0.38	0.18	0.59
By destination:			
Guangdong	0.22	0.13	0.42
Jiangsu	0.30	0.20	0.41
Shanghai	0.50	0.33	0.61
Zhejiang	0.18	0.07	0.41
Fujian	0.22	0.10	0.39
Other provinces	0.71	0.53	0.76

Notes: The changes in migration costs by destination province are the migrant-population weighted average across origin provinces and sectors. Other provinces include all provinces other than Guangdong, Jiangsu, Shanghai, Zhejiang and Fujian.

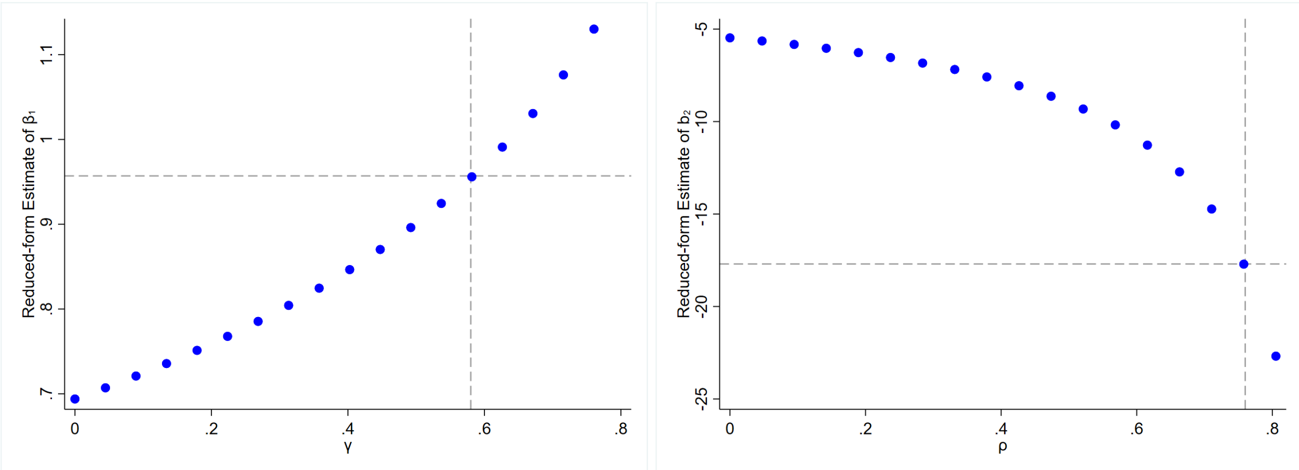
Note that the underlying assumption of our baseline calculation is that migrants' sectoral comparative advantages do not change over time, and thus, do not contribute to the observed changes in sectoral migrant employment. Appendix D.1 considers two alternative scenarios, where we measure the changes in migration costs to be (1) specific to the broad manufacturing sector, and (2) same across all sectors. In either scenario, the changes in migration costs do not exactly match the observed changes in migrant employment in the detailed 29 sectors, leaving a degree of freedom for the changes in sectoral comparative advantages to explain the observed sectoral migrant employment changes. We find the export effects of internal migration in all alternative scenarios to be fairly similar.

4.2 Using Reduced-Form Estimates to Calibrate Structural Parameters

The credibility of our quantitative results depends crucially on the values of γ and ρ. We use an indirect inference approach (Gouriéroux and Monfort, 1996) to jointly search these structural parameters by targeting the reduced-form estimates in Section 2.4. Specifically, we solve the model for $20 \times 20 = 400$ times, each time setting the parameter values of γ and ρ as the pairwise combination in $[0, 0.9] \times [0, 0.9]$, with equally sized bins for each. We use the model-generated data of $\Delta M_{l,s}$ and $\Delta M_{l(m),s}$ to re-estimate equations (2) and (4), and search parameter values of γ and ρ under which the model-generated data can replicate the reduced-form estimates of $\beta_1 = 0.957$ (Column (3) of Table 1) and $b_2 = -17.38$ (Column (3) of Table 2). We provide details on the search algorithm in Appendix F.

Figure 5 (left) plots the reduced-form estimates of β_1 using the model-generated data against the associated value of γ, and Figure 5 (right) plots the reduced-form estimates of

b_2 using the model-generated data against the associated value of ρ. We see that a higher γ corresponds to a greater response of firms' location adjustments to internal migrants. We also find that a higher ρ indicates that lower import tariffs lead to larger responses of firms' switching to the ordinary regime, which corresponds to a more negative value of b_2. Our indirect inference approach yields estimates of $\gamma = 0.58$ and $\rho = 0.76$, both of which are comparable to those in the previous literature.[28]



(a) Estimate of β_1 in in Regression (2)

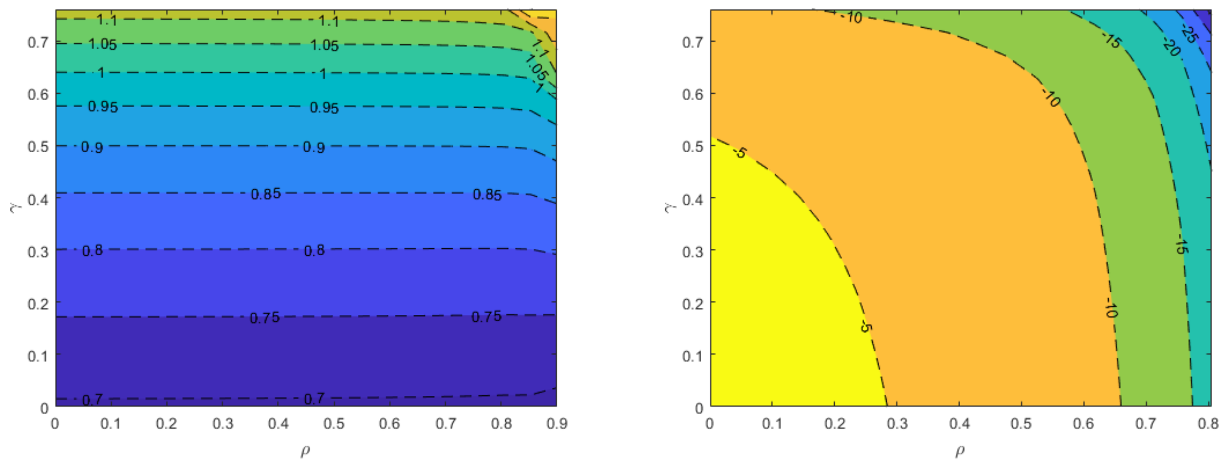
(b) Estimate of b_2 in Regression (4)

Figure 5: Reduced-form Estimates of β_1 against γ (left); Reduced-form Estimates of b_2 against ρ (right)

The left-hand figure varies γ in the counterfactual exercise with changes in migration barriers, holding all other parameters at their baseline levels. The vertical line represents the value of $\gamma = 0.58$, which matches the estimate in Column (3) of Table 1. The right-hand figure varies ρ 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 $\rho = 0.76$, which matches the estimate in Column (3) of Table 2.

To confirm that our approach indeed identifies each structural parameter from its associated firm adjustments, Figure 6 plots the structural parameters ρ and γ on the horizontal and vertical axes, respectively. Given a pair of structural parameter values ρ and γ, the value of each contour line is the reduced-form estimates of β_1 using the model-generated data (left), and the reduced-form estimates of b_2 (right). Figure 6 (left) shows that the reduced-form estimate of β_1 is only responsive to γ but not to ρ. Similarly, Figure 6 (right) shows that the reduced-form estimate of b_2 is mostly responsive to ρ but not to γ. These pieces of evidence confirm that γ is identified from the firm location response, and ρ from the firm regime switching.

[28] ARRY find the correlation of productivity draws across countries to be 0.55. Brandt et al. (2019) find the correlation of productivity draws between export regimes to be 0.71.



(a) Estimate of β_1 in Regression (2)

(b) Estimate of b_2 in Regression (4)

Figure 6: Reduced-form Estimates of β_1 (contour line) against γ (y-axis) and ρ (x-axis), Left-hand Panel; Reduced-form Estimates of b_2 (contour line) against γ (y-axis) and ρ (x-axis), Right-hand Panel

4.3 Other Parameter Values

Table 4: 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

To solve the model, we need nine additional sets of parameter values, which we summarize with their data sources in Table 4. Briefly, we calculate β_s, the share of income spent on sector s, as the ratio of total consumption on sectoral goods to the total global income. We compute sectoral value-added shares $\lambda^L_{l(m),s}$ for processing and ordinary firms by matching the 2005 China's Annual Survey of Industrial Firms (ASIF) with the 2005 Customs Database. We draw cost shares of inputs $\lambda^k_{l(m),s}$ from China's input-output tables, and rescale the 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.[29]

4.4 Model Fit

As we solve the model in changes, it is difficult to compare the model fit with the data in levels. For model validation, we compare employment responses to tariff changes between the model and the data. Specifically, we introduce changes in China's export and import tariffs between 2000 and 2005 into our model to obtain model-predicted changes in the province-sector-level employment for processing and ordinary firms. We also measure the actual province-sector-level employment changes by the processing and ordinary firms from the merged ASIF-Customs data for the same period.[30] We regress the model-generated and actual province-sector-level employment changes, respectively, on tariff changes measured as $\frac{1+t_{k,2005}}{1+t_{k,2000}}$, where $t_{k,t}$ is the tariff rate at time t for sector k.

Table 5: 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	-3.212**	-2.956***	-8.154***	-3.885***
	(1.225)	(0.193)	(2.423)	(0.548)
Obs	382	380	306	299
R-squared	0.008	0.237	0.039	0.116
Panel B: export tariff changes between 2000–2005				
export tariff changes	-6.753***	-8.677***	-11.236**	-11.785***
	(2.547)	(0.401)	(4.463)	(1.041)
Obs	382	380	306	299
R-squared	0.010	0.570	0.021	0.297

Notes: Changes in employment are defined following Davis and Haltiwanger (1992). We perform the regressions across 30 provinces and 16 manufacturing sectors. The changes in export tariffs are calculated as the average of export tariffs changes across all destinations. Standard errors are in parenthesis and clustered by province. Significance levels: 10% * 5% ** 1% ***.

Panel A of Table 5 reports the coefficients for import tariff changes, by ordinary and pro-

[29]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 $\lambda^L_{n,s} = 1 - \sum_k \lambda^k_{n,s}$.

[30]We compute firms' ordinary (processing) employment using their total employment multiplied by the share of ordinary (processing) exports in its total sales.

cessing exporters. Although all the coefficients only reflect the raw correlation between tariff and employment changes, the model and the data show great similarity in the coefficient estimates. In Panel B, we again find a relatively similar magnitude of coefficients for export tariff changes. We take these findings as suggestive evidence that our model is able to capture heterogeneity in province-sector-level employment changes.

5 Quantitative Results

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 export growth was more concentrated among coastal provinces (see Appendix Figure G.2). We begin by accounting for the observed export growth according to the changes in each of the three policies and for the residual growth unexplained by tariff and migration policies. The residual growth includes the potential spillover of tariff and migration policies, as well as other factors such as firm-level TFP growth and reductions in non-tariff trade barriers. These non-tariff barriers are captured in iceberg and fixed trade costs that potentially absorb factors such as the elimination of direct trading rights (Bai et al., 2017), the falling in trade uncertainty (Handley and Limão, 2017), and the elimination of export quotas (Khandelwal et al., 2013). We keep the tariff structure between foreign countries unchanged in counterfactual exercises.

5.1 The Effects of Individual Policy

National Export Growth. We first evaluate the export impact of each individual policy shock. We do so by applying each shock to the model individually. Panel A of Table 6 shows that the reduction in migration costs led to a 1.29 p.p. increase in the annual export growth rate, accounting for $\frac{1.29}{17.8} \approx 7.2\%$ of the overall export growth during this period. Because foreign countries differed in their sourcing patterns from China's provinces, the reduction in migration costs favored exports to the US and European countries more than to the Asian trade partners (detailed in Appendix D.4).

The reduction in import tariffs caused a 2.25 p.p. increase in the annual export growth rate and accounted for $\frac{2.25}{17.8} \approx 12.6\%$ of the overall export growth. We elaborate below that the equilibrium wage and labor adjustments both played an important role, particularly in promoting the growth of processing exports. The changes in export tariffs resulted in a 1.37 p.p. increase in the annual export growth rate and accounted for $\frac{1.37}{17.8} \approx 7.7\%$ of the overall export growth.

Table 6: The Overall Impact on China's Export Growth (in percentage points), 1990–2005

Migration Costs		**Import Tariff**		**Export Tariff**	
Panel A: Impact on the overall national exports					
1.29		2.25		1.37	
Panel B: Impact on ordinary and processing exports					
Ordinary	Processing	Ordinary	Processing	Ordinary	Processing
0.89	1.61	2.66	1.95	0.66	1.99

Each shock had differential impacts on processing and ordinary exports, as reported in Panel B. Although the share of labor value added was higher in ordinary production than in processing production (Kee and Tang, 2016), we find that the reduction in migration costs had a larger impact on processing exports than on ordinary exports at the national level, causing a 1.61 p.p. increase in annual growth for processing exports and a 0.89 p.p. for ordinary exports. This unexpected result is primarily driven by the fact that migrants' employment shares were larger in processing-oriented sectors.

Reductions in the import tariff caused a 2.66 p.p increase in annual growth for ordinary exports, which was larger than the impact on processing exports. The results are driven by the fact that the imported materials for processing exporters were duty-free and thus unaffected by these reductions in nominal tariffs. However, differing from the partial equilibrium analysis in Brandt and Morrow (2017), our general equilibrium approach also predicts a 1.95 p.p increase in annual growth of processing exports, which is a result of input-output linkages and equilibrium wage adjustments (similar to Ossa, 2014). Finally, because there were more processing producers than ordinary producers in sectors that experienced large export tariff reductions, the impacts were larger on processing exports than on ordinary ones.

Provincial Export Growth. The export growth of internal migration took place primarily among coastal provinces. Panel A of Table 7 shows that 95% of the growth was from the three provinces of Guangdong, Jiangsu and Shanghai, with Guangdong itself accounting for 68.6% of the total growth. Panel B breaks down the contributions by processing and ordinary exports. In line with the large migrant employment in processing-oriented sectors, Guangdong accounted for 77.8% of the processing export growth from the reduced migration costs, but only 48.4% for the ordinary exports. In contrast, driven by industrial composition, Jiangsu and Shanghai both contributed higher percentages to China's ordinary export growth than to processing exports.

In Section 2.3, we decomposed the effect of migration on export growth into an aggregate productivity gain and comparative advantage reinforcement. One of the several factors overlooked there was the general equilibrium wage adjustments. As reported in Appendix

Table G.1, these wage adjustments appear to be large: on average, internal migration caused the manufacturing wages to fall by 7% in Guangdong, with the largest wage decline of 11.4% from the electronic and optical equipment sector. Revisiting the decomposition in equation (1) in our equilibrium model, we find that migration cost reductions led to a 0.54 p.p. increase in China's annual output growth, accounting for $\frac{0.54}{1.29} = 42\%$ of the impact of migration cost reductions on national export growth.[31] The remaining $1 - 42\% = 58\%$ was due to the increase in the national export intensity.

The effects of tariff reductions were less concentrated among coastal provinces. On the aggregate, the three listed provinces accounted for $26\% + 15.2\% + 11.9\% = 53.1\%$ of the national export growth from import tariff reductions and $31.8\% + 20.0\% + 12.6\% = 64.4\%$ from export tariff reductions. Because export processing activities were more concentrated in Guangdong and Jiangsu, import and export tariff reductions both had larger impacts on their processing export growth than on their ordinary export growth. We find the opposite pattern for Shanghai.

Table 7: The Provincial Share in National Export Growth, 1990–2005

	Migration Costs		**Import Tariff**		**Export Tariff**	
	Panel A: Provincial Share in National Export Growth					
Guangdong	68.6%		26.0%		31.8%	
Jiangsu	6.9%		15.2%		20.0%	
Shanghai	19.9%		11.9%		12.6%	
	Panel B: Provincial Share in National Export Growth by Regime					
	Ordinary	Processing	Ordinary	Processing	Ordinary	Processing
Guangdong	48.4%	77.8%	17.0%	35.2%	14.4%	36.8%
Jiangsu	8.0%	6.5%	13.7%	16.7%	11.4%	22.5%
Shanghai	24.7%	17.7%	16.3%	7.4%	12.8%	12.6%

5.2 The Policy Spillovers

As the reductions in migration costs caused China to be more export-oriented, China could enjoy a faster export growth from opening up trade. This suggests a potential positive spillover effect of migration and trade policies. We quantify the policy spillover in this section.

[31] Here, the result is nearly half of that calculated in Section 2.4, because the calculation in section 2.4 holds the sectoral labor force of local Hukou residents unchanged.

Table 8: The Spillover of Migration and Trade Policies

The Joint Effects of Tariffs and Migration		Aggregating Individual Effects of Tariffs and Migration	
5.27		4.91	
Ordinary	Processing	Ordinary	Processing
4.22	6.21	4.21	5.55

To do so, we evaluate the joint effects of the three policies by applying the three policy changes to the model collectively. Table 8 reports a joint effect of 5.27 p.p., which accounts for $\frac{5.27}{17.8} = 30\%$ of China's export surge between 1990 and 2005. This leaves a remainder of 70% of China's export surge that is unexplainable by migration and tariff policy changes, reflecting other factors that contributed to China's export surge, such as firm-level TFP growth and reductions in non-tariff trade barriers. Interestingly, the joint effect is larger than the aggregation of individual effects, which adds up to 4.91 p.p. The latter is computed based on Table 6. The comparison indicates a positive spillover of tariff and migration policies, which contributed to a 5.27-4.91=0.36 p.p. annual export growth. This spillover effect would have been overlooked if migration and tariffs had been analyzed separately.

By analyzing the results according to processing and ordinary exports, we find that, consistent with migrants' sectoral sorting, the spillover effects of tariff and migration policies arose only for processing exports but were absent for ordinary exports. Specifically, the joint effects caused a 6.21 p.p. annual growth for processing exports, which was 6.21-5.55=0.66 p.p. larger than the aggregation of individual effects. This mechanism would have been overlooked if processing and ordinary exports had not been distinguished in the model.

5.3 The Firm and Worker Adjustments

Our model departs from ARRY by allowing labor adjustments across locations and sectors, and differs from Tombe and Zhu (2019) and Fan (2019) by allowing firm adjustments across locations and regimes. This section analyzes the impact of firm and worker adjustments on China's exports.

Table 9: The Export Effects of Firm and Labor Adjustments

Impact of Tariffs No Labor Adjustments		**Impact of Tariffs Benchmark Model**	
Panel A: The Role of Workers Adjustments			
The Aggregate Export Effects			
3.34		3.75	
Ordinary	Processing	Ordinary	Processing
3.14	3.51	3.18	4.24
The Joint Effects of Tariffs and Migration $\gamma = \rho = 0$		**The Joint Effects of Tariffs and Migration Benchmark Model**	
Panel B: The Role of Firm Adjustments			
The Aggregate Export Effects			
2.94		5.27	
Ordinary	Processing	Ordinary	Processing
2.86	3.00	4.22	6.21

First, we study what the effects of import and export tariffs would have been if workers' location and sectoral adjustments were absent. We carry out this exercise by directly applying ARRY to multiple sectors and regions in China's context with fixed labor force in each province and sector. Using this model, we find that tariff reductions caused export growth to increase by 3.34 p.p. annually, as reported in Panel A of Table 9. Using our benchmark model, however, the effect of tariffs became 3.75 p.p. and the difference reflected the role of labor adjustments in driving the overall export growth. Moreover, because migration was prominent at processing-oriented sectors, the impact of labor adjustments was substantial for processing exports but negligible for ordinary exports: the effect of tariffs on processing export growth was 21% higher with labor adjustments than without, increasing from 3.51 p.p. to 4.24 p.p..

Next, we analyze the role of firm adjustments in affecting exports. Note that our model-implied (partial) trade elasticity to trade costs is

$$\frac{\partial X_{l(m),n,s}}{\partial d_{l(m),n,s}} = \underbrace{\left(\sigma - 1\right)}_{\text{Intensive Margin}} + \underbrace{\left(\theta - \sigma + 1\right)}_{\text{Extensive Margin}} + \underbrace{\frac{\theta\gamma}{1-\gamma}\left(1 - \frac{M_{l,n,s}}{M_s}\right)\frac{M_{l(m),n,s}}{M_{l,n,s}}}_{\text{Firm-location}} + \underbrace{\frac{\theta\rho}{1-\rho}\left(1 - \frac{M_{l(m),n,s}}{M_{l,n,s}}\right)}_{\text{Export-regime}}. \tag{21}$$

The first two terms in equation (21) measure the *intensive* and *extensive margins* that follow the same formula as that of Chaney (2008). The third and the fourth terms capture the aggregate export response resulting from firm location and regime changes. As a special case when $\rho = \gamma = 0$, the number of processing and ordinary firms is fixed in each province and sector, and our model turns off firm location and regime adjustments. We then re-evaluate the joint effects of three policies in a model that sets $\rho = \gamma = 0$, and compare the effects with our benchmark results. Unsurprisingly, Panel B of Table 8 shows that the effects drop by nearly half, from 5.27 p.p. to 2.94 p.p. The effects of firm adjustments on exports appear to be stronger for processing exports, with a larger percentage drop of $\frac{6.21-3}{6.21} = 52\%$ for processing exports than the $\frac{4.22-2.86}{4.22} = 32\%$ for ordinary exports.

We conclude that firm and worker adjustments are both quantitatively important for evaluating China's export growth.

6 Conclusion

A large number of studies have examined the economic consequences of China's export surge on advanced economies: Autor, Dorn and Hanson (2013) and Pierce and Schott (2016) on the US; and Bloom, Draca and Van Reenen (2016) and Dippel, Gold, Heblich and Pinto (2022) on European countries, among others. However, the causes of China's export growth are relatively understudied. This paper builds a spatial equilibrium model to quantify how reductions in tariffs and migration costs affected Chinese exports between 1990 and 2005. The model incorporates heterogeneous firms' location and regime choices, and workers' location and sectoral choices. Using reduced-form estimates to discipline the key structural parameters, our results show that the tariff and migration policies jointly accounted for 30% of China's export growth. More importantly, we find a positive spillover of migration and trade policies, which arose entirely from processing export growth. We also find evidence suggesting the quantitative importance of firm and worker adjustments in evaluating China's export growth. Our analysis demonstrates the importance of analyzing migration and tariff policies collectively, as well as the importance of distinguishing processing and ordinary exports in China's context.

China has experienced a spectacular economic growth over the past three decades. The policy spillover in China's context suggests that internal market integration can potentially prepare a country to better enjoy the economic gain from globalization, offering a lesson for developing countries.

References

Adao, R., Costinot, A. and Donaldson, D. (2017), 'Nonparametric counterfactual predictions in neoclassical models of international trade', *American Economic Review* **107**(3), 633–89.

Adao, R., Kolesár, M. and Morales, E. (2019), 'Shift-share designs: Theory and inference', *The Quarterly Journal of Economics* **134**(4), 1949–2010.

Allen, T. and Arkolakis, C. (2014), 'Trade and the topography of the spatial economy', *The Quarterly Journal of Economics* **129**(3), 1085–1140.

Allen, T. and Arkolakis, C. (2015), 'Elements of advanced international trade', *Class Notes for Graduate Trade Courses* .

Allen, T., Arkolakis, C. and Takahashi, Y. (2029), 'Universal gravity', *Journal of Political Economy* **128**(2), 393–433.

Arkolakis, C., Ramondo, N., Rodríguez-Clare, A. and Yeaple, S. (2018), 'Innovation and production in the global economy', *American Economic Review* **108**(8), 2128–73.

Arkolakis, C., Rodríguez-Clare, A. and Su, J.-H. (2016), 'A multivariate distribution with pareto tails', *Working Paper* .

Autor, D. H., Dorn, D. and Hanson, G. H. (2013), 'The china syndrome: Local labor market effects of import competition in the united states', *American Economic Review* **103**(6), 2121–68.

Autor, D. H., Dorn, D. and Hanson, G. H. (2016), 'The china shock: Learning from labor-market adjustment to large changes in trade', *Annual Review of Economics* **8**, 205–40.

Autor, D. H., Dorn, D., Hanson, G. H. and Song, J. (2014), 'Trade adjustment: Worker-level evidence', *The Quarterly Journal of Economics* **129**(4), 1799–1860.

Bai, X., Krishna, K. and Ma, H. (2017), 'How you export matters: Export mode, learning and productivity in china', *Journal of International Economics* **104**, 122–37.

Bloom, N., Draca, M. and Van Reenen, J. (2016), 'Trade induced technical change? the impact of chinese imports on innovation, it and productivity', *The Review of Economic Studies* **83**(1), 87–117.

Borjas, G. J. (2003), 'The labor demand curve is downward sloping: Reexamining the impact of immigration on the labor market', *The Quarterly Journal of Economics* **118**(4), 1335–74.

Borjas, G. J., Freeman, R. B. and Katz, L. F. (1997), 'How much do immigration and trade affect labor market outcomes?', *Brookings Papers on Economic Activity* **1997**(1), 1–90.

Borusyak, K., Hull, P. and Jaravel, X. (2022), 'Quasi-experimental shift-share research designs', *The Review of Economic Studies* **89**(1), 181–213.

Brandt, L., Li, B. and Morrow, P. M. (2019), 'Is processing good?: Theory and evidence from china', *Working Paper* .

Brandt, L. and Lim, K. (2019), 'Accounting for Chinese Exports', *Working Paper* .

Brandt, L. and Morrow, P. M. (2017), ‘Tariffs and the organization of trade in china’, *Journal of International Economics* **104**, 85–103.

Brandt, L., Van Biesebroeck, J., Wang, L. and Zhang, Y. (2017), ‘Wto accession and performance of chinese manufacturing firms’, *American Economic Review* **107**(9), 2784–2820.

Brandt, L., Van Biesebroeck, J. and Zhang, Y. (2012), ‘Creative accounting or creative destruction? firm-level productivity growth in chinese manufacturing’, *Journal of Development Economics* **97**(2), 339–51.

Bryan, G. and Morten, M. (2019), ‘The aggregate productivity effects of internal migration: Evidence from indonesia’, *Journal of Political Economy* **127**(5), 2229–68.

Burstein, A., Morales, E. and Vogel, J. (2015), ‘Accounting for changes in between-group inequality’, *NBER Working Paper No. 20855* .

Caliendo, L. and Parro, F. (2015), ‘Estimates of the trade and welfare effects of nafta’, *The Review of Economic Studies* **82**(1), 1–44.

Card, D. (2001), ‘Immigrant inflows, native outflows, and the local labor market impacts of higher immigration’, *Journal of Labor Economics* **19**(1), 22–64.

Chaney, T. (2008), ‘Distorted gravity: the intensive and extensive margins of international trade’, *American Economic Review* **98**(4), 1707–21.

Chen, Y., Jin, G. Z. and Yue, Y. (2010), ‘Peer migration in china’, *NBER Working Paper No. 15671* .

Combes, P.-P. and Gobillon, L. (2015), ‘The empirics of agglomeration economies’, *Handbook of Regional and Urban Economics* **5**, 247–348.

Cosar, A. K. and Fajgelbaum, P. D. (2016), ‘Internal geography, international trade, and regional specialization’, *American Economic Journal: Microeconomics* **8**(1), 252–88.

Costinot, A., Donaldson, D. and Komunjer, I. (2011), ‘What goods do countries trade? a quantitative exploration of ricardo’s ideas’, *The Review of Economic Studies* **79**(2), 581–608.

Costinot, A. and Rodríguez-Clare, A. (2014), ‘Trade theory with numbers: Quantifying the consequences of globalization’, *Handbook of International Economics* **4**, 197–261.

Dai, M., Maitra, M. and Yu, M. (2016), ‘Unexceptional exporter performance in china? the role of processing trade’, *Journal of Development Economics* **121**, 177–89.

Davis, S. J. and Haltiwanger, J. (1992), ‘Gross job creation, gross job destruction, and employment reallocation’, *The Quarterly Journal of Economics* **107**(3), 819–63.

Dean, J. M. and Lovely, M. E. (2010), *China’s Growing Role in World Trade*, NBER and University of Chicago Press, Chicago.

Defever, F. and Riaño, A. (2017), ‘Subsidies with export share requirements in china’, *Journal of Development Economics* **126**, 33–51.

Dekle, R., Eaton, J. and Kortum, S. (2008), ‘Global rebalancing with gravity: Measuring the burden of adjustment’, *IMF Staff Papers* **55**(3), 511–40.

Di Giovanni, J., Levchenko, A. A. and Zhang, J. (2014), 'The global welfare impact of china: trade integration and technological change', *American Economic Journal: Macroeconomics* **6**(3), 153–83.

Dippel, C., Gold, R., Heblich, S. and Pinto, R. (2022), 'The effect of trade on workers and voters', *The Economic Journal* **132**(641), 199–217.

Eaton, J. and Kortum, S. (2002), 'Technology, geography, and trade', *Econometrica* **70**(5), 1741–79.

Ethier, W. J. (1982), 'Decreasing costs in international trade and frank graham's argument for protection', *Econometrica* **50**(5), 1243–68.

Fajgelbaum, P. D., Morales, E., Suárez Serrato, J. C. and Zidar, O. M. (2018), 'State taxes and spatial misallocation', *The Review of Economic Studies* **86**(1), 333–76.

Fan, J. (2019), 'Internal geography, labor mobility, and the distributional impacts of trade', *American Economic Journal: Macroeconomics* **11**(3), 252–88.

Feenstra, R. C. and Hanson, G. H. (2005), 'Ownership and control in outsourcing to china: Estimating the property-rights theory of the firm', *The Quarterly Journal of Economics* **120**(2), 729–61.

Feenstra, R. and Wei, S. (2010), *Introduction to "China's Growing Role in World Trade"*, NBER and University of Chicago Press, Chicago.

Galle, S., Rodriguez-Clare, A. and Yi, M. (2017), 'Slicing the pie: Quantifying the aggregate and distributional effects of trade', *NBER Working Paper No. 23737* .

Gouriéroux, C. and Monfort, A. (1996), *Simulated-based Econometric Methods*, Oxford University Press.

Handley, K. and Limão, N. (2017), 'Policy uncertainty, trade and welfare: theory and evidence for china and the us', *American Economic Review* **107**(9), 2731–83.

Hao, T., Sun, R., Tombe, T. and Zhu, X. (2020), 'The effect of migration policy on growth, structural change, and regional inequality in china', *Journal of Monetary Economics* **113**, 112–34.

Head, K. and Mayer, T. (2014), 'Gravity equations: Workhorse, toolkit, and cookbook', *Handbook of International Economics* **4**, 131–95.

Head, K. and Ries, J. (2001), 'Increasing returns versus national product differentiation as an explanation for the pattern of US-Canada trade', *American Economic Review* **91**(4), 858–76.

Hsieh, C.-T., Hurst, E., Jones, C. I. and Klenow, P. J. (2019), 'The allocation of talent and us economic growth', *Econometrica* **87**(5), 1439–74.

Hsieh, C.-T. and Ossa, R. (2016), 'A global view of productivity growth in china', *Journal of International Economics* **102**, 209–24.

Kee, H. L. and Tang, H. (2016), 'Domestic value added in exports: Theory and firm evidence from china', *American Economic Review* **106**(6), 1402–36.

Khandelwal, A. K., Schott, P. K. and Wei, S.-J. (2013), 'Trade liberalization and embedded institutional reform: evidence from chinese exporters', *American Economic Review* **103**(6), 2169–95.

Kinnan, C., Wang, S.-Y. and Wang, Y. (2018), 'Access to migration for rural households', *American Economic Journal: Applied Economics* **10**(4), 79–119.

Krugman, P. (1980), 'Scale economies, product differentiation, and the pattern of trade', *American Economic Review* **70**(5), 950–59.

Lagakos, D. and Waugh, M. E. (2013), 'Selection, agriculture, and cross-country productivity differences', *American Economic Review* **103**(2), 948–80.

Liu, W., Chen, J., Tang, Z., Liu, H., Han, D. and Li, F. (2012), *China's Multi-regional Input-output Table of 30 Provinces, Autonomous Regions and Municipalities in 2007*, China Statistics Press.

Luxembourg Income Study Database (LIS), www.lisdatacenter.org (multiple countries) (n.d.).

Ma, L. and Tang, Y. (2020), 'Geography, trade, and internal migration in china', *Journal of Urban Economics* **115**.

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

Olney, W. W. (2013), 'Immigration and firm expansion', *Journal of Regional Science* **53**(1), 142–57.

Ossa, R. (2014), 'Trade wars and trade talks with data', *American Economic Review* **104**(12), 4104–46.

Pierce, J. R. and Schott, P. K. (2016), 'The surprisingly swift decline of us manufacturing employment', *American Economic Review* **106**(7), 1632–62.

Redding, S. J. and Rossi-Hansberg, E. A. (2017), 'Quantitative spatial economics', *Annual Review of Economics* **9**, 21–58.

Simonovska, I. and Waugh, M. E. (2014), 'The elasticity of trade: Estimates and evidence', *Journal of International Economics* **92**(1), 34–50.

Spearot, A. (2016), 'Unpacking the long-run effects of tariff shocks: New structural implications from firm heterogeneity models', *American Economic Journal: Microeconomics* **8**(2), 128–67.

Suárez Serrato, J. C. and Zidar, O. (2016), 'Who benefits from state corporate tax cuts? a local labor markets approach with heterogeneous firms', *American Economic Review* **106**(9), 2582–2624.

Tian, Y. (2019), 'International trade liberalization and domestic institutional reform', *Working Paper* .

Tombe, T. and Zhu, X. (2019), 'Trade, migration and productivity: A quantitative analysis of china', *American Economic Review* **109**(5), 1843–72.

Yang, D. L. (2005), 'China's Looming Labor Shortage', *Far Eastern Economic Review* **168**(2), 19–24.

Yu, M. (2015), 'Processing trade, tariff reductions and firm productivity: evidence from chinese firms', *The Economic Journal* **125**(585), 943–88.

Zi, Y. (2020), 'Trade liberalization and the great labor reallocation', *Working Paper* .

Online Appendix

A Derivation

A.1 Firm Location and Regime Choices

The proof follows ARRY closely, while the only difference is that we allow the productivity correlation across regimes (ρ) to differ from the productivity correlation across locations (γ). To ease the argument, we define the following two random variables Y and Z as follows:

$$Y = \arg\max_{l(m),j} \left\{ \vec{\widetilde{\phi}}_{l(m),n,s}, \vec{\widetilde{\phi}}_{j,n,s} \right\},$$

where Y is a discrete random variable denoting firms' location and regime choices. $\widetilde{\phi}_{l(m),n,s} = \frac{\phi_{l(m),s}}{c_{l(m),s} d_{l(m),n,s} \tilde{t}_{i,n,s}}$ and $\widetilde{\phi}_{j,n,s} = \frac{\phi_{j,n,s}}{c_{j,s} d_{j,n,s} \tilde{t}_{j,n,s}}$.

We omit subscript n and s, but are aware that Y is destination- and sector-specific.

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

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

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

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

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

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

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

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

$$P\Big(Y=l(m)|Z=z\Big)=\frac{P\Big(Y=l(m)\ \&\ Z=z\Big)}{P\Big(Z=z\Big)}=\frac{\psi_{l(m),n,s}}{\sum_m\psi_{l(m),n,s}}\times\frac{\Psi_{l,n,s}}{\sum_l\Psi_{l,n,s}+\sum_j\psi_{j,n,s}}. \tag{23}$$

Note that $P(Y=l(m)|Z=z)$ is not a function of z, which means that $P(Y=l(m)|Z=z)=P(Y=l(m))$. We have

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

A.2 Aggregate Price and Trade Shares

Again, let $\widetilde{\phi}_{l(m),n,s}=\frac{\phi_{l(m),s}}{c_{l(m),s}d_{l(m),n,s}\tilde{t}_{i,n,s}}$ and $\widetilde{\phi}_{j,n,s}=\frac{\phi_{j,n,s}}{c_{j,s}d_{j,n,s}\tilde{t}_{j,n,s}}$. With subscripts n and s dropped for most variables to simplify the notation, the trade flows from $l(m)$ to n can be written as:

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

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 $M_{l(m),n,s}$ as in equation (10), $x_{l(m),n,s}(\widetilde{\phi})$ as in equation (13), and $P\Big(Z=\widetilde{\phi}\mid Y=\{l,m\}\Big)$ as in equation (23). Analogously, one can derive the trade flows from country j to n as

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

We can obtain the aggregate price index as

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

$\iff$

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

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

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

The price index is

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

where $\Theta=\sigma^{\frac{\sigma-\theta-1}{\sigma-1}}\Big(\frac{\theta}{\theta-\sigma+1}\Big)\Big(\frac{\sigma}{\sigma-1}\Big)^{-\theta}$, and $\vartheta=\frac{\sigma-1-\theta}{\sigma-1}$. Using the aggregate price just obtained, we express trade shares as the following

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

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.3 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 $x_{g,l,s} \geqslant \frac{\tau_{g,l',s'}x_{g,l',s'}V_{l',s'}}{\tau_{g,l,s}V_{l,s}}$. 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.4 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

$$
\widehat{\Pi}_{r,n,s} = \frac{\widehat{M}_{r,n,s}\widehat{\tilde{t}}^{\vartheta}_{r,n,s}}{\sum_{r'} \widehat{M}_{r',n,s}\widehat{\tilde{t}}^{\vartheta}_{r',n,s}\Pi_{r',n,s}}. \tag{24}
$$

When r refers to a province-regime combination in China, then

$$
\frac{\widehat{M}_{l(m),n,s}}{\widehat{M}_{l,n,s}} = \frac{\widehat{\psi}_{l(m),n,s}}{\sum_m \widehat{\psi}_{l(m),n,s}\frac{M_{l(m),n,s}}{M_{l,n,s}}}, \qquad \widehat{M}_{l,n,s} = \frac{\widehat{\Psi}_{l,n,s}}{\sum_l \widehat{\Psi}_{l,n,s}\frac{M_{l,n,s}}{M_s} + \sum_j \widehat{\psi}_{j,n,s}\frac{M_{j,n,s}}{M_s}}.
$$

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

$$\widehat{M}_{j,n,s} = \frac{\widehat{\psi}_{j,n,s}}{\sum_l \widehat{\Psi}_{l,n,s} \frac{M_{l,n,s}}{M_s} + \sum_j \widehat{\psi}_{j,n,s} \frac{M_{j,n,s}}{M_s}},$$

where $\widehat{\psi}_{l(m),n,s} = \widehat{A}_{l(m),s} \left(\widehat{c}_{l(m),s} \widehat{d}_{l(m),n,s} \widehat{\tilde{t}}_{i,n,s} \right)^{-\frac{\theta}{1-\rho}}$, $\widehat{\psi}_{j,n,s} = \widehat{A}_{j,s} \left(\widehat{c}_{j,s} \widehat{d}_{j,n,s} \widehat{\tilde{t}}_{j,n,s} \right)^{-\frac{\theta}{1-\gamma}}$, and $\widehat{\Psi}_{l,n,s} = \left[\sum_m \widehat{\psi}_{l(m),n,s} \frac{M_{l(m),n,s}}{M_{l,n,s}} \right]^{\frac{1-\rho}{1-\gamma}}$.[32]

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

$$\widehat{P}_{n,s} = \left[\left(\frac{\widehat{c}_{n,s} \widehat{f}_{n,s}}{\widehat{E}_{n,s}} \right)^{\vartheta} \frac{\left[\sum_l \widehat{\Psi}_{l,n,s} \frac{M_{l,n,s}}{\sum_l M_{l,n,s}} \right] \widehat{\tilde{t}}^{\vartheta}_{i,n,s} \Pi_{i,n,s} + \sum_j \widehat{\psi}_{j,n,s} \widehat{\tilde{t}}^{\vartheta}_{j,n,s} \Pi_{j,n,s}}{\left(\sum_l \widehat{\Psi}_{l,n,s} \frac{M_{l,n,s}}{M_s} + \sum_j \widehat{\psi}_{j,n,s} \frac{M_{j,n,s}}{M_s} \right)^{\gamma}} \right]^{-\frac{1}{\vartheta}}. \tag{25}$$

The proportional changes of migration flows are

$$\widehat{\Lambda}_{g,l,s} = \frac{\widehat{\tau}^{\kappa}_{g,l,s} \widehat{V}^{\kappa}_{l,s}}{\sum_{l',s'} \widehat{\tau}^{\kappa}_{g,l',s'} \widehat{V}^{\kappa}_{l',s'} \Lambda_{g,l',s'}}. \tag{26}$$

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

$$E_{r,s} \widehat{E}_{r,s} = \beta_s I_r \widehat{I}_r + \sum_k \lambda^s_{r,k} \left((1-\eta) \sum_u \frac{\Pi_{r,u,k} E_{u,k} \widehat{\Pi}_{r,u,k} \widehat{E}_{u,k}}{\tilde{t}_{r,u,k} \widehat{\tilde{t}}_{r,u,k}} + \eta \sum_u \frac{\Pi_{u,r,k} E_{r,k} \widehat{\Pi}_{u,r,k} \widehat{E}_{r,k}}{\tilde{t}_{u,r,k} \widehat{\tilde{t}}_{u,r,k}} \right), \tag{27}$$

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:

$$\begin{aligned} &\sum_m \lambda^L_{l(m),s} \left((1-\eta) \sum_u \frac{\Pi_{l(m),u,s} E_{u,s} \widehat{\Pi}_{l(m),u,s} \widehat{E}_{u,s}}{\tilde{t}_{l(m),u,s} \widehat{\tilde{t}}_{l(m),u,s}} + \eta \sum_u \frac{\Pi_{u,l(m),s} E_{l(m),s} \widehat{\Pi}_{u,l(m),s} \widehat{E}_{l(m),s}}{\tilde{t}_{u,l(m),s} \widehat{\tilde{t}}_{u,l(m),s}} \right) \\ &= \sum_g w_{l,s} \widehat{w}_{l,s} L_{g,l,s} \widehat{L}_{g,l,s} \end{aligned} \tag{28}$$

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

$$\sum_s \lambda^L_{n,s} \left((1-\eta) \sum_u \frac{\Pi_{n,u,s} E_{u,s} \widehat{\Pi}_{n,u,s} \widehat{E}_{u,s}}{\tilde{t}_{n,u,s} \widehat{\tilde{t}}_{n,u,s}} + \eta \sum_u \frac{\Pi_{u,n,s} E_{n,s} \widehat{\Pi}_{u,n,s} \widehat{E}_{n,s}}{\tilde{t}_{u,n,s} \widehat{\tilde{t}}_{u,n,s}} \right) = w_n \widehat{w}_n L_n \widehat{L}_n. \tag{29}$$

[32]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 $L_{l(m),s}$.

B Additional Evidence on Internal Migrants

B.1 The Sector Sorting of Internal Migration

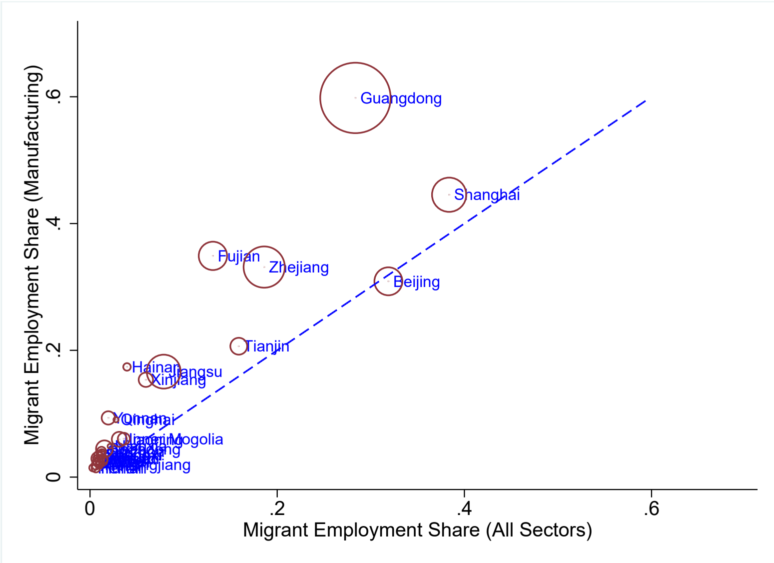
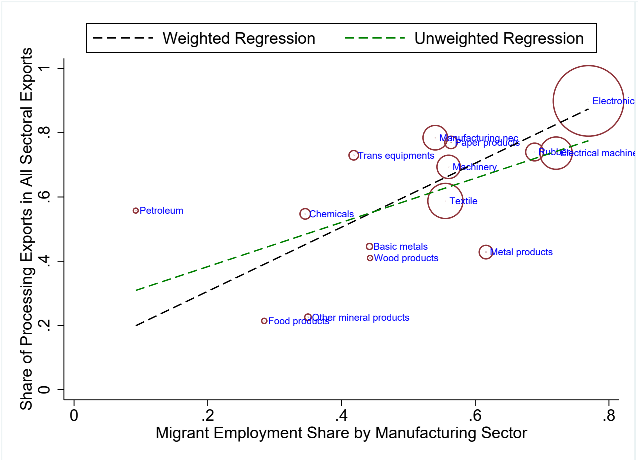


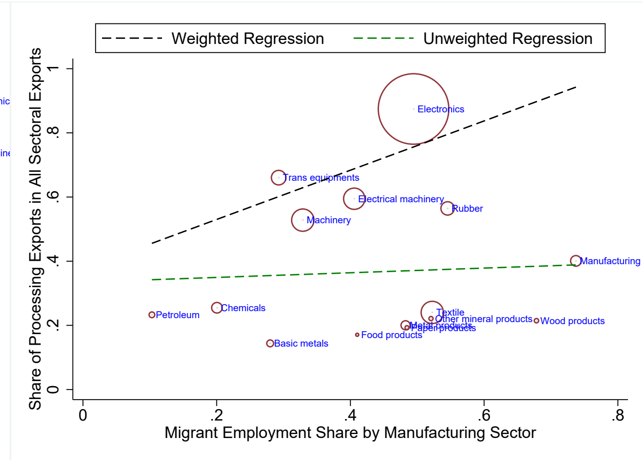
Figure B.1: Manufacturing vs. Overall Migrant Shares of Employment. The circle size is based on the number of migrants each province received.

Internal migration is over-represented in the broad manufacturing sector in destination provinces, confirming that migration expanded employment more in manufacturing sectors. Figure B.1 plots the migrant share of provincial overall employment against the migrant share of provincial manufacturing employment, with an auxiliary 45-degree line (blue dashed line). We see that most provinces lie above the 45-degree line.

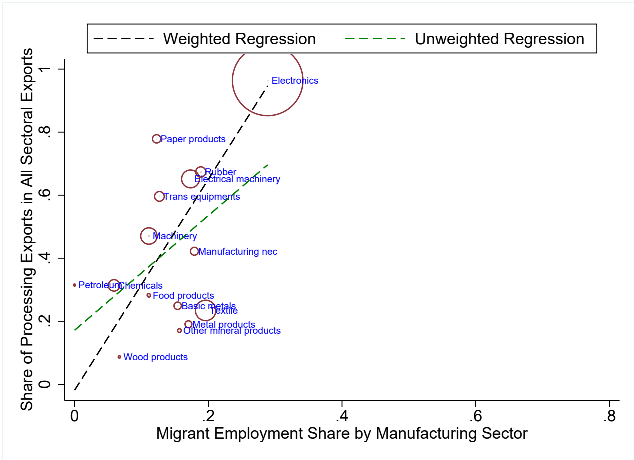
Figure B.2 plots the processing export shares against migrant employment shares across manufacturing sectors separately by the four coastal provinces. We find a strong positive correlation in Guangdong province. There are also positive correlations in Zhejiang and Jiangsu provinces, despite their migrant employment shares being smaller than Guangdong's. The positive correlation holds for Shanghai when weighting industries by export volumes.



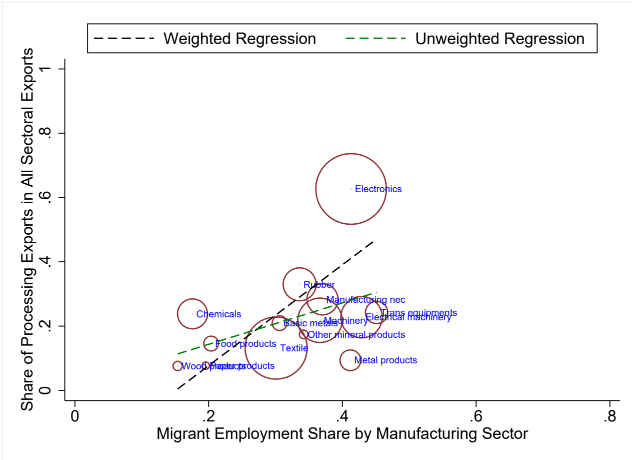
(a) Guangdong



(b) Shanghai



(c) Jiangsu



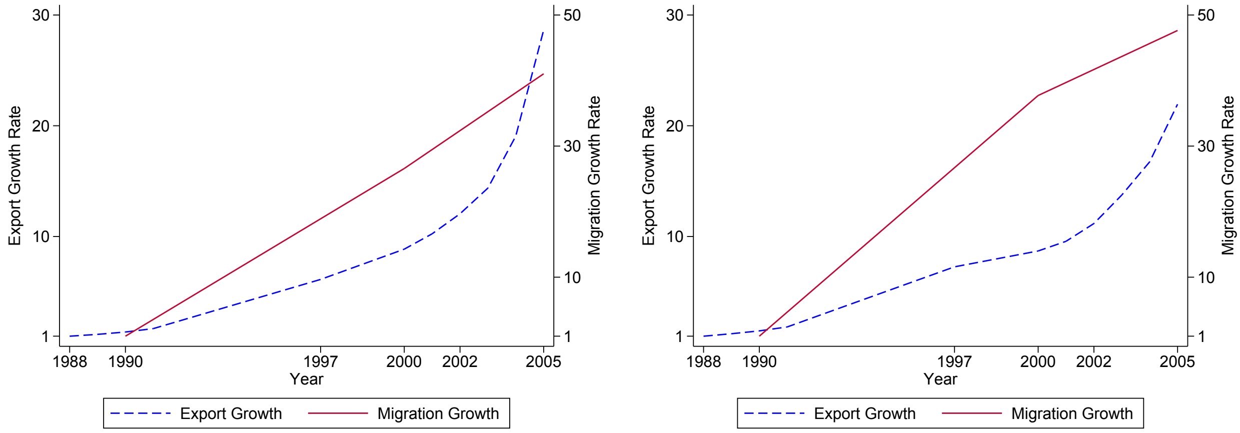
(d) Zhejiang

Figure B.2: Provincial and Sectoral Migrant Employment Share vs. Share of Processing Exports. The black dashed line is the linear fit weighted by province-sector-level processing export volumes (reflected by the circle size).

B.2 The Timing of Migration and Trade

We compare the timing of the migration and trade surges. Our migration data have three time points drawn from China's Population Survey (1990, 2000, and 2005). Our export data are based on China's Customs Transactions Database in the years 1988-1991, 1997, 2000, and 2005. Figure B.3 (left) is for five coastal provinces, namely Guangdong, Shanghai, Fujian, Zhejiang, and Jiangsu, and Figure B.3 (right) 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.

Among the coastal provinces considered in Figure B.3 (left), manufacturing migrant employment grew steadily in both the period of 1990–2000 and the period of 2000–2005. Figure B.3 (right) shows that in Guangdong Province, the steep rise in migrant employment of the manufacturing sector took place prior to 2000, and migrant employment grew relatively slowly after 2000. The time-series evidence of migration and export growth suggests that migration to the coastal provinces started prior to the surge in Chinese exports to the global market. The trend suggests internal migrants promoted industrial agglomeration in the coastal provinces.



(a) Five Coastal Provinces

(b) Guangdong

Figure B.3: Growth in Exports and Manufacturing Migrant Employment for Coastal Provinces, 1990–2005

C Data Appendix

Provincial Gross Output by Sectors and Regimes. Since processing output 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 measure province-sector-level 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 2007. The difference between gross output and the overall processing exports (which also equal processing output) reflects the gross output in ordinary production.[33]

Inter-provincial Trade Flows by Sectors and Regimes. Again, since processing output 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 using data from input-output tables, processing exports, and processing imports. The remaining domestic sales are 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. This assumption allows us to construct trade flows between province-regime-sectors. 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 results have been collected every five years. We use China's input-output table for the year 2007, which is the closest available year to 2005. We deflate these trade flows and output to the year 2005 using the growth rate of China's sectoral output between 2005 to 2007. China's input-output table reports industries using the 2-digit China's Industrial Classification for National Economic Activities (CSIC, Rev. 2002), and contains 42 industries. We discuss the crosswalk of the CSIC industries to our 29 industries below.

[33] China's regional input-output tables in 2007 are obtained from Liu et al. (2012). We match the 2-digit CSIC used in China's regional input-output tables with the 2-digit ISIC code, using the concordance in Dean and Lovely (2010).

Trade Flows Between Foreign Countries. We measure the bilateral trade flows between foreign countries using the STAN Bilateral Trade Database and measure the sectoral gross output of each foreign country using the OECD Input-Output Database. We also measure imports from the rest of the world by subtracting the imports from each country in our consideration from the total import volume from the world.[34]

Measuring the Location Choice Probability of Firms. For the distribution of firms, we first use equilibrium conditions (10) and (11) to pin down the relative probability between any two locations (including any foreign country and China's provinces). Second, we divide the provincial firms into processing and ordinary regimes using equilibrium conditions which imply that the provincial share of firms in each regime equals the share of exports. Combining equations (10) and (11), we have

$$\frac{M_{l,n,s}}{M_{j,n,s}} = \frac{\left[\sum_m \Pi_{l(m),n,s}\right]\tilde{t}_{i,n,s}^{-\vartheta}}{\Pi_{j,n,s}\tilde{t}_{j,n,s}^{-\vartheta}}, \tag{30}$$

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

$$\sum_l M_{l,n,s} + \sum_j M_{j,n,s} = M_s. \tag{31}$$

We solve $M_{l,n,s}$ and $M_{j,n,s}$ for all l and j from the system of equations (30) and (31). Finally, we obtain the share of provincial firms in each regime m, which is equal to the share of exports, from the following equation:

$$\frac{M_{l(m),n,s}}{M_{l,n,s}} = \frac{\Pi_{l(m),u,s}}{\sum_m \Pi_{l(m),u,s}}.$$

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 different from that of their *Hukou* registration. The set of migrant population we measure reflects the effect of China's *Hukou* reform on the "floating population".[35] Since the variable for 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.[36] 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. We measure the shares of sectoral employment, $\{\Lambda_{g,i,s}\}$, and sectoral average wages, $\{w_{g,i,s}\}$, using data from the 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 specified (tradable) manufacturing sectors by using proportions of countries'

[34]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.

[35]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.

[36]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.

sectoral output. Details of the data sources used for foreign countries are provided in the table below.

Table C.1: Data Sources to Measure Foreign Labor Markets

Data Source	Sectoral Wages	Sectoral Employment Shares
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 (OWW)	Thailand, Turkey, Vietnam	

Linking China's Annual Survey of Industrial Firms with China's Customs Transactions Database. China's Customs Transactions Database provides information on whether a firm is engaged in exporting processing activities. Following Yu (2015) and Dai et al. (2016), we link these two datasets based on variables including firm name, telephone number, and zip code. Overall, the match between the two databases is good; in 2005, around 70% the of manufacturing exports reported in the Annual Survey of Industrial Firms could be matched with the customs data. 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.

Industrial Aggregation and Crosswalks. China's Customs Transactions Database reports product types using the 8-digit Harmonized System (HS) classification, China's input-output table reports industries using the 2-digit CSIC for 42 industries, and China's Population Census uses the CSIC for 96 industries. In addition, we extract the bilateral trade flows between foreign countries using the STAN Bilateral Trade Database and draw tariff data from the TRAINS data. The former uses ISIC industry codes, whereas the latter uses the 6-digit HS product codes. The OECD database provides input-output tables for 64 countries for the years 1995, 2000, and 2005, and contains information for 34 ISIC Rev 3 industries.

Table C.2: 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

Our strategy is to map the HS codes or CSIC industry codes to the 2-digit ISIC code, and thereafter, group the 2-digit ISIC code to our 29 industry aggregations as shown in Table C.2. Specifically, we map the 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.[37] The 4-digit ISIC code has 292 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-digit ISIC code. The mapping of the CSIC code to the 2-digit ISIC code follows the concordance in Dean and Lovely (2010).

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

D Additional Quantitative Results

We present quantitative evidence using alternative models or calibration strategies.

D.1 Quantitative Results with Alternative Migration Costs

Our baseline results compute $\widehat{\tau}_{g,l,s}$ specific to 30 provinces and 29 sectors. In this case, $\widehat{\tau}_{g,l,s}$ matches the observed changes in the sectoral migrant employment and wages. Comparative advantages play no role in shaping the sectoral employment changes.

Here, we present quantitative results with two alternative ways of computing $\widehat{\tau}_{g,l,s}$. In the first case, we compute $\widehat{\tau}_{g,l,s}$ using equation (20), but aggregate the 16 manufacturing sectors into one broad manufacturing sector. Here, the migration costs match the changes in migrants' employment shares and wages at the broad manufacturing sector exactly. In the second case, we compute origin-destination-specific changes in the migration costs, constant across all tradable and non-tradable sectors. Here, the migration costs match exactly the aggregate migrant employment and wage changes. In either case, because the changes in migration costs do not match exactly the observed employment and wage changes of the detailed 29 sectors exactly, this leaves a degree of freedom for the changes in comparative advantages to play a role.

Table D.1: Annual Export Growth (1990–2005) under Different Migration Cost Calibration

Migration Costs	(Baseline) 16 Manufacturing + 13 Non-tradable Sectors	One Manufacturing Sector + 13 Non-tradable Sectors	One Sector
(1) Overall Export Growth	1.29	1.23	1.09
(2) Ordinary Export Growth	0.89	1.02	0.97
(3) Processing Export Growth	1.61	1.41	1.18

Row (1) of Table D.1 compares the impact on export growth for the three scenarios listed. Rows (2) and (3) compare the impact on ordinary and processing export growth, respectively. These three scenarios only differ by how we compute the changes in migration costs; we measure trade flows by 29 disaggregate sectors in all models. In the two alternative scenarios of computing migration cost changes mentioned in the previous paragraph, we observe that the effects of migration on the overall export growth are sizable and similar to our baseline results. Although we find that the effects vary to a lesser degree across processing and ordinary exports, the impacts by regimes remain comparable to our benchmark result. We take this phenomenon as evidence that it is the observed massive internal migration that drives the large export impact, rather than our model choice of calibrating $\widehat{\tau}_{g,l,s}$.

D.2 A Model with Firm Entry

We now compare our baseline results with that predicted by an alternative model with firm entry. We model firm entry similarly to Krugman (1980) and Melitz (2003) and extend it with export regime choice. Specifically, we assume that in region r and sector s, entrepreneurs can hire $f^e_{r,s}$ units of labor to create a firm. Firms will produce in the location where they are created. For a firm in Chinese province l to serve destination n, the firm first draws the productivity levels under two export regimes, then chooses the export regime with the lowest unit cost of export, and finally, will only export if the profit is positive after paying marketing costs.

Our settings of productivity distributions at the level of the region are 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:

$$F\left(\vec{\phi}_{l(m),s}\right) = 1 - \left(\sum_m A_{l(m),s}\phi_{l(m),s}^{-\frac{\theta}{1-\rho}}\right)^{1-\rho}. \tag{32}$$

For destination n, the firm will first choose regime m which minimizes the unit cost of export $\min_m \frac{c_{l(m),s}d_{l(m),n,s}\tilde{t}_{i,n,s}}{\phi_{l(m),s}}$. The firm will then decide whether or not to export, depending on whether the profit is positive after paying the marketing costs $c_{n,s}f_{n,s}$. We exclude the export regime choices from our considerations for foreign firms, similar to the baseline model. The foreign firm's productivity is Pareto-distributed as $F\left(\phi_{j,s}\right) = 1 - A_{j,s}\phi_{j,s}^{-\theta}$, and a foreign firm will export to destination n if the profit is positive after paying $c_{n,s}f_{n,s}$. With these changes, and following a procedure similar to that presented in Section 3.2, the share of destination n's expenditure on goods produced by province l and regime m becomes:

$$\Pi_{l(m),n,s} = \frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}} \times \frac{M_{l,s}\Psi_{l,n,s}\tilde{t}_{i,n,s}^{\vartheta}}{\left[\sum_l M_{l,s}\Psi_{l,n,s}\right]\tilde{t}_{i,n,s}^{\vartheta} + \sum_j M_{j,s}\psi_{j,n,s}\tilde{t}_{j,n,s}^{\vartheta}}, \tag{33}$$

where $M_{l,s}$ is the number of firms in province l and sector s, and $\frac{\psi_{l(m),n,s}}{\sum_m \psi_{l(m),n,s}}$ is the share of firms that choose export regime m to export to destination n. $M_{j,s}$ is the number of firms in country j and sector s. $\psi_{l(m),n,s}$, $\Psi_{l,n,s}$, and $\Psi_{j,s}$ are still identically defined as in the baseline model except for $\gamma = 0$. In the equilibrium, the number of firms in a province-sector, $M_{l,s}$, is determined by the free-entry condition, which requires firms' average profits to equal entry costs,

$$M_{l,s}f_{l,s}^{e}w_{l,s} = \frac{\sigma - 1}{\sigma\theta}\sum_m\sum_r \frac{\Pi_{l(m),r,s}E_{r,s}}{\tilde{t}_{l(m),r,s}}. \tag{34}$$

The left side of the equation is the total costs of entry, while the right-hand side represents the total profits, where $\frac{\sigma-1}{\sigma\theta} = \frac{1}{\sigma} - \eta$ is the profit ratio after deducting marketing costs. Because entrepreneurs' profits are now used to pay the workers they hire for entry, the market clearing condition for final goods in Chinese provinces is

$$E_{l(m),s} = \beta_s I_{l(m)} + \sum_k \lambda_{l(m),k}^{s}\left(\frac{\sigma - 1}{\sigma}\sum_r \frac{\Pi_{l(m),r,k}E_{r,k}}{\tilde{t}_{l(m),r,k}} + \eta\sum_r \frac{\Pi_{r,l(m),k}E_{l(m),k}}{\tilde{t}_{r,l(m),k}}\right). \tag{35}$$

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 province l and sector s in China can be obtained with the following equation:

$$w_{l,s}M_{l,s}f_{l,s}^{e} + \sum_m \lambda_{l(m),s}^{L}\left(\frac{\sigma - 1}{\sigma}\sum_r \frac{\Pi_{l(m),r,s}E_{r,s}}{\tilde{t}_{l(m),r,s}} + \eta\sum_r \frac{\Pi_{r,l(m),s}E_{l(m),s}}{\tilde{t}_{r,l(m),s}}\right) = \sum_g w_{l,s}L_{g,l,s}. \tag{36}$$

The left side of the equation now includes entry costs.

With the trade shares in equation (33), migration shares in equation (17), free entry conditions in equation (34), and market clearing conditions in (35)-(36), we can solve the Chinese provinces' and sectors' endogenous variables $\{M_{l,s}, \Pi_{l(m),n,s}, \Lambda_{g,l,s}, E_{l(m),s}, w_{l,s}\}$. The conditions for foreign markets are determined similarly. We calibrate the model with firm entry to the observed economy in 2005 and continue to apply the "Exact Hat Algebra" to perform counterfactual exercises without needing the estimates of entry costs. For ease of comparison, except for the absence of the relocation parameter γ, we use the same parameter values used in our baseline model for the model with firm entry.

Table D.2: Annual Export Growth (1990–2005) in Baseline and Alternative Model Settings

Policy Shock	(1) Baseline	(2) Firm Entry	(3) Endogenizing M_s
Migration Cost Reductions	1.29	1.50	1.25
Import Tariff Reductions	2.25	1.33	1.82
Export Tariff Reductions	1.37	0.94	1.30

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.

Columns (1) and (2) of Table D.2 present the effects of policy changes on export growth for our baseline model and the model with firm entry. We highlight two findings. First, export effects of migration cost reductions were much stronger in the model with firm entry than in our model. In the model with firm entry, the large export effect of migration is because the free-entry condition implies that the number of firms is proportional to employment size. By contrast, in our model, local employment growth indirectly affects firms' location choices by lowering labor costs. Second, the effects of tariff reductions were smaller in the model with firm entry than in our model. In the model with firm entry, the total measure of firms in a region-sector is determined by the firms' total revenues. Because exports only account for a small fraction of the firms' revenues, changes in firm entry tend to be small or even negative in the face of import competition, and therefore, exports are mainly driven by their intensive and extensive margins. By contrast, in our model, for each foreign destination, firms choose their production locations by minimizing the unit cost of exports, and thus, the measure of firms that choose to locate in China is directly affected by import and export tariff reductions.

D.3 Endogenizing the Potential Firm Mass

Our benchmark model assumes that M_s, the number of potential firms in each sector, is fixed. We discuss two versions of our model's extension to endogenize M_s. First, we assume $\widehat{M}_s = \widehat{\pi}_s$, where the change in the number of potential firms is proportional to the changes in total sectoral profit π_s, a known feature in models with firm entry (Krugman, 1980; Melitz, 2003).[38] In this case, the effect of the tariff and migration policies on exports is identical to that of our baseline model, because changes in M_s affect the firm count in all regions proportionally and thus, do not affect relative trade shares within sector s.

Second, we distinguish the potential firms by two places of origin, China and the Rest of World, denoted by M_s^C and M_s^R, respectively. Superscript $\{C, R\}$ denotes firm origin. Firms that originate in China and the Rest of the World separately draw productivities from the distribution in equation (7) with productivity parameters $\{A^C_{l(m),s}, A^C_{j,s}\}$ and $\{A^R_{l(m),s}, A^R_{j,s}\}$, respectively. Following similar derivations in ARRY and Appendix A, equations (37) and (38) below characterize the share of destination n's expenditure on goods produced by province l, conditional on the origin of the production firms:

$$\frac{\Pi^C_{l,n,s}}{\sum_l \Pi^C_{l,n,s} + \sum_j \Pi^C_{j,n,s}} = \frac{M^C_{l,n,s}\tilde{t}^{\vartheta}_{i,n,s}}{\sum_l M^C_{l,n,s}\tilde{t}^{\vartheta}_{i,n,s} + \sum_j M^C_{j,n,s}\tilde{t}^{\vartheta}_{j,n,s}}, \tag{37}$$

[38] $\pi_s = \frac{\sigma-1}{\sigma\theta}\left[\sum_l \sum_m \sum_r \frac{\Pi_{l(m),r,s}E_{r,s}}{\tilde{t}_{l(m),r,s}} + \sum_j \sum_r \frac{\Pi_{j,r,s}E_{r,s}}{\tilde{t}_{j,r,s}}\right]$ is the total sectoral profit for firms in sector s, where $\frac{\sigma-1}{\sigma\theta} = \frac{1}{\sigma} - \eta$ is the profit ratio after deducting marketing costs.

$$\frac{\Pi^R_{l,n,s}}{\sum_l \Pi^R_{l,n,s} + \sum_j \Pi^R_{j,n,s}} = \frac{M^R_{l,n,s}\tilde{t}^{\vartheta}_{i,n,s}}{\sum_l M^R_{l,n,s}\tilde{t}^{\vartheta}_{i,n,s} + \sum_j M^R_{j,n,s}\tilde{t}^{\vartheta}_{j,n,s}}. \tag{38}$$

By definition of trade shares, for each destination n, $\sum_l(\Pi^C_{l,n,s} + \Pi^R_{l,n,s}) + \sum_j(\Pi^C_{j,n,s} + \Pi^R_{j,n,s}) = 1$. The share of destination n's expenditure on firms originating from China relative to firms originating from the Rest of the World is

$$\frac{\sum_l \Pi^C_{l,n,s} + \sum_j \Pi^C_{j,n,s}}{\sum_l \Pi^R_{l,n,s} + \sum_j \Pi^R_{j,n,s}} = \frac{\left[\sum_l \Psi^C_{l,n,s} + \sum_j \psi^C_{j,n,s}\right]^{-\gamma}\left(\sum_l \Psi^C_l \tilde{t}^{\vartheta}_{i,n,s} + \sum_j \psi^C_j \tilde{t}^{\vartheta}_{j,n,s}\right)}{\left[\sum_l \Psi^R_{l,n,s} + \sum_j \psi^R_{j,n,s}\right]^{-\gamma}\left(\sum_l \Psi^R_l \tilde{t}^{\vartheta}_{i,n,s} + \sum_j \psi^R_j \tilde{t}^{\vartheta}_{j,n,s}\right)}. \tag{39}$$

$\{M^C_{l,n,s}, M^C_{j,n,s}, \Psi^C_{l,n,s}, \psi^C_{j,n,s}\}$ and $\{M^R_{l,n,s}, M^R_{j,n,s}, \Psi^R_{l,n,s}, \psi^R_{j,n,s}\}$ are determined in a manner similar to our baseline model except for the firm-origin-specific firm counts (M^C_s and M^R_s), productivity levels ($\{A^C_{l(m),s}, A^C_{j,s}\}$ and $\{A^R_{l(m),s}, A^R_{j,s}\}$), and iceberg trade costs. $\Pi_{l,n,s} = \Pi^C_{l,n,s} + \Pi^R_{l,n,s}$ is the share of destination n's expenditure on goods produced by province l (aggregated over firm origins).

As shown by ARRY, solving the equilibrium requires data on the trade shares for firms that originate in each region. We measure $\Pi^C_{j,n,s}$ and $\Pi^R_{j,n,s}$ as follows: (1) $\Pi^C_{j,n,s} = 0$ is set for any foreign country j because there was little outward FDI from China before 2005; (2) for each destination n and Chinese province l, we choose $\Pi^R_{l,n,s} = 0.6\Pi_{l,n,s}$, according to the observation that in 2005, 60% of Chinese exports were produced by foreign-invested firms in China. With these two assumptions and the observed aggregated trade shares $\{\Pi_{j,n,s}, \Pi_{l,n,s}\}$, we obtain all the trade shares by firm origin $\{\Pi^C_{j,n,s}, \Pi^C_{l,n,s}, \Pi^R_{j,n,s}, \Pi^R_{l,n,s}\}$. Finally, we assume that the number of firms that originate in each region is proportional to their respective profits, $\widehat{M}^C_s = \hat{\pi}^C_s$ and $\widehat{M}^R_s = \hat{\pi}^R_s$. We solve the counterfactual exercises of policy changes using the "Exact Hat Algebra" and with all our baseline parameters.

Column (3) of Table D.2 presents the counterfactual results for this second check. We find that introducing firm entry in China and the Rest of the World slightly reduces the combined effects of migration and tariff policies on export growth by 10% (from 4.91 p.p. to 4.41 p.p.). The slight reduction is because firms that originate in China do not produce in foreign countries, which decreases the overall magnitude of firm relocation from overseas to China after the policy changes. This decrease in the strength of firm relocation outweighs the increasing entry of firms that originated in China after the changes in the migration and trade policies.

D.4 The Export Growth By Foreign Destinations

A large number of studies have examined the economic consequences of China's export surge on advanced economies: Autor et al. (2013) and Pierce and Schott (2016) on the US; and Bloom et al. (2016) and Dippel et al. (2022) on European countries, among others. We show that the export impact of reducing migration costs varied across destination countries. Figure D.1 plots the effect of migration on annual export growth against the migrant employment intensity of exports across destination countries. The migrant employment intensity of exports is computed as the weighted average of province-sector-level migrant employment shares, where the weights are the provincial-sector export volumes to the foreign destination. China's reduction in migration costs favored exports to the US and European countries more than to the Asian counterparts such as Japan and Korea. For example, the impact of the migration policy on the annual export growth rate was 1.64 p.p. for the US, but only 0.38 p.p. for Korea. These findings reflect countries' differences in sourcing patterns from China's provinces: the US's top sourcing province was Guangdong in 2005, where migrant employment was prominent; in contrast, Korea's top sourcing province was Shandong, where migrant employment was low.

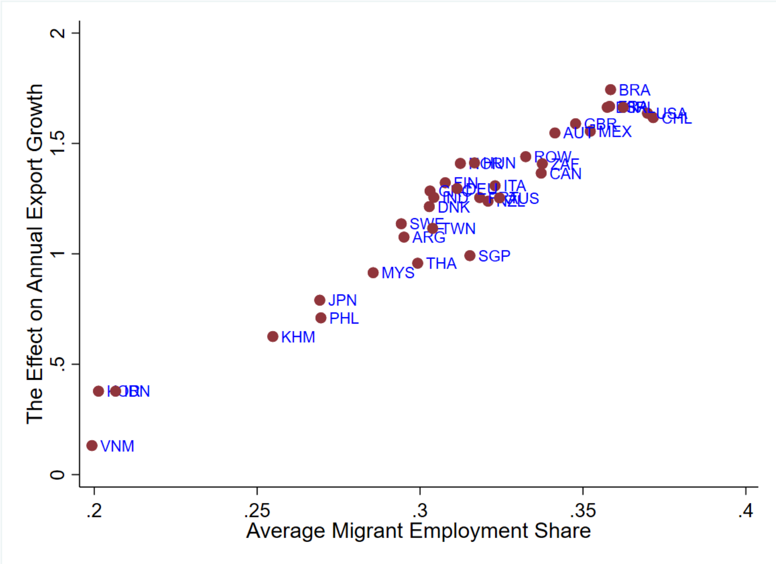


Figure D.1: The Export Impact of Reducing Migration Costs across Destinations

E Additional Validation Exercises

E.1 Model Fit to Employment Responses

In comparing the data with the predictions on province-sector employment changes across different models, we demonstrate that our baseline model matches the observed changes best. For each of the three models used in the comparison (baseline model, model with firm entry, baseline model with $\gamma = \rho = 0$), we introduce changes in tariffs (export and import tariffs separately) between 2000 and 2005 and solve the province-sector employment changes. We regress the model-generated employment changes on tariff changes, as discussed in Section 4.4. Columns (1) and (5) present the data estimates separately using changes in employment of ordinary and processing exporters, respectively, as dependent variables. Columns (2) and (6) present the results using the model-generated data from our baseline model. Columns (3) and (7) present the results for the model with firm entry. Finally, Columns (4) and (8) show the results of our baseline model with standard gravity ($\gamma = \rho = 0$). We present the results for import tariffs in Panel A and for export tariffs in Panel B.

Table E.1: Province-Sector-Level Employment and Tariff Changes between 2000 and 2005

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	Changes in employment ordinary exporters				Changes in employment processing exporters			
	data	baseline model	model with firm entry	baseline model ($\gamma = \rho = 0$)	data	baseline model	model with firm entry	baseline model ($\gamma = \rho = 0$)
Panel A: import tariff changes between 2000–2005								
import tariff changes	-3.212**	-2.956***	-1.494***	-1.689***	-8.154***	-3.885***	-2.467***	-1.937***
	(1.225)	(0.193)	(0.110)	(0.109)	(2.423)	(0.548)	(0.457)	(0.279)
Obs	382	380	380	380	306	299	299	299
R-squared	0.008	0.237	0.197	0.273	0.039	0.116	0.163	0.225
Panel B: export tariff changes between 2000–2005								
export tariff changes	-6.753**	-8.677***	-4.171***	-4.884***	-11.236**	-11.785***	-7.021***	-5.746***
	(2.547)	(0.401)	(0.231)	(0.203)	(4.463)	(1.041)	(0.897)	(0.601)
Obs	382	380	380	380	306	299	299	299
R-squared	0.010	0.570	0.427	0.636	0.021	0.297	0.369	0.553

Notes: We present the OLS estimates by regressing the employment changes on tariff changes. 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. Standard errors are in parenthesis and clustered by province. Significance levels: 10% * 5% ** 1% ***.

In all cases, we find that our baseline model is best able to capture the magnitude of province-sector-level employment responses as firms decide locations for each destination. As a result of weak firm entry in response to tariff changes, the model with firm entry predicts much smaller responses of province-sector-level employment by the export regime to tariff changes than the data show. Columns (4) and (8) show that when we deduce the firms' location and regime choices from our baseline model, our model falls short of capturing the magnitude of province-sector-level employment responses to tariff changes. These pieces of evidence support the use of our baseline model.

E.2 Model Fit to the Origin of Foreign Firms

In our analysis, firm mobility plays an important role in the aggregate trade impact of China's policy changes. In this final exercise, we provide suggestive evidence that our model can capture variations in the origins of new firms in the data.

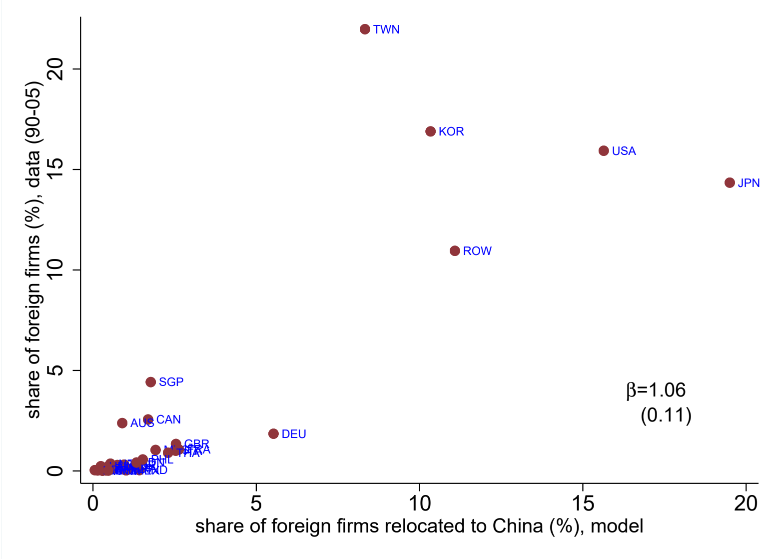


Figure E.1: Comparison of Model Predictions with Data on Foreign-invested Firms

We draw data from the Chinese Ministry of Commerce to measure the number of new foreign-invested firms. Before 2016, all foreign-invested firms in China were required to obtain approvals for registries and changes of business. These requests were then publicized on the website. We collect these raw data and use text analyses to identify information on the firms' names, industries, and ownership structures.[39] Between 1990 and 2005, there were 102,072 new registrations for foreign-invested firms, which is similar to the 91,047 existing manufacturing foreign-invested firms in the Firm Census 2004.[40] We identify the places of origin by the nationality of the firms' majority owners, omitting Hong Kong because it invested hugely in mainland China due to Hong Kong's well-developed financial markets and shared border.

Figure E.1 plots the model-predicted origins of new firms in China against the actual share of foreign-invested firms across origins obtained from the Chinese Ministry of Commerce. Our model-predicted origins of new firms are calculated as the number of firms relocated from each foreign origin divided by the overall increase in the number of firms in China. We compute this model-predicted result by taking the changes in China's tariffs and migration costs between 1990 and 2005 to the model.[41] It appears that our model-predicted origins of new firms match the data reasonably well. For instance, in the data, 15.9% of foreign-invested firms came from the US between 1990 and 2005, while our model predicts that the US accounted for 15.6% of the foreign firms that relocated to China after changes in China's migration costs and tariffs. This evidence suggests

[39] 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.

[40] 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.

[41] Using our model, for each destination and sector, we first compute the reduction in the firm's probability to produce in each foreign origin as a share of the total increase in the firm's probability to produce in China, after changes in China's trade and migration costs. We then take a weighted average of these shares, where the weights are the output sold to each destination and sector from China.

that our model can capture a reasonable amount of variation in the origin of foreign-invested firms in China.

F Indirect Inference of Structural Parameters

Below we describe the procedure we used to search for the joint 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 $\{\gamma, \rho\}$.

G Additional Tables and Figures

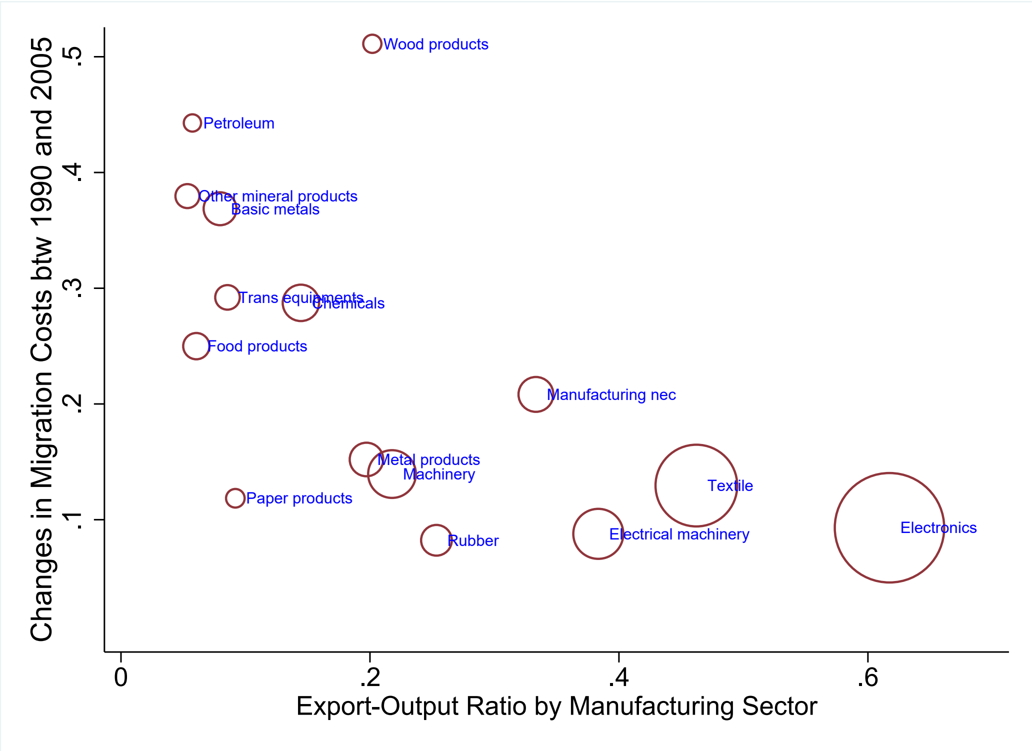


Figure G.1: Provincial Changes in Migration Frictions $\frac{\tau_{l,s,1990}}{\tau_{l,s,2005}}$ (Manufacturing Sectors)

Notes: Here we show the changes in migration costs for manufacturing sectors, which are the migrant-population weighted average across origin provinces and destination provinces. The circle size reflects the export volume in 2005.

Figure G.2: 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 the 14 national Economic and Technological Development Zones (ETDZs) in 1984; and the pink dots are the 18 national ETDZs added in the year 1992.

Table G.1: Overall Impacts on Wages Per Efficiency Unit

	Migration Costs		**Import Tariff**		**Export Tariff**	
	Average	Most Affected	Average	Most Affected	Average	Most Affected
Guangdong	-7.02%	-11.41%	-2.57%	-10.40%	5.94%	7.11%
Jiangsu	-2.16%	-3.41%	-1.56%	-10.61%	6.10%	8.60%
Shanghai	-0.86%	-4.14%	-0.13%	-8.86%	5.82%	8.33%

Notes: Panel A reports counterfactual changes in wages per efficiency unit for tradable sectors as a whole and for the most affected tradable sector.