DISCUSSION PAPERS IN ECONOMICS

Working Paper No. 15-06

International Trade and Internal Migration with Labor Market Distortions: Theory and Evidence from China

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October 2015

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International Trade and Internal Migration with Labor Market Distortions: Theory and Evidence from China*

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Job Market Paper, this version: October 18, 2015

Abstract

This paper discusses how globalization affects welfare by reallocating labor across sectors and space when factor markets are distorted. It incorporates a traditional agriculture sector into the trade literature with heterogeneous firms, matching frictions and multiple asymmetric regions in terms of their geographical locations. The model predicts that a reduction in trade impediments reallocates market share towards more productive producers, encourages firms to post more vacancies, and induces workers to migrate towards the manufacturing sector and towards the coastal regions. Therefore, the economy gains from trade through increase in productivity, expansion of the manufacturing sector, and reallocation of labor across locations. In addition, by comparing the decentralized competitive equilibrium with the socially optimal solution, I show that falls in trade barriers exacerbate existing distortions caused by matching frictions but decrease misallocation of labor across sectors and space. This implies potential gains from trade through increase in labor market efficiency. The empirical evidence supports the main theoretical implications. I find that rising export exposure explains more than 50% of the decline in agriculture employment share between 2000 and 2010 in China. Moreover, compared with prefectures at the 25th percentile of export exposure growth, the migrants share in prefectures at the 75th percentile increased by 11.66 percentage points more during this period.

JEL Codes: F12, F16, F66, O18, O19

Key Words: gains from trade, labor market distortions, internal migration, structural change

*I'm extremely grateful to my advisor James Markusen for his constant advice and encouragement. I am also indebted to Wolfgang Keller, Keith Maskus, Carol H. Shiue and Jeronimo Carballo for comments that substantially improved this paper, and to participants at various seminars and conferences for helpful discussions.

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1 Introduction

Factor markets inefficiencies are prevalent and have been widely studied in the economic development literature. Numerous studies have shown that labor allocation plays a significant role in explaining cross-country variation in total factor productivity (TFP) and total income (Gollin et al., 2002; Hsieh and Klenow, 2009; Vollrath, 2009; Duarte and Restuccia, 2010)[1]. Yet, one feature shared by most models of trade-induced structural change is that they abstract from changes in distortions of factor markets and concentrate on the benefits through expansion of sectors with comparative advantages. The goal of this paper is to go beyond this channel of gains from trade and discuss the welfare enforcement effects of international trade through increasing factor markets efficiency.

In this paper I incorporate three different types of labor market distortions in a unified framework. First, I consider the inefficiency within the manufacturing sector caused by two central market failures in the matching model: congestion externalities and appropriability problems[2]. When the appropriability and congestion problems do not balance each other, the competitive equilibrium involves either too many or too few vacancies. Second, the model includes misallocation of labor between the agriculture sector and the manufacturing sector due to the sharing rule of wages within family farms. I assume that the supply price of migrants is the value of the average product in the agriculture sector, rather than the marginal product. This mechanism of determining wages is common in developing countries where factor markets are absent, resulting in too many workers in the agriculture sector. Third, there is misallocation of factors across space due to frictions of internal trade costs. In contrast with the existing literature treating each country as a point in space, the distribution of economic activities across space is uneven in this paper. Decrease in trade costs exacerbates the first type of distortion as it has larger impact on the number of vacancies in the planner's problem than in the decentralized problem. Meanwhile, the second type of distortion is mitigated when trade induces some members in family farms to leave and makes the rest receive their full marginal product. The model also predicts that the trade-induced migration across space generates welfare gains by reallocating population towards regions which participate in the global market more.

An important contribution of this paper is to investigate all three mechanisms above within the standard international trade framework of monopolistic competition heterogeneous firms, so that I can separate out the impact of changes in labor market distortions from the total gains from trade. A general-equilibrium model is developed to bring together

[1] See Restuccia and Rogerson (2013) for a literature review.

[2] The discussion of these two problems goes back to Hosios (1990). The appropriability problem arises when firms only internalize a part of the value of the match created by its vacancy, while the social planner considers the whole social value of a job. It leads to too few vacancies. The congestion externality exists because firms only cares about the average probability at which a vacancy is filled, while the social planner makes its decision according to the marginal effects of an additional vacancy. This leads to too many vacancies. Since this paper takes a dynamic setting, the conditions that generate the optimality of the equilibrium is not exactly the same as in Hosios (1990).

the dual economy structure, trade between and within countries, structural change across sectors, and factor mobility across space. In particular, this paper considers multiple regions partitioned into two countries. Regions are distinguished from each other by differences in shipping costs. There are two sectors within each region: the agriculture sector and the manufacturing sector. Goods are assumed to be mobile between sectors, regions, and countries, but factors move only between sectors and regions within the same country. Labor is fully employed in the agriculture sector and gets average product as their income, while unemployment generated by the search frictions exists in the manufacturing sector and acts as the equilibrating mechanism between labor markets across sectors.

The model is first analyzed for a special case with symmetric regions. No labor migrating across space under this assumption. The assumption is then relaxed to account for the gains from trade through labor reallocation across space. I show that the model yields implications consistent with several stylized facts about China, a country featured with large reforms in openness policy, serious factor misallocation across sector and space (Brandt et al., 2013; Tombe and Zhu, 2015), and large domestic trade cost (Poncet, 2005). First, there are higher shares of employment in the non-agriculture activities in the coastal cities. Second, there are large migration flows from the interior to the China's coastline. Third, there is a dramatic shift of employment from agriculture towards other sectors, as well as growing spatial inequalities in the last couple of decades. Specifically, the model predicts that within each region, a reduction in trade impediments raises the average productivity as in Melitz (2003). Firms post more vacancies, which makes it more valuable for workers to search jobs in the manufacturing sector. As a consequence, workers migrate from the agriculture sector to the manufacturing sector, with an increase in wages in both urban and rural sectors. In addition, reductions in international trade barriers have larger impacts on the labor market at locations with geographical advantages, inducing spatial movements of labor from the interior regions to regions closer to the global market.

With the model calibrated to China's economy, I decompose the welfare gains from trade with counterfactual analysis into four channels: increase in market share of the more efficient firms in the manufacturing sector, increase in vacancy-unemployment ratio in the manufacturing sector, reallocation of labor from rural to urban, and migration flows towards the ports. The results show that although the change within the manufacturing sector plays an important role in explaining the welfare gain from trade, the reallocation of labor across sectors and space contributes around 40% of the total welfare increase. I then separate out the impact of changes in labor market efficiency from the total gains from trade. By comparing the decentralized competitive equilibrium with the first-best labor market conditions, I show that decreasing trade barriers exacerbates within sector inefficiency but raises across-sector allocative efficiency. The total revenue in the calibrated economy converges to its first-best value as trade cost falls. This suggests that opening to trade can impact welfare through changes in the labor market efficiency.

The main theoretical implications are examined with China's census data in 1990, 2000, and 2010. My empirical analysis follows studies using micro level data to evaluate local effects of trade (Edmonds et al. 2006, Kovak 2013, Autor, 2013) and exploits the fact that cities in China vary in their composition of employment across industries and tariff changes vary across industries. The empirical evidence supports the main predictions of the theoretical model that a reduction in variable trade costs reduces size of labor force in the agricultural sector and induces inter-regional labor migration. In particular, in the district that experience the average rising export exposure, the increase in export explains more than 50 percent of the decline in the employment share in agriculture during 2000-2010. Additionally, compared with prefectures at the 25th percentile of export exposure growth, the migrants share in prefectures at the 75th percentile increased by 11.66 percentage points more during this period. Moreover, the effects of export exposure decrease over distance to the coastline. Using firm level data from the Annual Survey of Industrial Production, I also provide empirical support of the differentiation in trade effects on regional average productivity, which is the central mechanism of the model.

The work in this paper builds on several strands of existing literature. It relates closely to the literature on trade and structural change. Reduction in trade cost induces expansion in sectors with comparative advantage due to differences in technology, relative factor endowments, or institution quality[3]. A more recent strand of theoretical literature examines how institutional frictions affect the implications of trade for labor market reallocation (Cuñat and Melitz, 2012; Kambourov, 2009; Helpman and Itskhoki, 2010; Davis and Harrigan, 2011). This work, however, has largely focused on the composition of economy and stays silent on the efficiency of the division of labor markets between sectors. In contrast with the existing literature, the model in this paper is built in the dual economy framework which is characterized with between-sector distortions. Individuals earn their average product in the agriculture sector and make migration decisions according to the expected values of searching jobs in the manufacturing sector, following the influential work in Harris and Todaro (1970). This set up is used to capture the welfare enhancement effects of trade through alleviating labor markets distortion across sectors.

This paper also connects with models investigating the impact of international trade on internal geographical labor mobility. A commonly used theoretical framework in this strand of literature is the new economic geography model, which explains the importance of region's access to markets and the agglomeration of economic activity. However, only a small number of papers have explicitly incorporating regional heterogeneity within a country, such as Allen and Arkolakis (2013), Cosar and Fajgelbaum (2013), Redding (2012), and Tombe and Zhu (2015). My main departure from these papers is that it allows for incomplete specialization at each location and examines the structural transformation within each region. In addition,

[3] There is also a large strand of literature empirically investigating labor reallocation induced by trade opening. See, for example, Wacziarg and Wallack (2004), Uy et al. (2012) and McCaig and Pavcnik (2013)

the regional heterogeneity in terms of the access to world market is not the focus of this paper. It is only used to explain the pattern of trade-induced migration and capture the welfare gains from trade through labor reallocation across space.

My work also contributes to the literature on the welfare gains of trade with the presence of distortions. This literature has focused distortions in the goods market and discussed gains from trade through changes in markup dispersions[4]. Davidson et al. (1999) show the importance of the introduction of Diamond–Mortensen–Pissarides-type search and matching frictions into competitive models of international trade. Its extensions include, but are not limited to, Helpman and Itskhoki (2010), Helpman et al., (2010) and Felbermayr et al. (2011). None of these papers, however, has discussed the importance of this type of factor markets distortion in explaining gains from trade, which is the main concern of this paper.

Lastly, my paper is most closely related to several papers. Using a two-country two-sector model of trade, Helpman and Itskhoki (2010) investigate how reductions in trade impediments generates welfare gains by changing the distribution of labor across sectors. In this paper, I extend it to a richer spatial setting by borrowing the idea of regional heterogeneity from Fajgelbaum and Redding (2014), as well as assumptions of agriculture wage determination and equilibrating mechanism across sector from Harris and Todaro(1970). There are two important differences between my work and Helpman and Itskhoki (2010). First, in contrast with Helpman and Itskhoki (2010) in which labor market tightness depends only on the labor market parameters, I model labor market tightness as endogenous and make it dependent on trade barriers, following the key assumption in Felbermayr et. al. (2011)[5]. This assumption is used to captures additional channel through which opening to trade affects welfare. Second, the the focus of the analysis is different. Helpman and Itskhoki (2010) do not explicitly discusses the impacts of trade on the efficiency of the economy, while my main interest lies in separating the impact of changes in labor market distortions out from the total welfare gains from trade.

The rest of the paper is structured as follows. Section 2 describes two stylized facts that motivate my analysis. Section 3 develops the model and characterizes its steady state equilibrium. I also compare different mechanisms of welfare gains from trade with counterfactual analysis. In Section 4 I discuss the empirical strategy to test the main prediction of the model and present the main evidence. Section 5 concludes. The Appendix provides the proof of the theoretical implications and details of main measurements used in the empirical analysis.

[4]See for instance Epifani and Gancia (2011), Edmond et al. (2014) and Holmes et al. (2014). Epifani and Gancia (2011) discuss the conditions under which trade may reduce welfare by changing the distribution of markups and exacerbating the market distortions. Edmond et al. (2014), on the contrary, identify the condtions for trade to reduce markup distortions.

[5]Felbermayr et. al. (2011) consider a economy with only one sector whereas my model considers two sectors and investigates both changes within sector and between sectors. In addition, my main interest lies in how welfare gains from trade are affected by labor market distortions, while Felbermayr et. al. (2011) concentrate on how trade openness affects unemployment rate.

2 Motivating stylized facts

As shown in Figure 1, since the opening policy in 1978, China has experienced a sharp increase in the export of GDP ratio, from 4.6% in 1978 to 24.11% in 2013, with the agriculture employment share dropped from 70% in 1978 to 34.36% in 2012. Data from the National Rural Fixed-point Survey shows that the average share of migrants out of total rural labor force rose from 15.45% in 2000 to 30.12% in 2009. In additional, the number of inter-provincial migrants increased from 42.6 million to 85.8 million during 2000-2010 according to the population census in 2000 and 2010. Meanwhile, these changes are not equally distributed across all regions in China. There are two main stylized facts manifested in the population census of the spatial pattern of these changes that motivate the analysis in this paper.

First, the employment share in non-agriculture sector is higher in coastal cities than that in most interior regions (Figure 2 Panel A). Prefectures with more than 60% population above the age of 16 employed in the non-agriculture sector are all located in the two major coastal megacity regions, the Pearl River Delta and the Yangtze River Delta. Moreover, given the initial employment share, the coastal area experienced a sharper decrease in the agriculture employment share during 2000-2010 (Figure 2 Panel B). Prefectures in Jiangsu and Zhejiang province particularly involved the most significant structural transformation. We can also see larger changes in the central region than the western region, which might be caused by the shorter geographical distance between the central region and eastern coastal cities than that between the western and eastern regions.

Second, there is a clear geographic pattern of the inter-regional migration flows in China. Based on population census in 2010, Panel A in Figure 3 shows the largest 20 inter-provincial migration flows. All flows are directed primarily towards coastal provinces such as Guangdong and the Yangtze Delta. Additionally, major flows between provinces are largely unidirectional. The major players in inter-provincial flows were basically either export provinces (such as Sichuan) or import provinces (such as Guangdong). In 2010, the migrants in the top 20 prefectures that had the largest inter-province migration population account for 47.65% of the total inter-province migrants in China. 18 out of these 20 cities were located in the three major coastal megacity regions (Figure 3 Panel B).

The model in the next section is developed to capture these two stylized facts.

3 Theoretical framework

The model is built upon the work of Helpman and Itskhoki (2010) and Felbermayr et. al. (2011). Essentially, I extend the model in Melitz (2003) with the incorporation of a traditional agriculture sector and labor market frictions in the modern manufacturing sector, and adapt the original model to a setting with multiple asymmetric regions with respect to their geographical locations. Wages are determined in different manners across sectors, following the standard practice in the dual-economy literature. Within each location, individuals make their migration decision based on the wage they can earn in the agriculture sector and the value of searching jobs in the manufacturing sector. Additionally, workers move across regions in search for high welfare until no one has incentives to change his/her location.

In particular, the economy consists of K locations arbitrarily arranged in two countries. There are two sectors at each location, the rural or agricultural sector (A) and the urban or manufacturing sector (M). Labor is the only factor used in production. It is perfect intersectorally and interregionally mobile within countries, but immobile across countries. I devise my model in discrete time. All payments are paid at the end of each period. To simplify notations, henceforce I denote the current period variable x_t as x and the next period variable x_{t+1} as x'. $\hat{x}$ refers to the percentage change of variable x.

3.1 The setup of model

3.1.1 Demand

Each location i ($i = 1, ...K$) has a representative consumer with preferences given by the quasi-linear utility function[6]

$$U_i = X_i + \frac{1}{\alpha} Y_i^{\alpha} + \frac{\bar{H}_i}{N_i^{\zeta}}$$

in which X_i is the consumption of a homogeneous product in the rural agriculture sector in region i. Y_i is consumption of a composite of urban manufacturing varieties ω, defined as:

$$Y_i = [\int_{\omega} y_i(\omega)^{\rho} d\omega]^{\frac{1}{\rho}} \qquad 0 < \alpha < \rho < 1$$

where $y_i(\omega)$ is the consumption of ω. N_i is the total population at location i. $\bar{H}_i$ is the given value of local amenity shared by all workers at i. Note that I expect that the congestion acts as a spreading force that increases as the population grows. X_i is freely tradable between regions and it is considered as the numeraire. Its price p_{Xi} equals 1. The lifetime utility of the representative consumer is $\mathbb{U}_i = \sum_t \frac{1}{(1+r)^t} U_{it}$, where r is the discount rate shared by all locations. By solving the consumer's problem, the demand of each manufacturing variety ω is given by

$$y_i(\omega) = p_i(\omega)^{-\frac{1}{1-\rho}} Y_i^{-\frac{\rho-\alpha}{1-\rho}} \tag{1}$$

where $p_i(\omega)$ is the price of ω at location i. Additionally, $Y_i = P_i^{-\frac{1}{1-\alpha}}$, with $P_i = [\int_{\omega} p_i(\omega)^{\frac{\rho}{\rho-1}} d\omega]^{\frac{\rho-1}{\rho}}$ as the price index of Y_i. Hence, the total expenditure on the differentiated good equals Y_i^{α}

[6] All conclusions in this paper also hold for a model with CES preferences.

at location i. The indirect utility of the representative consumer is

$$V_i = E_i + \frac{1-\alpha}{\alpha} P_i^{-\frac{\alpha}{1-\alpha}} + \frac{\bar{H}_i}{N_i^{\zeta}} \tag{2}$$

where E_i refers to the total income. Falls in trade barriers can increase welfare at location i either by raising total income or reducing the price index.

3.1.2 Labor markets

At each location, the labor market is segmented into two sectors, labeled agricultural (A) and manufacturing (M). w_{si} and N_{si} are the wage rate and total population searching for jobs in sector s, respectively, where $s = A, M$. L_{Mi} is the total employment in sector M at location i. The total population at location i is N_i. The total population in the economy is given as $\bar{N}$.

Rural labor markets All labor in the agricultural sector work on a big farm with full employment and share the same pot of income, i.e. $w_{Ai} = \frac{X_i}{N_{Ai}}$, where X is produced with the technology

$$X_i = F(N_{Ai}), \quad F' > 0,\ F'' < 0$$

Then the wage rate in the agricultural sector is given by:

$$w_{Ai} = \frac{F(N_{Ai})}{N_{Ai}} \tag{3}$$

where $N_{Ai} = N_l(1 - \frac{N_{Mli}}{N_i})$. This wage function implies that wage in the agriculture sector decreases with the total labor at each location and increases with the share of labor searching job in the manufacturing sector. I denote W_i as the value function of rural employment and U_i as the value of an urban unemployed worker searching for urban jobs. Assume that, to find an urban job, rural workers must move to the urban area[7]. Then the following relationship between U_i and W_i holds

$$(1+r)W_i = w_{A_i} + B_i' \tag{4}$$

where r is the discount factor and $B' = \max\{W_i', U_i'\}$. Equation (4) implies that $(1+r)W_i$ is equal to the flow of agriculture wage plus the value of the choices in the next period.

Urban labor markets There are search-and-matching frictions in the manufacturing sector. Firms post v vacancies to attract workers, while workers have no knowledge about

[7]The main results in this paper do not change when I assume workers can search for jobs in the manufacturing sector while staying in the agriculture sector.

whether a particular firm is hiring. Workers are hired by firms with a matching technology. As commonly assumed in the search and matching literature, the probability that a vacancy is filled can be expressed as $q(\varphi_i)$, where φ_i is the vacancy-unemployment rate and represents the labor market tightness in the manufacturing sector. $q(\varphi_i)$ is decreasing in φ_i. Unemployed workers are hired at the rate $x(\varphi_i) = \varphi_i q(\varphi_i)$, which is an increasing function of φ_i. Before the beginning of the next period, each pair of match is destroyed with probability η due to match-specific shocks.

Once the matching technology brings together firms and workers successfully, wage w_{Mi} is decided through Nash-bargaining. The surplus from successful matches is split between workers and the firm to solve:

$$\max_{w_{Mi}}(E_i(\theta) - U_i)^{\beta}(\frac{\partial J_i(l;\theta)}{\partial l})^{1-\beta}, \quad 0 \leq \beta \leq 1 \tag{5}$$

where $J_i(l;\theta)$ is the asset value of a firm with productivity θ and l workers, to be defined below. $\partial J_i(l;\theta)/\partial l$ measures the firm's surplus by hiring an additional worker. β shows the bargaining power of the worker. $E_i(\theta)$ is the present value of being employed by a firm with productivity θ, and it satisfies the following Bellman equations:

$$(1+r)E_i(\theta) = w_{Mi} + [(1-\psi)\max\{E_i'(\theta), B_i'\} + \psi B_i']$$

$$(1+r)U_i = (1 - x(\varphi)')B_i' + (1 - x(\varphi_i))\max\{E_i'(\theta), X_i'\} \tag{6}$$

where ψ is the actual separation rate of each firm-work match[8]. The above equations imply that $(1+r)E_i(\theta)$ depends the wage rate in each period and the probability at which the current employment status continues.The same holds for $(1+r)U_i$[9].

3.1.3 Manufacturing sector producers

The production in the manufacturing sector is modeled in a similar fashion as in Melitz (2003). Manufacturing firms produce heterogeneity varieties under monopolistic competition, incurring melting-iceberg type variable cost $\tau_{ij} \geqslant 1$ when shipped between location i and j. A firm with productivity θ produces θl units of output if it employs l units of labor, with θ drawn from a common distribution $G(\theta)$, which is same across locations. Before entry, firms only know the distribution of their productivity. In order to enter the market, a firm needs to pay an entry cost f_e. After entry, firms decide the optimal number of vacancies to be posted according to their productivity level and consider wage as given. Henceforce I use θ to index firms. Before the beginning of the next period, firms are forced to leave the

[8]In this paper, I consider two reasons that may lead to a job separation in each period. First, firms are hit by a idiosyncratic shock at the rate of δ that forces firms to leave the market. Second, each match of workers and firms may be destroyed by a match-specific shock with probability η. Therefore, the actual rate of job separations is $\psi = \eta + \delta - \eta\delta$.

[9]For simplicity, I set unemployment benefit to 0. This assumption does not have any impacts on all main results in this paper.

market with the probability δ. Firms at location i bear fixed cost f_{ij} for sales to location j.

Assume the cost of posing a vacancy is c. The producer maximizes its market value by solving

$$J_i(l:\theta) = \max_{v_i} \frac{1}{1+r} \left[R_i(h:\theta) - w_{Mi}(l;\theta)l - cv_i - f_{ii} - \sum_{j\neq i} I_{ij}(\theta) f_{ij} + (1-\delta) J_i(l':\theta) \right]$$

$$\text{s.t.} \quad l'_i = (1-\eta) l_i + q(\varphi_i) v_i \tag{7}$$

where $I_{ij}(\theta)$ is an indicator function and takes one if a firm chooses to sell to location j. $R_i(l:\theta)$ is the total revenues of a firm with productivity θ and l workers at location i.

Let $\pi_{ij}(\theta)$ denote the profits earned in market j in each period. An entering firm with productivity θ will continue to produce when $\pi_{ii}(\theta) \geq 0$ and will sell to market j if $\pi_{ij}(\theta) \geq 0$. Or in other words, define θ^*_{ij} as the cutoff productivity such that $\pi_{ij}(\theta^*_{ij}) = 0$, then firms with productivity lower than θ^*_{ii} cannot make profits. For firms with productivity at least as high as θ^*_{ii}, they do not sell to market j unless their productivity is higher than θ^*_{ij}.

Additionally, a prospective firm enters the market only if the expected profits from entry are at least as high as the entry cost. Therefore, we have the free-entry condition as

$$\frac{1+r}{r+\delta} \sum_{j=1}^{K} \int_{\theta^*_{ij}\cdot}^{\infty} \pi_{ij}(\theta_{ij}) dG(\theta) = f_e, \, i = 1, 2 \cdots K$$

3.2 Steady state equilibrium

In this section I characterize the structure of the general equilibrium conditions in the steady state. First let's define the equilibrium of the economy.

Definition 1 *An equilibrium of the economy consists of labor density N_i, factor distribution $\{N_{Ai}, N_{Mi}\}$, factor prices $\{w_{Ai}, w_{Mi}\}$, goods prices P_i, productivity threshold $\{\theta^*_{ij}\}_{j=1,2...K}$, labor market tightness φ_i, and number of firms M_{ei} at each location i such that : 1) consumers maximize utility; 2) firms maximize profits; 3) labor markets clean; 4) trade is balanced.*

Condition 1 implies that workers equalize value of W_i and U_i within each location i and the utility of the representative consume is equal across all locations, which determines the labor distribution across sectors and locations. Condition 2 gives us the optimal vacancy post strategy of firms and productivity cutoffs, while condition 3 and 4 pin down the price series.

3.2.1 Optimal vacancy post and wage bargaining result

As proved in the Appendix A, the first order condition of the firm's problem in (7) yields the optimal hiring rule of a firm in the steady state as

$$\frac{\partial R_i(l;\theta)}{\partial l} = w_{Mi}(l:\theta) + \frac{c}{q(\varphi_i)}\frac{r+\psi}{1-\delta} + \frac{\partial w_{Mi}(l;\theta)}{\partial l}l \tag{8}$$

This equation differs from the solution in a friction-free market with the consideration of the expected cost to hire extra workers. Additionally, reinserting the first order condition for vacancy posting into the bargaining rule and plugging in the relations in equation (6) , we obtain the relationship between φ_l and w_{Ml} as

$$w_{Mi} = rU_i + \frac{\beta}{1-\beta}\frac{r+\psi}{1-\delta}\frac{c}{q(\varphi_i)} \tag{9}$$

with $rU_i = \frac{\beta}{1-\beta}\frac{1}{1-\delta}\varphi_i c$[10]. From equation (9), we can see that the manufacturing wage is a function of labor market tightness φ_i and it's independent of firms' productivity levels. This is due to the assumption that the posting cost are the same across firms. Additionally, wage is increasing in the market tightness. Larger φ means lower probability of successful match, which indicates higher expected costs of hiring new workers. This implies that increases in φ raise marginal costs and reduce firm's profits. This is the same as the conclusion in Felbermayr et al. (2011).

3.2.2 Equilibrium in goods markets

Substituting the expression of wage (9) into equation (8), firm's optimal hiring rule can be rewritten as

$$\frac{\partial R_i(l;\theta)}{\partial l} = \frac{\beta}{1-\beta}\frac{1}{1-\delta}\frac{\sigma-\beta}{\sigma}[\varphi_i c + \frac{r+\psi}{\beta}\frac{c}{q(\varphi_i)}] \tag{10}$$

where $\sigma = \frac{1}{1-\rho}$. Define $a(\varphi) \equiv \dfrac{\partial R(l;\theta)}{\partial l}$. Since $q(\varphi_i)$ is decreasing in φ, $a(\varphi)$ is an increasing function in φ. Substituting the expression of $a(\varphi)$ into the zero cutoff condition, the productivity thresholds are given by

$$(\theta^*_{ii})^{\frac{\rho}{1-\rho}} = Bf_{ii}a(\varphi_i)^{\frac{\rho}{1-\rho}}Y_i^{\frac{\rho-\alpha}{1-\rho}}$$

$$(\theta^*_{ij})^{\frac{\rho}{1-\rho}} = Bf_{ij}\tau_{ij}^{\frac{\rho}{1-\rho}}a(\varphi_i)^{\frac{\rho}{1-\rho}}Y_j^{\frac{\rho-\alpha}{1-\rho}} \tag{11}$$

where $B = (\frac{1+r}{1-\delta}\frac{\sigma-\beta}{1-\beta})\rho^{-\frac{1}{1-\rho}}$. Therefore, for any pair of locations i and j the productivity cutoffs satisfy

$$\frac{\theta^*_{ii}}{\theta^*_{ji}} = (\frac{f_{ii}}{f_{ji}})^{\frac{\rho}{1-\rho}}\tau_{ji}^{-1}(\frac{a_i(\varphi)}{a_j(\varphi)}) \tag{12}$$

[10] See Appendix A for more details.

Equation (12) implies that the cutoffs depend on the relative size of marginal revenues at the equilibrium, which are influenced by the labor market conditions. In addition, as proved in Appendix A, the free entry condition can be simplified as

$$\sum_j \int_{\theta^*_{ij}}^{\infty} f_{ij}[(\frac{\theta}{\theta^*_{ij}})^{\frac{\rho}{1-\rho}} - 1]dG(\theta) = \frac{r+\delta}{1+r} f_e, i = 1, 2 \cdots K \tag{13}$$

Relation (12) and (13) derive $K * K$ functions, which can be used to pin down θ^*_{ij} as functions of φ_i and φ_j ($j = 1, 2...K$). Once the productivity thresholds are determined, we can get the consumption level of Y_i with equation (11). Additionally, total expenditure in the differentiated sector equals total revenues of all firms serving demand in this sector, which determines the entry rate of new firms as[11]

$$Y_i^{\alpha} = \frac{1+r}{1-\delta}\frac{\sigma-\beta}{1-\beta}\{\sum_j \frac{M_{ej}}{\delta} \int_{\theta^*_{ji}}^{\infty} f_{ji}(\frac{\theta}{\theta^*_{ji}})^{\frac{\rho}{1-\rho}} dG(\theta)\}, \ i = 1, 2 \cdots K \tag{14}$$

With these K functions we can write M_{ei} as function of φ_i and φ_j ($j = 1, 2...K$) as well[12].

3.2.3 Equilibrium in labor markets

Analogous to the Harris and Todaro (1970) model, the mobility equilibrium condition requires that staying in the rural sector has the equal value as migrating to the urban sector and searching for urban job as an unemployment worker, i.e. $W_l = U_l$. Therefore, the wage and labor market tightness satisfy

$$w_{Ai} = \frac{\beta}{1-\beta}\frac{1}{1-\delta}\varphi_i c \tag{15}$$

Equation (15) implies that the labor in the agriculture sector depends on the labor market tightness in the manufacturing sector. Quite intuitively, increases in φ raise the probability at which the unemployed workers meet firms. Therefore, the value of urban unemployment goes up and this encourages more workers to move to the urban sector and search for job. In addition, combining with equation (9), equation (15) yields the rural-urban wage gap as

$$\frac{w_{Mi}}{w_{Ai}} = \frac{r+\psi}{x(\varphi_i)} + 1 \tag{16}$$

which is decreasing in φ_i. This suggests that the harder it is to find urban jobs, the larger the wage gap is, which is quite straightforward. Furthermore, in the steady state equilibrium

[11] To see this, recall that the total expending on differentiated products is equal to $P_i Y_i = Y^{\alpha}$. In addition, we have $R_{ij}(\theta^*_{ij}) = \frac{1+r}{1-\delta}\frac{\sigma-\beta}{1-\beta} f_{ij}$ and for $\frac{R_{ij}(\theta_1)}{R_{ij}(\theta_2)} = (\frac{\theta_1}{\theta_2})^{\frac{\rho}{1-\rho}}$, where $R_{ij}(\theta_{ij})$is the revenue from sales to market j. Therefore, $R_{ij}(\theta_{ij}) = (\frac{\theta_{ij}}{\theta^*_{ij}})^{\frac{\rho}{1-\rho}} \frac{1+r}{1-\delta}\frac{\sigma-\beta}{1-\beta} f_{ij}$. See appendix for more details.

[12] In this paper I only discuss the equilibrium with positive entry of firms in all regions.

the flow-in employment is the same as the flow-out employment. Therefore,

$$\frac{x(\varphi_i)}{x(\varphi_i)+\psi}N_{Mi} = L_{Mi} \tag{17}$$

where L_{Mi} is determined by

$$L_{Mi} = \frac{M_{ei}}{\delta}\frac{1+r}{1-\delta}\frac{\sigma-\beta}{1-\beta}\frac{\rho}{a_i}\{\sum_j \int_{\theta^*_{ij}}^{\infty} f_{ij}(\frac{\theta}{\theta^*_{ij}})^{\frac{\rho}{1-\rho}} dG(\theta)\}$$

Equation (15) and (17) depend only on N_{Mi} and φ_i if we take the total labor at each location i as given. Therefore, these two equations can be used to pin down the value of N_{Mi} and φ_i. As proved in Appendix A, there exists a unique solution. Note that in contrast with Helpman and Itskhoki (2010) in which labor market tightness is constant, φ_i in this model is endogenous and its value varies with trade cost. This feature provides additional channels through which falls in trade barriers affect welfare and makes the trade-induced labor market change more complex.

The optimal distribution of labor force across locations comes with the condition that the indirect utility equalization across all location:

$$E_i + \frac{1-\alpha}{\alpha}Y_i^{\alpha} + \frac{\bar{H}_i}{N_i^{\zeta}} = E_j + \frac{1-\alpha}{\alpha}Y_j^{\alpha} + \frac{\bar{H}_j}{N_j^{\zeta}}$$

With the presence of congestion forces, wages are not equalized across regions.

3.3 The impacts of international trade cost reduction

3.3.1 Symmetric regions

First I consider in this section symmetric locations with $\tau_{ij} = \tau_{ik}$,$f_{ij} = f_{ik} = f_x$, $f_{ii} = f_d$, for all $l, k, j = 1, 2, \cdots K$ in order to understand how the level of trade costs affects labor markets across sectors. With this assumption, the steady state equilibrium variables are the same in all locations. Changes in trade impediments have same impacts at all locations, so there is no labor movement across locations and population size at each location is fixed at $\frac{1}{K}\bar{N}$. Therefore in this section I drop the location index for convenience and use θ^*_d and θ^*_x to show the productivity cutoffs to sell locally and to other market, receptively. Total differentiating equation (12) and (13), we get

$$\hat{\theta}^*_d = -\frac{\mu_x(K-1)}{\mu_x(K-1)+\mu_d}\hat{\tau} \tag{18}$$

$$\hat{\theta}^*_x = \frac{\mu_d}{\mu_x(K-1)+\mu_d}\hat{\tau}$$

where $\mu_i = \frac{f_i}{\theta_i^{*\sigma-1}} \int_{\theta_i^*} \theta^{\sigma-1} dG(\theta), i = d, x$. The sign of coefficients in (18) implies the following lemma.

Lemma 1. *Assume all locations are symmetric. As in Melitz (2003), a reduction in trade impediments raises the productivity cutoff for domestic production, decreases the cutoff to sell to other markets and reallocates labor towards the more productive firms.*

Equation (18) also implies that the productivity threshold is independent of the labor market parameters. This property holds with symmetric regions since cutoffs only depend on the relative values of labor market tightness. We can then substitute the value of cutoffs into equations (15) and (17) to obtain the solution for N_M and φ. Since a reduction in trade costs affects labor market conditions only through the change in cutoffs, as shown in Figure 4, a decrease in τ has no impact on equation (15) but raises the steady state N_M by moving the steady state employment flow equation (17) upward. We prove in Appendix A the following lemma.

Lemma 2. *In an equilibrium with symmetric locations, a decrease in trade costs increases the labor market tightness φ and reduces the share of labor working in the agriculture sector.*

The intuition of this result is quite straightforward. The reduction in trade impediments results in the exit of the least productivity firms and increases in the market share of the most productivity firms and, hence make firms on average more productive. The urban sector wage increases less than proportionally with the average productivity due to the bargaining power of firms. Therefore, the value of filled vacancies gets larger, which encourages firms search for workers more intensively. It then becomes easier for unemployed workers to find a job in the urban sector, raising the asset value of unemployed worker (U goes up). This drives more workers to migrate from the rural sector to the urban area, and the steady state rural wage w_A increases as well. In addition, given equation (9), the urban wage w_M is augmented by both the increase in the value of worker's outside option U and higher expected hiring cost $\frac{r+\psi}{1-\delta}\frac{c}{q(\varphi)}$. However, the rural-urban wage gap reduces as in equation (16). The increase in φ has a proportional effect on w_A but a less than proportional effect on w_M due to changes in firm's behavior.

3.3.2 Asymmetric regions

When all locations are symmetric, the location of each regions is irrelevant. In this section I discuss the impacts of trade cost reduction when some regions have a geographical disadvantage. In particular, I assume that only some locations can trade directly with the rest of the world and we call them international ports. Goods from other locations must be shipped through ports to the international market.

Because of the high non-linearity the model, I cannot derive its solution analytically. The impacts of location heterogeneity on properties of the steady state equilibrium in the previous section are examined with numerical examples where specific parameter values are assigned. The model is calibrated to match the labor market conditions in China in the 2000s. I choose China since it is featured with large reforms in openness policy and its agriculture sector is sizable. In addition, it is featured with serious factor misallocation across sector and space and large domestic trade cost. To consider the regional differentiation of trade impacts, it is necessary to have at least three regions located in two countries. Assume country H has two locations, labeled $c(oast)$ and $i(nland)$, while country F has only one location $f(oreign)$. Location c functions as the port in country H. Assume the trade impediments between the coastal location c and the foreign country F is lower than that between the interior location i and country F, and satisfy$1 < \tau_{ci} < \tau_{cf} < \tau_{if} = \tau_{cf}\tau_{ci}$.

I focus on equilibrium with incomplete specialization, i.e. $M_{ei} > 0$ for all i. The values of main parameters in the model are picked based on the existing literature, and the rest are determined to match the empirical evidence from China. Following a large literature of firm's heterogeneity, I assume that the probability density of firms productivity is $g(\varphi) = \gamma\varphi^{-(1+\gamma)}$, where γ satisfies $\gamma > \sigma - 1$ to ensure that the variance of the sales distribution is finite. σ is set as 4. The production function in the rural sector is given by $F(N_{Ai}) = N_{Ai}^{0.6}$. I set $r = 0.05$ as the annual interest rate. The bargaining power of worker is $\beta = 0.5$. The labor market tightness is 1.1 in China in 2011 (Xiao, 2013) and unemployment rates was around 11% in 2002, so the vacancy posing cost c is set as 1.4 and the scale of matching function is 0.6. The domestic trade cost is set as the minimum level of international trade used in the conterfactual analysis. More details of parameters values used in calibration are shown in Table 1.

The results from numerical simulations are shown in Table 2 and Figure 4. The model is calibrated to obtain an economy in which is the urban employment share increases from 35.65% to 52.63% in the coastal region due to the tariff reduction. The unemployment rate decreases from 11.33% to 9.47% , while the vacancy-unemployment rate increases from 0.8335 to 1.2439. There are three propositions can be concluded from the numerical analysis.

Proposition 1. *Locations that are closer to the world market (ports) has larger share of export firms, higher average productivity, higher labor market tightness and lower employment share in the agriculture sector.*

Building on lemma 1 and 2, this proposition is quite intuitive. The cost of trade to the world market for coastal regions is lower than it is for interior regions. Lemma 2 implies it's more profitable for firms in the coastal cities to export than it's in the interior regions. This theoretical implication is consistent with the stylized facts in the second section in this paper. Additionally, given that lower trade impediment is accompanied with higher welfare and with free inter-regional labor mobility, labor moves towards regions with higher indirect utility until welfare is equalized across regions, make coastal regions to have higher population density than interior regions. The domestic trade cost does not only affect the equilibrium distribution of economic activities, but also shapes the pattern across space of the impacts of a reduction in international trade costs. I summarize the impacts of international trade cost in regions with different geographical locations as follows.

Proposition 2. *Reductions in international trade impediments increase the domestic cut-offs at each locations, reallocate labor towards firms selling to other markets and increase the labor market tightness φ at each location.*

Proposition 3. *Reductions in international trad impediments have larger impacts on the labor market at locations with geographical advantages.*

Proposition 2 states that lemma 2 still holds in an economy with asymmetric regions and indicates labor mobility from rural sector to urban sector at each region. Proposition 3 follows proposition 1. Assume a special case that the internal trade cost is extremely high, which will stop all firms in the interior region from exporting. As a consequence, the change in international trade costs has no impact in the interior area, as long as the interior region is still in the autarky status, but this change affects the coastal region as described in Proposition 2. Attracted by the higher welfare level at coastal regions, workers migrate from the interior regions until the new equilibrium is reached (as shown in Figure 5).

3.4 Welfare analysis

3.4.1 Decomposition of welfare gains

Having studied the properties of the equilibrium, I now turn to the discussion of its welfare implications. According to equation (2), the indirect utility function for consumers within each region is increasing in aggregate income and declining in price index of the differentiated good. Proposition 2 and 3 implies that the reduction in trade impediments increases total welfare of country H by raising E or reducing P through four channels. First, it reallocates markets shares towards more efficient firms, which impacts P negatively. Welfare gains from this channel have been discussed intensively in the literature following Melitz (2003). Second, a drop in trade cost increases the labor market tightness in the manufacturing sector. This change, on one hand, raises firms' cost of hiring per worker, thus reducing the mass of firms in the differentiated sectors. On the other hand, higher vacancy-unemployment ratio increases wages in both sectors, contributing to a higher value of total income. Third, trade liberalization leads to an expansion in the total labor force in the manufacturing sector and increases the total production of Y. Last, the reduction in international trade cost induces population to move towards regions with high average productivity cost, which increase welfare in both regions.

Among all four mechanisms, only the impact of a change in labor market tightness is ambiguous. Whether or not the increase in vacancy-unemployment ratio generates welfare gains depends on the prevalence of two opposite effects. The net effect is positive only when the higher income offsets the loss of firm's entry. This mechanism is absent in Helpman and Itskhoki (2010), in which the cost of hiring is constant. Despite the ambiguity of the effect of one mechanism, the within-sector effects of trade, however, is always positive on total welfare.

I use counterfactual analysis to isolate different mechanisms above. Figure 6 illustrates the decomposition of total trade effects. The solid line in the figure plots the welfare change as a joint result of four mechanisms. The total welfare is scaled so that the value equals 1 when international trade cost is 1.85. To get the top dotted line, I allow for firm's exit and entry, but keep the vacancy-unemployment ratio in each region and labor distribution fixed at their initial values when international trade cost is 1.85. The bottom dashed line presents the total welfare when firm can change the vacancy posting behavior freely but labor distribution is constant at their initial values. The middle dashed line summarizes what total welfare would be if we keep the same labor distribution across space at the initial values but allow labor flows between sectors.

The bottom line captures the impacts of changes within the manufacturing sector, which is a joint outcome of both change in firm's exit and entry and firm's vacancy posting behavior. The difference between the bottom line and the middle line implicitly summarizes the results of structural change, while the gap between the solid line and middle dashed line shows the effects of changes in population scale at each location . We can see that in the calibrated model, the welfare effects of vacancy-unemployment ratio is negative, which is shown by the gap between the top dotted line and the bottom line. The net effect of the within-sector adjustment accounts for about 60% of the total welfare gains. Quite intuitively, this ratio will be smaller if the misallocation of labor across sectors and space is more severe.

3.4.2 Welfare gains and changes in labor market efficiency

How do distortions in the labor market affect these results? To answer this question, I consider the population distribution at each location as given and focus on adjustment within each location[13]. The impacts of changes in labor market distortions are captured by the disparity between the decentralized competitive equilibrium and the optimal solution from the utilitarian social planner's problem. Following the conceptual tools from Lee (2008), the problem of the social planner is to maximize total net revenue by choosing the appropriate number of vacancy posted by firms in the manufacturing sector and allocating workers across sectors. Appendix A provides detailed analysis of this problem. In contrast with the competitive equilibrium described by equation (10) and equation (15), the first-best

[13]The efficiency effects of across-space changes is quite straightforward. As implied by proposition 3, falls in trade barriers induce labor movement across regions, from the interior region (with low TFP) to the coastal region (with high TFP). This type of reallocation helps to reduce the between-region labor market distortions and generates welfare gains.

labor market tightness and labor allocation across sectors are determined by

$$\frac{\partial R(l;\theta)}{\partial l} = \frac{1-\zeta}{\zeta}\varphi c + \frac{r+\psi}{\zeta}\frac{c}{q(\varphi)}$$

$$F'(N_A) = \psi\frac{-c\varphi + \frac{\partial R_i(l;\theta)}{\partial l}\frac{x(\varphi)}{r+\psi}}{r+\psi+x(\varphi)} \tag{19}$$

where ζ is the elasticity of $x(\varphi)$ with respect to φ[14]. Figure 7 shows the difference between the decentralized competitive equilibrium with the first-best choice of $\{\varphi,\ N_A\}$. In the calibrated model, the competitive equilibrium involves too few vacancies posting in the manufacturing sector and too many workers in the agriculture sector. Therefore, there exist both within-sector distortions and between-sector misallocation. I summarize features illustrated in Figure 7 with the following lemma.

Lemma 3. *(i) Within the manufacturing sector distortion exists when the bargaining power of the worker is either too high or too low. (ii) At the same time, across section distortion is caused by the wage sharing rule in the agriculture sector. The competitive equilibrium results in too many workers staying in the agriculture sector.*

The first part of this lemma is similar as the analysis in Lee (2008). Distortion exists within the manufacturing sector if the usual Hosios condition (Hosios,1990) does not hold. When the elasticity of the job-finding rate with respect to φ is too low, the appropriability problem dominates the congestion externality on the firms' side, resulting in too few vacancies. In contrast with Lee (2008), the between-sector distortion allocates too many workers in the agriculture sector, which is more consistent with the facts in developing countries. This between-sector misallocation is caused by the absence of factor markets in the agriculture sector and the sharing rule used to determine individual income. The supply price of migrants, namely the average product, is much higher than the marginal product.

In addition, Figure 7 also shows that the disparity between labor market tightness in the decentralized problem and the planner's problem becomes more significant as trade barrier falls, while the employment share in the two cases converge to each other. Table 3 presents more details. With the international trade cost reduced from 1.85 to 1.05, the first-best level of φ increases by 23.32% while the actual φ only increases by 20.54%. On the contrary, compared with that in the planner's problem, the manufacturing employment share in the decentralized problem increases by 30.78% more. As a result, the difference between the first-best value of total revenue and the actual total revenue decreases from 7.71% to 5.51%.

[14] Another condition used to pin down the value of φ and N_A is

$$\frac{x(\varphi)}{x(\varphi)+\psi}N_M = L_M$$

which comes from the transition condition. This equation is exactly the same as the one used in the decentralized problem.

One method to see the difference between the equilibrium and optimum more clearly is to check the policy scheme that can correct the distortions. Assume there exist two policy instruments $\{s, d\}$ that can replicate the first-best values of for the competitive equilibrium by subsidizing (taxing) firms' vacancy posting cost and agriculture wages. In other words, the values of $\{\varphi, N_A\}$ solved from

$$\frac{\partial R(l;\theta)}{\partial l} = \frac{\beta}{1-\beta}\frac{1}{1-\delta}\frac{\sigma-\beta}{\sigma}[\varphi + \frac{r+\psi}{\beta}\frac{1}{q(\varphi)}]c(1-s)$$

$$\frac{F(N_{Ai})}{N_{Ai}}(1+d) = \frac{\beta}{1-\beta}\frac{1}{1-\delta}\varphi_i c(1-s) \tag{20}$$

are the same as in the solution of equation (19). As shown in Table 3, as trade barrier falls, the tax on agriculture wage to replicate the first-best values of labor allocation across sectors decreases, and the required subsidy on the vacancy posting cost increases. This is because the reduction of trade cots moves labor out of the agriculture sector, moving the average product level towards the marginal product in the agriculture sector. In the manufacturing sector, however, since firms benefit more from the increase in average productivity in the case without labor market distortions than in that with distortions, trade has larger impact on the vacancy posting behavior of firms in the planner's problem. Therefore, the first-best value and the competitive equilibrium value of labor market tightness diverges as trade impediments are reduced.

Proposition 4. *Reduction in trade cost decreases the misallocation across sectors and exacerbate the labor market distortions within the manufacturing sector.*

This proposition captures a potential welfare enhancement channel that is absent in Helpman and Itskhoki (2010). In the calibrated model, the labor market distortions with 1.05 trade cost relative to 1.85 trade cost is 0.71 (5.51/7.71). Therefore, besides all four channels discussed in the previous section, the economy gains from trade through increases in labor market efficiency as well. This conclusion suggests an important policy implication that subsidies to encourage firm's vacancy posting can offset the downside of trade liberalization. In addition, this proposition implies that the trade-induced welfare gains depends on the extent to which labor market is distorted, namely the values of parameters in the agriculture production function and matching functions, and the cost of posting vacancies. As shown in Figure 8, larger distortion in the agriculture sector or smaller distortions in the manufacturing sector is associated with larger increases in the total welfare.

4 Empirical Evidence

4.1 Empirical Strategy

This section tests the main predictions of the theoretical model that a reduction in variable trade costs reduces share of labor working in the agricultural sector and induces inter-regional labor migration. I also conduct an empirical examination of the central mechanism in the model, namely the differentiation in trade effects on regional average productivity due to the interaction between international and internal trade costs. I exploit the fact that cities in China vary in their composition of employment across industries, while tariff changes vary across industries. Although the empirical strategy in this paper is inspired by studies using micro level data to evaluate local effects of trade (e.g. Edmonds et al. 2007; Autor et al.,2013; Kovak 2013), my analysis differs from this literature in a few aspects. First, whereas tariff reduction is the fundamental reason that induces the inter-sector and interregional labor mobility, a more direct test of the model is to consider the impacts of the rise in labor demand induced by exports. This is parallel to the analysis in Fukase (2013) who investigates the impacts of export liberalization on skill premium in Vietnam.

Second, most studies that exploit the geographic heterogeneity across regions in exposure to trade liberalization to examine the impact of trade reforms assume labor to be "sufficiently immobile" across regions. Without this assumption, it is impossible to observe how changes in wages differ in districts with large tariff cut relative to districts with little change in trade barriers because interregional labor mobility smooths out the regional price variation. The theoretical model in this paper, however, predicts that the even with perfect labor mobility, changes in employment share in the agriculture sector would still be larger in regions experiencing larger tariff declines. Therefore, unlike empirical studies investigating the relationship between regional tariff and factor prices, in which allowing for migration underestimates the impacts of trade, analysis in this paper overestimates the trade-induced structure change if labor is mobile across regions.

In fact, labor is neither perfectly mobile nor perfectly immobile in China. Biased estimation would be less likely to occur when the unit of analysis is chosen appropriately so that there is little migration between each unit. The administrative divisions of China consist of five levels: the province, prefecture, county, township, and village. There are 34 provinces, 333 districts at the prefecture level, 2,853 counties or county-level cities, 40,497 township-level regions and even more village-level regions. Numerous studies have reported that China's migration flows are features with obvious spatial patterns (Chan, 2013). First, most intra-province migrants move cross county-level units, but stay within prefectures. Second, the inter-province migration flows are directed primarily towards coastal provinces (such as Guangdong) from inland provinces (such as Sichuan), with little between coastal provinces. In addition, major flows between provinces are largely unidirectional. Therefore, treating the districts at the prefecture level as the unit of analysis and controlling for the distance of each district to China's coastline mitigates the potential bias in the estimated impacts of tariff.

The baseline specification used in this section is

$$y_{dt} = \alpha_t + \beta Export_{dt} + \gamma_d + \varepsilon_{dt} \tag{21}$$

where d denotes district at the prefecture level and t denotes time (2000, 2010). y_{dt} is the variable of our concern, such as the agriculture employment share, in-migration share and regional productivity. $Export_{dt}$ is the measure of prefecture d's exports exposure at time t, constructed in the way that is described with more details in the next section. γ_d is the prefecture level fixed effects, which captures all time-invariant unobservable district effects including the distance to coastline. The model predicts $\beta < 0$ in the regression of agriculture employment share, while $\beta > 0$ in the regression of in-migration share, i.e. exports increases are associated with decreases in the agriculture employment share and increases in the migration in-flows relative to the national trend.

First differencing equation (21) removes the constant district heterogeneity and yields

$$\triangle y_d = \theta + \beta \triangle Export_d + \triangle \varepsilon_d \tag{22}$$

To eliminate potential bias, I extend equation (22) as the following to control for time-variant district factors that might affect both the export exposure and the agriculture employment share or the in-migrants flows

$$\triangle y_d = \theta + \beta_1 \triangle Export_d + \beta_2 \triangle X_d + \beta_3 y_{d,2000} + \beta_4 Z_d + \triangle \varepsilon_d \tag{23}$$

where $\triangle X_d$ is a vector of differenced control variables, including the population density, teacher to student ratio, education expenditure, access to public services, indicators of infrastructure, green land coverage, and the pollution indicators in the urban area within each district. $y_{d,2000}$ is the value of y_d in 2000 and it is used to capture the potential mean reversion. Z_d denotes the fixed district features, which includes economic region dummies and the distance to coastline.

Even with all control variables, $\triangle Export_d$ may still be endogenous. For example, the composition of consumers in each district might affect the likelihood of exporting. It is also correlated with the labor share in the urban area and the number of migrants. This potential endogeneity problem is addressed with the instrument variable (IV) method, with the reduction in tariff imposed by foreign countries on their imports from China as an IV. It is constructed along the same line as $\triangle Export_d$. More details can be found in the next section.

4.2 Data

This section describes two principal sources of data used in the subsequent analysis: the National Population Census and the Annual Survey of Industrial Production.

4.2.1 National Population Census (1990, 2000, 2010)

The sector employment data and migration data, which are used to construct the dependent variables in regressions, come from the fifth and sixth national population census conducted in 2000 and 2010 by the China's National Bureau of Statistics (NBS). It covers 2283 administrative units at the county level. Data on total population, registered household population, employed population by sectors, total population above 15 years old, stock of migrants of different types, and urban and rural population are aggregated to the prefecture level for analysis in the next section. The agriculture employment share is defined as the proportion of agriculture employment in total population above 15. Migrants in the census refer to people staying in one county other than their registered residence (*Hukou*) and have left their registered residence for more than 6 months. Only information on the stock of in-migrants is available. The absolute volume of migrants is not comparable across prefectures, so I use the ratio of in-migrants to the *Hukou* population to measure the attractiveness of each prefecture to migrants. I also use the individual data from the 1990 national population census to compute the industry employment used in the instrument. This microdata set is released by the IPUMS International database from the Minnesota Population Center.

4.2.2 Annual Survey of Industrial Production (1998-2007)

The employment in the manufacturing sector in 2000 at the prefecture-industry-year level and regional productivity are derived from the Annual Survey of Industrial Production conducted by NBS. It covers all state-owned enterprises (SOEs) and non-SOEs whose revenue is more than five million yuan each year in the manufacturing sector. The number of observations increases from 165,118 in 1998 to 336,768 in 2007 (Brandt et al., 2014). The dataset provides rich information on more than 100 financial variables listed in the main accounting sheets. It has been used in numerous studies to estimate productivity in China (Hsieh and Klenow, 2009; Song et al., 2011; Brandt et al., 2012). Though this survey does not cover all firms in China, the dataset accounts for 60% of total manufacturing employment (Coşar and Fajgelbaum. 2013). Observations with missing key financial variables and firms with fewer than eight workers[15] are excluded in the calculation of regional productivity.

[15]Following Brandt et al. (2012), firms with fewer than eight workers are dropped excluded since they fall under a different legal regime.

4.2.3 Other data

The prefecture-level control variables are constructed using data from the China City Statistics Year Book (2000, 2010) and the China County Economic Statistical Yearbook (2000, 2010). Data for 264 cities at the prefecture level are available for each year. The foreign tariff data come from the Trade Analysis and Information System (TRAINS) database, maintained by the United Nations Conference on Trade and Development (UNCTAD), aggregate using each trading partner's share in China's exports of that particular industry. Data on exports from China comes from the UN Comrade Database and is deflated using the GDP deflator from the World Bank. The original data is available at the six-digit HS product level. It is matched to the China Standard Industrial Classification (GB/T4754-1984, GB/T4754-1994 and GB/T4754-2002) at four-digit level. The distance to coastline is provided by the NASA's Ocean Biology Processing Group, which is used as a measure of world market access.

Table 4 presents summary statistics for export exposure per worker and agriculture employment share for years covered by the empirical analysis. The national average agriculture employment share decreased from 43.2% in 2000 to 32.0% in 2010, while the average export exposure per worker increased from 3,540 USD to 17,600 USD during this period.

4.3 Measures of Key Variables

4.3.1 Measures of exports induced employment

The empirical strategy relies on the geographic heterogeneity within China in exposure to trade based on the initial composition of employment. Instead of using the "district tariff" as the main control variable in regressions, I develop an export index to test the theoretical predictions in the previous sector directly. It is defined as the district-specific employment weighted sum of exports per worker, constructed with a methodology similar to the one used in Autor et al. (2013). Specifically, the index is defined as

$$Export_{dt} = (\sum_i \frac{Employ_{id2000}}{Employ_{i2000}} * EX_{it}) * \frac{1}{Employ_{d2000}}$$

where $Employ_{idt}$ stands for the number of workers employed by industry i in prefecture d at year t. So this index depends on the concentration of employment in export-intensive industries within each location. Since the Annual Survey of Industrial Production only covers 60% of total manufacturing employment in China, I time the employment share in each industry computed using firm-level data by the total number of employment in the manufacturing sector from the national population census to get the approximation of $Employ_{idt}$ in the total population. $Employ_{dt}$ is the size of total employed population reported by the national census in prefecture d in year t, while $Employ_{it}$ is the total employment in industry i at time t. EX_{it} denotes China's exports in industry i at time t. I use the start period employment for the calculation of both $Export_{d2000}$ and $Export_{d2010}$ so that the change in the employment composition over time does not affect the measure of district export exposure. Therefore, the first-differenced form of $Export_{dt}$ is

$$\triangle Export_d = \sum_i \left(\frac{\triangle EX_{it}}{Employ_{i2000}} * \frac{Employ_{id2000}}{Employ_{d2000}} \right) \quad (24)$$

To address the potential endogeneity problem of $\triangle Export_d$ in equation (23), I employ the tariff cut as the instrument, which is constructed as

$$\triangle Tariff_d = \sum_i \left(\frac{\triangle \ln(1+\tau_i)}{Employ_{i1990}} * \frac{Employ_{id1990}}{Employ_{d1990}} \right)$$

where $\triangle \ln(1+\tau_i)$ presents the log difference of other countries' tariffs for import from China during 2000-2010. This measure of foreign tariff cut is exogenous in the sense that it is the result of other countries trade policy and is unlikely to be influenced by the sectoral structural in China. It is also unlikely to influence the structural change and migration within China through channels other than export. In addition, it uses employment from 1990 to address the possibility that the contemporaneous employment in equation (24) is affected by the anticipated China's trade policy changes. Figure (9) reveals strong positive correlation between the change in regional export exposure and the change in the foreign tariff change.

4.3.2 Measures of regional manufacturing productivity

The regional manufacturing productivity used in this paper is defined as the weighted aggregate TFP in each prefecture

$$Pr_{dt} = \sum_i s_{idt} \ln TFP_{it}$$

where s_{idt} is the plant i's share of industry output at district d, and $\ln TFP_{idt}$ is the log form of plant-level TFP constructed using the approach following Pavcnik (2002). Specifically, the CobbDouglas production function:

$$\ln y_{it} = \beta_0 + \beta_1 \ln w_{it} + \beta_2 \ln m_{it} + \beta_3 \ln k_{it} + \epsilon_{it} \quad (25)$$

is estimated using the semi-parametric approach in Olley and Pakes (1996) in each industry, where y_{it}, w_{it}, m_{it} and k_{it} are plant i's gross output, total wage payment, intermediate inputs, and capital in year t, respectively. The effects of firms export behavior and the state-ownership are also taken into consideration in the estimation. TFP is defined as

$$\ln TFP_{it} = \ln y_{it} - (\hat{\beta}_1 \ln w_{it} + \hat{\beta}_2 \ln m_{it} + \hat{\beta}_3 \ln k_{it})$$

where $\hat{\beta}_i$ (i=1,2,3) are estimated coefficients in equation (25). Appendix D provides more details of the estimation procedure. Table 5 shows the estimated coefficients in equation (25) and average $\ln TFP$ in each main industry. There is large variation of the input coefficients across industries. Additionally, we could see a steady increase in the measured TFP across years.

4.4 Main findings

4.4.1 Basic results

Table 6 presents the primary estimates of the effects on increase in export on the agriculture employment share and migration patterns. Each column reports a different version of equation (23). The OLS results are given in the first two columns. Column (3) and (4) report results with the IV approach. China is divided into 8 regions, and I use region dummies in all regressions to capture unobserved regional trends. Standard errors are clustered by regions to account for spatial correlations.

For regressions where the only explanatory variable is the change in export exposure, the coefficients contradict predictions of the theoretical model but are statistically insignificant, while regressions with the initial value of the dependent variables supports the theoretical implications. This might be caused by mean reversion. Prefectures with larger change in trade exposure might be places where the initial agriculture employment share was already quite low in 2000, thus experienced less reduction in the agriculture employment during trade liberalization between 2000 and 2010. Therefore, the specification generating estimates in column (2) and column (4) is the preferred specification. The difference between the OLS and 2SLS estimates indicates that the potential simultaneity problem attenuates the point estimates towards zero.

Results in Panel A of Table 6 supports the theoretical implications of the relationship between increases in the export exposure and relative decrease in the agriculture employment share. The coefficients are significant at the 5 percent level. To find out whether the effects of export exposure is economically significant, consider the average employment-weight export exposure increased from 0.354 ($10,000) to 1.76 ($10,000) from 2000 to 2010, the point estimates in column (4) suggest a 6.4% decline in the agriculture employment share in a district experiencing the average increase. While the average decrease in agriculture employment share is 11.2% between 2000 and 2010 (see Table 3), the rising export exposure explains more than 50 percent of the decline during this period.

We next move to the impact of export increase on the relative attractiveness of prefectures to migrants. The preferred specification in Panel B suggests that during 2000-2010, the migrants to *Hukou* population ratio in the prefecture at the 75th percentile of export exposure growth (1.50) increased by 11.66 percentage points more than in a prefecture at the 25th percentile (0.41).

4.4.2 Heterogeneity in the trade effects

The model predicts that the effects of trade cost reduction on structural change decline over distance to the coastline. To test this prediction, I divide China into four bins based on the Eculidian distance of each cities to China's coastline and estimate the modification of equation (23):

$$\triangle y_d = \theta + \sum_{b=1}^{4} \beta_b(\triangle Export_d * D_b) + \sum_{b=2}^{4} \gamma_b D_b + \eta_1 \triangle X_d + \eta_2 y_{d,2000} + \triangle\varepsilon_d \qquad (26)$$

where D_b are dummies which takes the value of 1 when a prefecture belongs to the distance bin b. Results are presented in Table 6. The effect of the increase in the export exposure on the agriculture employment share is largest in the distance bin 150-300km, where the point estimate is around -0.06 for both the OLS and 2SLS estimations. It then decreases over distance to the coastline, which supports the theoretical implication of the heterogeneity in the effects of international trade. β_1 is smaller than β_2, but this is not inconsistent with the model, since both the first and second distance bins belong to the coastal area, while the second bin is closer to the interior region than the first one and associated with lower migrating cost for migrant workers.

I also run the 2SLS estimates of equation (23) for four distance bins separately. The point estimates of interests is still largest in the second distance bin but not statistically significant. Results are reported in column 3 to column 6 in Table 7.

4.4.3 Trade effects on manufacturing productivity

The underlying mechanism of the theoretical model is the productivity increase in the manufacturing sector induced by the trade impediments reduction. Employing the same identification strategy used for the analysis of labor mobility across space and sectors, I get significantly positive coefficient on the export exposure index. The value in column (2) of Table 8 suggests that an average increase in average employment-weight export exposure (from 0.354 to 1.76) raises the value of lnTFP by 0.04, while the average increase in the regional weighted average productivity ($\ln TFP$) is 0.09.

The estimated effects of export on productivity by distance distribution are presented in column (3) and (4) in Table 8. The effect is more than two times larger in the second distance bin, where the estimate is 0.0939, than in the last distance bin. The magnificence of coefficients on the interaction term is not monotonically increasing across distance, which is not perfectly consistent with the model. However, the effect of the increase in export exposure is statistically significant only in the first two distance bins, implying that the effects in regional further than 300 kilometers away from China's coastline are not precisely estimated.

4.5 Robustness checks

In this section, I discuss several robustness checks of the empirical results presented in Table 6. The first concern is the unit of analysis. As stated before, analysis with local markets requires labor to be "sufficiently immobile" across regions, otherwise labor migration smooths out price variations caused by difference in trade exposure. Therefore, in the regression of immigration ratio, the magnificence of the export exposure coefficient is expected to decreases if the unit of analysis is changed from prefecture to county[16]. However, the model predicts that regions with export increase would experience larger change in the agriculture employment in the case when migration is allowed than that in the case without interregional migration. Therefore, the effects of export exposure would be overestimated when we use a more detailed unit of analysis. Table 9 presents the results. Compared with Table 6, we can see that both coefficients are more statistically significant due to the increase in sample size, while there magnificence of coefficients move towards the direction as predicted.

I next turn to results from regressions with additional controls or alternative measure of openness. I only present results estimated with the IV method. The first column in Table 10 discusses factors in the agriculture sector that pushing migrants towards the manufacturing sector. Pushing factors discussed intensively in the literature includes low productivity, poor economic conditions, exhaustion of natural resources, and mechanization of certain processes reduce labor requirement in rural areas. Column (1) presents the results of the regression with rural population density, production of grains per capita and agriculture machines owned by each household. The incorporation of additional controls into the regression does not change our main results. Column (2) presents the results with import exposure per worker as additional controls. The point estimates are quite similar as that in Table 6.

The next two columns examine the issue with alternative measures of international trade exposure. Column (3) uses the gross export, which includes both exports and re-exports, as the main explanatory variable. Both the magnitude and statistical significance remain unchanged. The last column, however, shows that net-export, the difference between exports and imports, does not have significant impact on migration across space and sectors. This is not inconsistent with the model, since import might have opposite effects on firms' behavior compared with exports. In addition, the instrument is weak in predicting the export exposure than the net export change, as indicated by the Wald F-test in the first stage.

5 Conclusion

This paper develops a new general equilibrium model that brings together the dual economy structure, trade between and within countries, structural change across sectors, and factor mobility across space. I show that within each region a reduction in trade impediments

[16] This is because there are more labor flows between counties than between prefectures.

raises the average productivity. As a consequence, firms post more vacancies and workers migrate from the rural sector to the urban sector. In addition, reductions in international trade impediments have larger impacts on the labor market at locations with geographical advantages, inducing spatial movements of labor towards regions closer to the global market. Therefore, the economy gains from trade through increase in productivity, expansion of the manufacturing sector, and reallocation of labor across locations. Empirical evidence with China's population census data further confirms the theoretical implications.

In addition, by comparing the decentralized competitive equilibrium with the socially optimal solution, I show that falls in trade barriers exacerbate the existing distortions caused by matching frictions but decrease the misallocation of labor across sectors and space. Trade can significantly reduce labor market distortions if between-sector distortions are quite large. It implies a potential channel through which the economy can gain from trade. It also suggests important policy implications that subsidies to encourage firms to search for workers more insensitively can offset part of the downside of trade liberalization.

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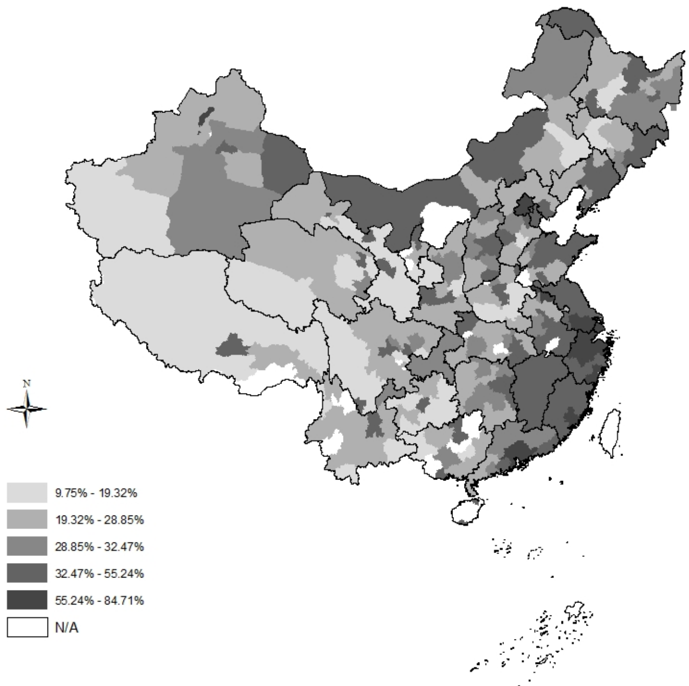
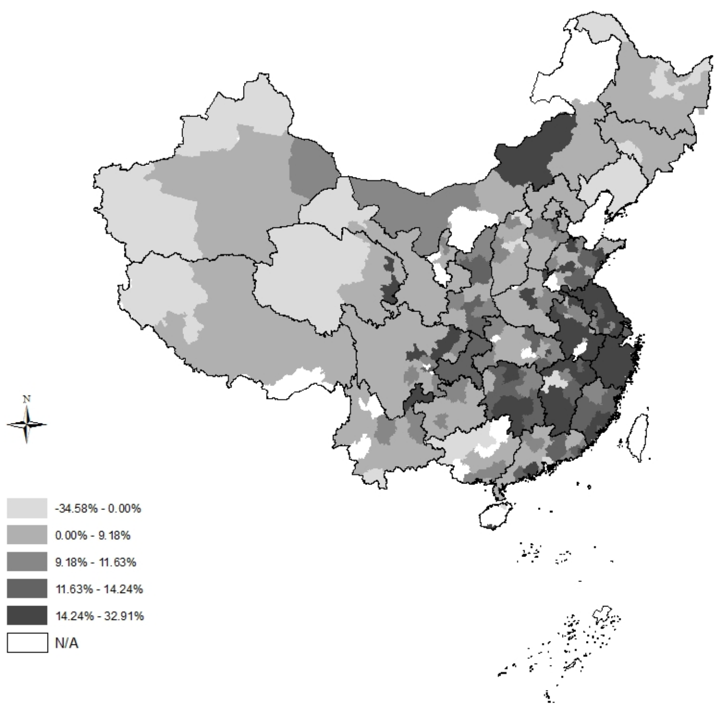
Figure 1: Agriculture employment share and export share during 1978-2008



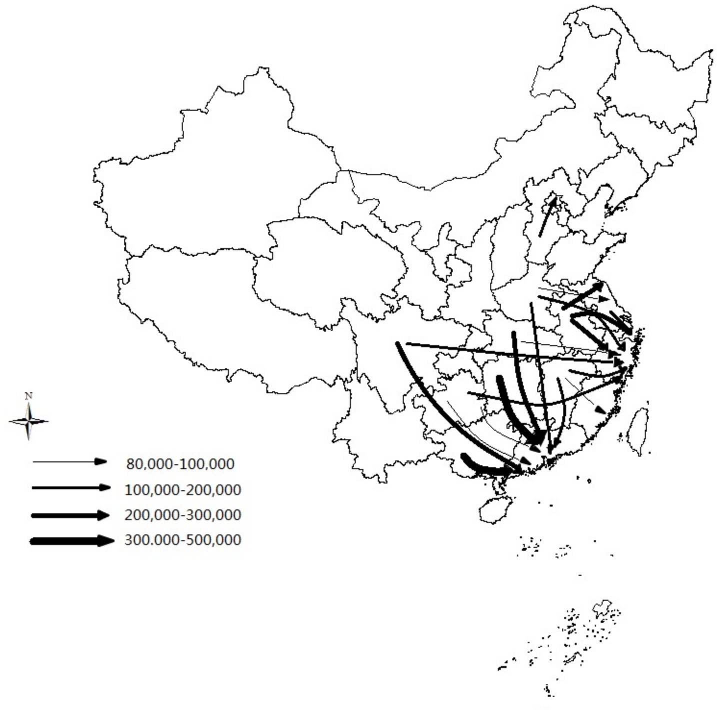
(a) Share of non-agriculture sector employment



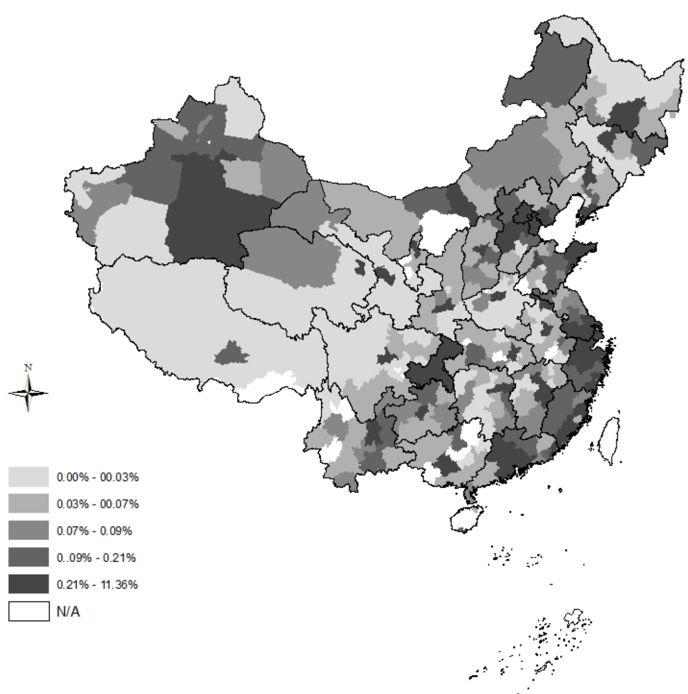
(b) Change in non-agriculture employment share during 2000-2010

Source: See main text; N/A=data is not available

Figure 2: Share of non-agriculture employment in 2010



(a) 20 largest inter-province migration flows



(b) Share of inter-province migration

Source: See main text; N/A=data is not available

Figure 3: Share of Inflow and outflow population in 2010

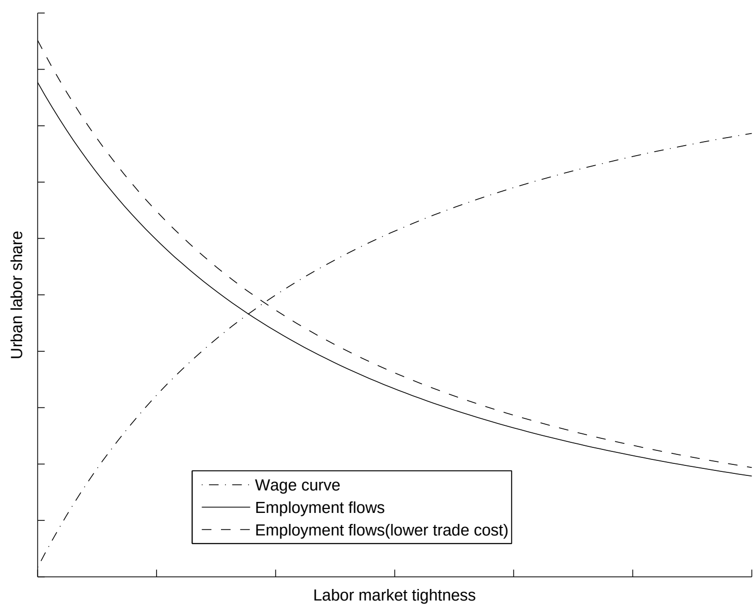
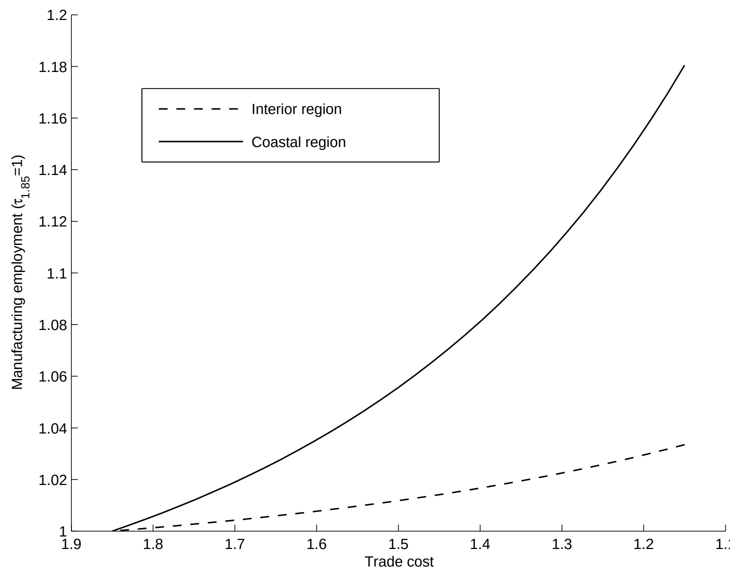
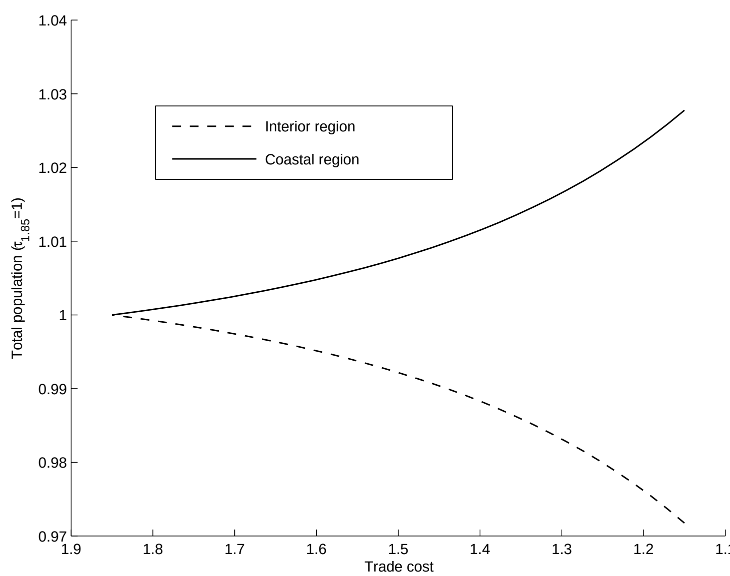


Figure 4: Effects of trade cost reduction with symmetric regions

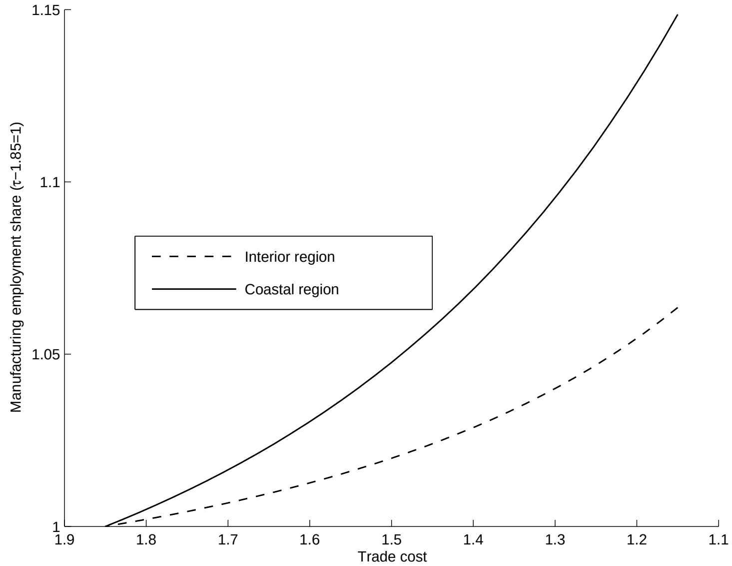


(a) International Trade cost and total regional urban employment



(b) International trade cost and total regional population change

Figure 5: Effects of trade cost reduction with asymmetric regions



(c) International trade cost and urban labor share

Figure 5: Effects of trade cost reduction with asymmetric regions (continue)

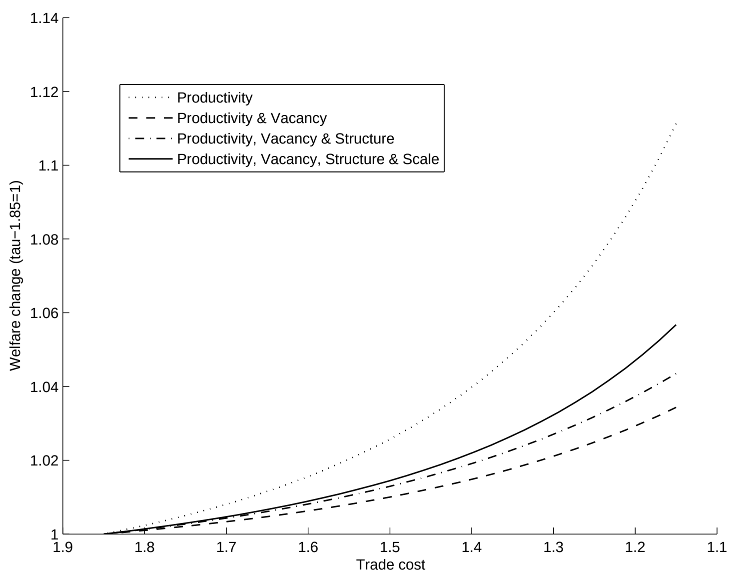
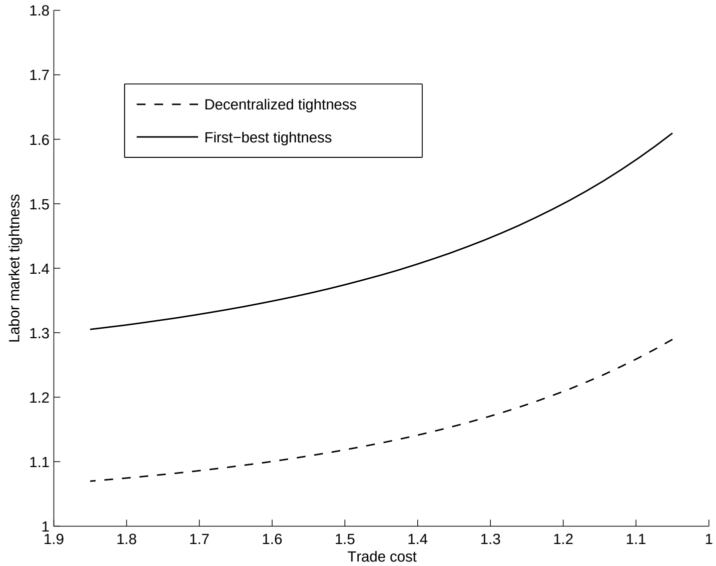
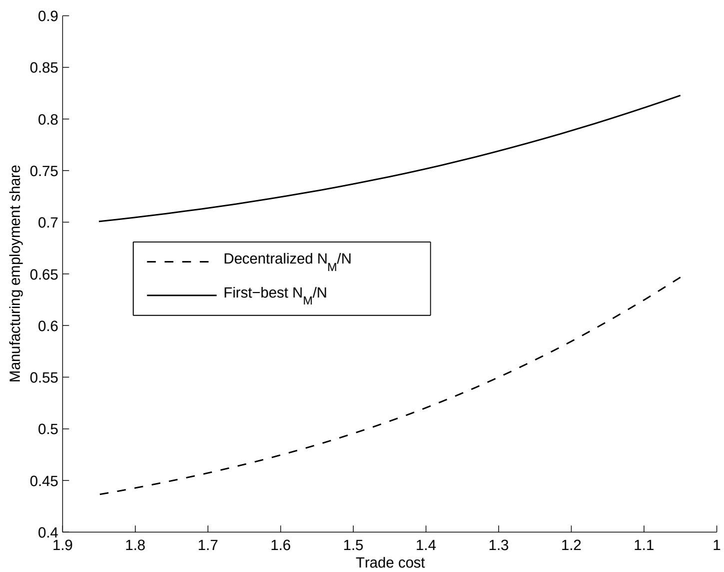


Figure 6: Decomposition of the welfare gains from trade

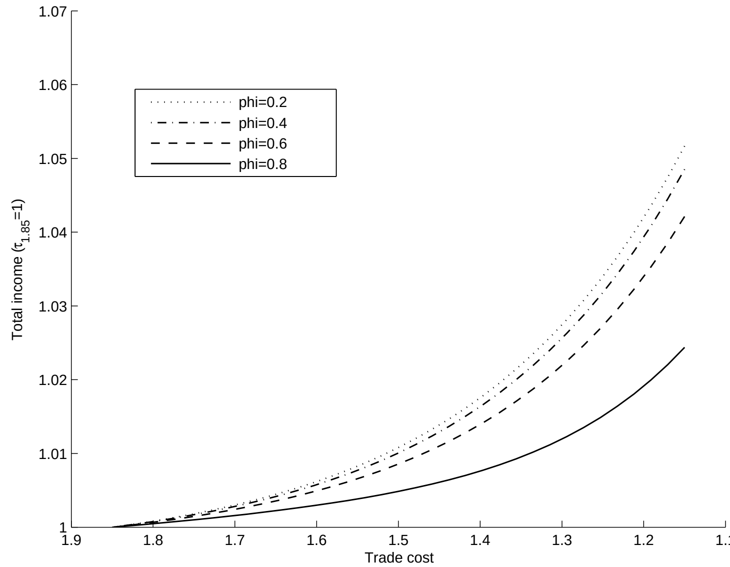


(a) Trade cost and labor market tightness

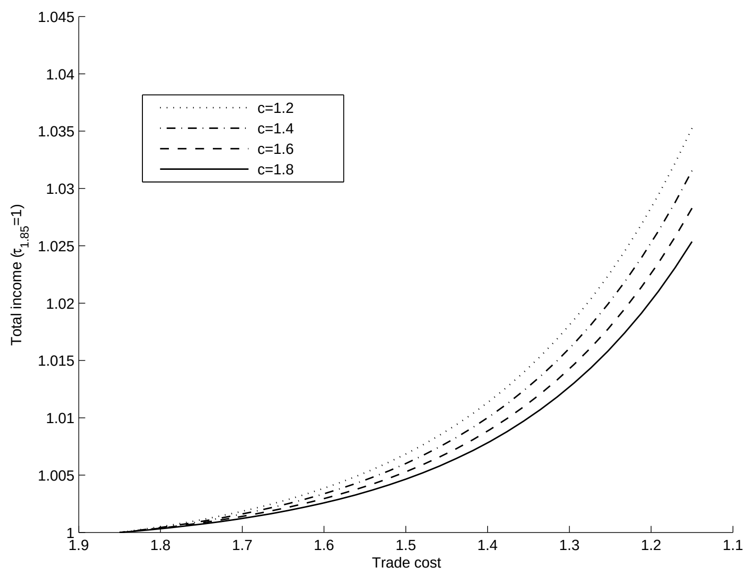


(b) Trade cost and manufacturing employment share

Figure 7: The decentralized competitive equilibrium and social optimal solution

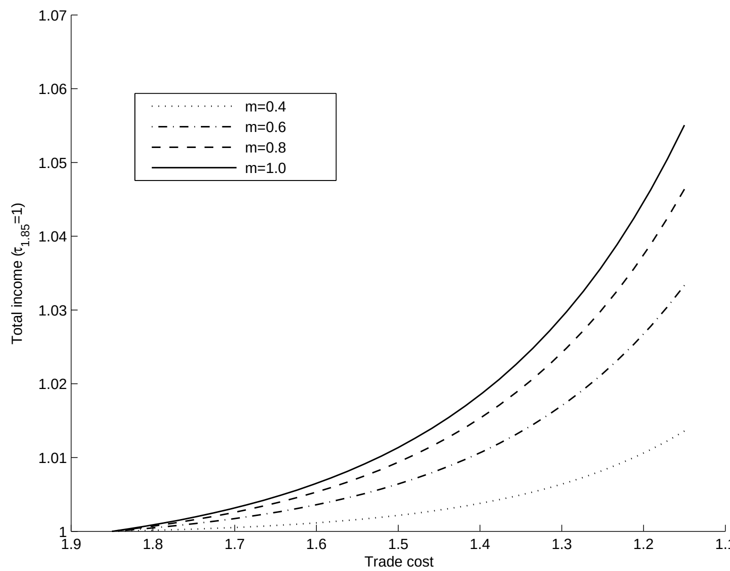


(a) Different values of labor elasticity in the agriculture production function



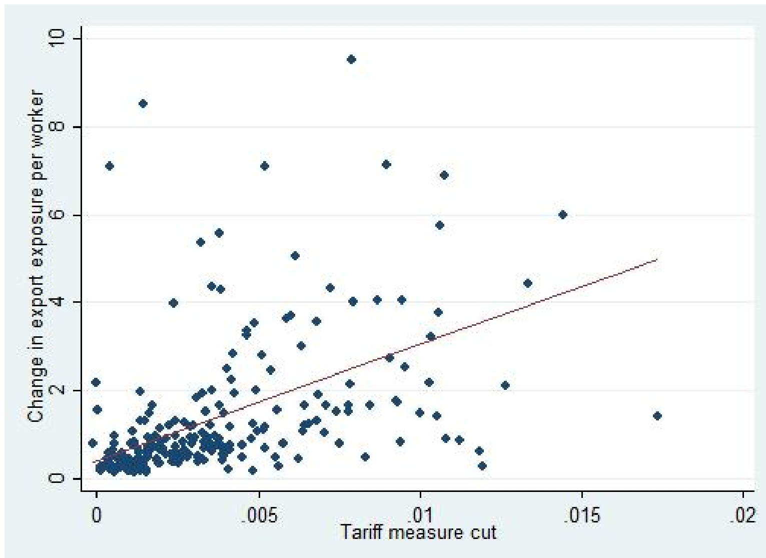
(b) Different values of vacancy posting cost

Figure 8: The welfare gains from trade and labor market distortions

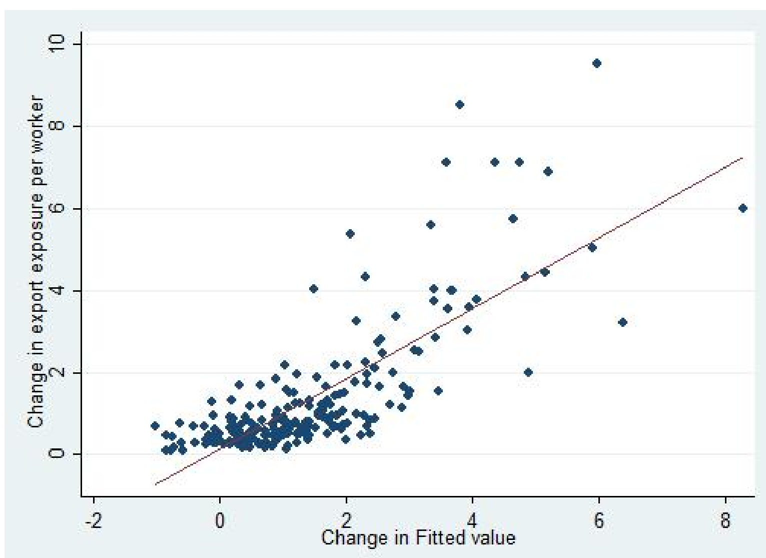


(c) Different values of matching efficiency

Figure 8: The welfare gains from trade and labor market distortions (continue)



(a) First Stage: Change in export exposure and foreign tariff



(b) Change in export exposure and Predicted values

Figure 9: The prediction power of the instrument variable

Table 1: Calibration-parameter values

Parameter	Definition	Value	Source/Target
σ	Elasticity of substitution	4	Bernard et al. (2003)
c	Cost of hiring	1.4	1.1 times monthly wage (Felbermayr et al., 2011)
α	Parameter in the utility function	0.7	$0 < \alpha < (\sigma - 1)/\sigma < 1$
γ	Decay of productivity distribution	3.2	$\gamma > \sigma - 1$ to ensure that the variance of the sales distribution is finite
s	Actual rate of job separation	0.07	Unemployment rate around 11% (Giles et al., 2005)
m	Scale of matching function	0.6	labor market tightness 0.9-1.1 (Xiao, 2013)
β	Wage bargaining power	0.5	Standard
δ	Rate of firm exit	0.01	Felbermayr et al. (2011)
r	Monthly discount rate	0.42%	5% annual interest rate
N	Total population size	2	Normalization
H	Local amenity shared by worker	1	Normalization

Table 2: Simulation results of main variables

International trade cost	1.15	1.45	1.85	1.15	1.45	1.85
	Interior region			Coastal region		
Domestic sale productivity threshold	4.5001	4.3249	4.2446	4.5781	4.3693	4.27
International sale productivity threshold	6.966	8.6963	11.1246	6.7052	8.3246	10.6182
Urban labor	0.4193	0.3719	0.3289	0.5263	0.4277	0.3565
Total population	0.9577	0.9805	0.9904	1.0423	1.0195	1.0096
Urban labor share	43.79%	37.93%	33.21%	50.50%	41.95%	35.65%
Vacancy-unemployment rate	1.1774	0.9619	0.8106	1.2439	1.0008	0.8335
Unemployment rate	9.71%	10.63%	11.47%	9.47%	10.44%	11.33%

Table 3: Gains from trade and changes in distortions

Decrease in the trade cost (initial τ=1.85)	0.2	0.4	0.6	0.8
Change in manufacturing employment share (%)	7.14	16.26	30.80	48.20
Change in first-best manufacturing employment share(%)	2.76	6.19	11.43	17.42
Gains from efficiency increase	4.37	10.07	19.37	30.78
Change in φ (%)	2.30	5.53	11.51	20.54
Change in first-best φ (%)	2.71	6.46	13.27	23.32
Gains from efficiency increase	-0.41	-0.93	-1.75	-2.77
Relative total revenue (competitive/first-best) (%)	92.29	92.74	93.50	94.49
Change in tax on w_A (%)	-0.29	-0.47	-0.60	-0.68
Change in subsidy on c (%)	0.11	0.27	0.53	0.88

Table 4: Summary statistics

	2000		2010		Difference
	Mean	Sd	Mean	Sd	Mean
Export exposure per worker(10,000 USD)	0.354	0.518	1.76	2.7	1.41
Agriculture employment share	0.432	0.196	0.32	0.15	-0.112
Migration ratio	0.0996	0.367	0.148	0.282	0.0481
Population density	1,189	1,032	1,080	1,087	-109
Green land	28.47	10.25	40.6	22.69	12.13
Education expenditure	13.51	4.914	17.53	4.387	4.02
Teacher to student ratio	0.0674	0.0143	0.0734	0.0254	0.006
Waste	69.55	24.84	94.6	8.001	25.05
Paved Road	5.218	3.461	10.49	5.419	5.272

Table 5: Estimates of Olley-Pakes TFP by industry

Industry	Labor	Materials	Capital	lnTFP1998	lnTFP2000	lnTFP2002	lnTFP2005
13	0.0533	0.8783	0.0396	0.489	0.5866	0.6241	0.6244
14	0.0623	0.9048	0.0307	0.3791	0.429	0.4137	0.5119
15	0.0883	0.8815	0.0358	0.4334	0.4639	0.4644	0.5796
17	0.0665	0.8801	0.0254	0.5183	0.535	0.571	0.6417
18	0.1115	0.819	0.0391	0.6427	0.6579	0.6437	0.7755
19	0.0693	0.8756	0.03	0.5383	0.5458	0.5492	0.6165
20	0.1451	0.8105	0.0523	0.4833	0.7484	0.7073	1.0753
21	0.1034	0.8683	0.0299	0.4991	0.479	0.5382	0.7656
22	0.0731	0.8811	0.0242	0.5083	0.5488	0.5749	0.7735
23	0.1056	0.8685	0.0425	0.3629	0.3687	0.4049	0.6253
24	0.0962	0.8531	0.0329	0.5599	0.5618	0.549	0.7063
25	0.0374	0.8837	0.0282	0.696	0.6474	0.7204	0.5323
26	0.0789	0.8533	0.0386	0.5297	0.581	0.6088	0.6388
27	0.0996	0.8358	0.0589	0.4143	0.4979	0.5269	0.7385
29	0.08	0.8459	0.0653	0.2946	0.3639	0.4042	0.5537
30	0.0954	0.8352	0.0461	0.5301	0.5324	0.6	0.8543
31	0.077	0.8723	0.0328	0.4637	0.5243	0.5347	0.7778
32	0.0436	0.9019	0.0314	0.4333	0.4694	0.4968	0.4529
33	0.0604	0.8735	0.0204	0.6609	0.6686	0.7487	0.6743
34	0.0777	0.846	0.047	0.5314	0.5384	0.5747	0.6221
35	0.074	0.8734	0.0366	0.4326	0.4505	0.4699	0.5779
36	0.0887	0.878	0.0302	0.395	0.4402	0.4619	0.5981
37	0.1002	0.8644	0.0314	0.4551	0.4944	0.5299	0.6419
39	0.0751	0.8623	0.0387	0.5335	0.585	0.5808	0.5915
40	0.1436	0.8237	0.0386	0.5982	0.6647	0.6627	0.9054
41	0.1206	0.8366	0.0368	0.5494	0.6132	0.6498	0.8315
42	0.0703	0.867	0.0225	0.6865	0.7364	0.7531	0.8095

Notes: The Chinese industries are classified as: (13) food processing; (14) food manufacturing; (15) beverage; (17) textiles; (18) apparel; (19) leather, fur, feather products; (20) wood processing and wood, bamboo and palm fiber products manufacturing; (21) furniture; (22) paper and paper products; (23) printing and reproduction of recording media; (24) education and sporting goods; (25) petroleum and nuclear fuel processing; (26) chemicals and chemical products; (27) medicines; (28) chemical fibers; (29) rubber; (30) plastic; (31) non-metallic minerals; (32) ferrous metal smelting and rolling processing; (33) non-ferrous metal smelting and rolling processing; (34) fabricated metal; (35) general machinery; (36) special machinery; (37) transportation equipment; (39) electrical machinery; (40) communications equipment, computers and other electronic equipment; (41) instrumentation and office machinery; (42) artwork and other manufacturing. Other industries not listed in the table are dropped due to the small sample size in the estimation of TFP

Table 6: The effects of export exposure on migration across sectors and space

	OLS		2SLS	
	(1)	(2)	(3)	(4)
		A. △Agriculture share		
△Export exposure per worker	0.0103	-0.0093*	0.0193*	-0.0456*
	(0.0060)	(0.0048)	(0.0094)	(0.0240)
Constant	-0.123***	0.185**	-0.130***	0.320***
	(0.0096)	(0.0502)	(0.0136)	(0.0700)
Agriculture share 2000	No	Yes	No	Yes
△Prefecture controls	No	Yes	No	Yes
Region dummies	Yes	Yes	Yes	Yes
Distance to coastline	Yes	Yes	Yes	Yes
Observations	259	228	238	213
R-squared	0.493	0.69	0.475	0.59
		B.△Migrants ratio		
△Export exposure per worker	-0.0437	0.0551***	-0.0139	0.107**
	(0.0260)	(0.0118)	(0.0490)	(0.0476)
Constant	0.113***	-0.0488*	0.0799	-0.0719**
	(0.0315)	(0.0232)	(0.0608)	(0.0352)
Migrants ratio 2000	No	Yes	No	Yes
△Prefecture controls	No	Yes	No	Yes
Region dummies	Yes	Yes	Yes	Yes
Distance to coastline	Yes	Yes	Yes	Yes
Observations	259	228	238	213
R-squared	0.163	0.881	0.109	0.853

Note: Standard errors in parentheses are cluster in region.
[*] $p < 0.05$, [**] $p < 0.01$, [***] $p < 0.001$

Table 7: Heterogeneity in the effects of trade

Dependent Variable	Full sample		0-150Km	150-300km	300-650km	650-1200km
△Agriculture share	OLS	2SLS	2SLS	2SLS	2SLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)
△Export exposure per worker	-0.0212**	-0.0342*				
× Coastline 0-150km	(0.00823)	(0.0190)				
△Export exposure per worker	-0.0616**	-0.0622				
× Coastline 150-300km	(0.0229)	(0.0400)				
△Export exposure per worker	-0.0182	-0.0519				
× Coastline 300-650km	(0.0366)	(0.0339)				
△Export exposure per worker	-0.0098	-0.00844				
× Coastline 650-1200km	(0.0200)	(0.0668)				
△Export exposure per worker			-0.0578**	-0.0748	0.212	0.0318
			(0.0275)	(0.0678)	(0.537)	(0.0876)
Constant	0.244**	0.289***	0.387***	0.317***	-0.335	0.0706
	(0.0783)	(0.0807)	(0.0944)	(0.0917)	(0.885)	(0.179)
Agriculture share 2000	Yes	Yes	Yes	Yes	Yes	Yes
△Prefecture controls	Yes	Yes	Yes	Yes	Yes	Yes
Distance bin dummies	Yes	Yes	No	No	No	No
Observations	221	206	76	39	47	44
R-squared	0.622	0.617	0.643	0.748	0.207	0.746

Note: Standard errors in parentheses are cluster in region.
[*] $p < 0.05$, [**] $p < 0.01$, [***] $p < 0.001$

Table 8: The effects of export exposure on productivity

	(1)	(2)	(3)	(4)
Dependent Variable: △lnTFP	OLS	2SLS	OLS	2SLS
△Export exposure per worker	0.0196***	0.0282***		
△Export exposure per worker			0.0182***	0.0244***
× Coastline 0-150km			(0.00280)	(0.00502)
△Export exposure per worker			0.0606**	0.0939***
× Coastline 150-300km			(0.0183)	(0.0314)
△Export exposure per worker			-0.0437	-0.00983
× Coastline 300-650km			(0.0445)	(0.0305)
△Export exposure per worker			0.0241	0.0236
× Coastline 650-1200km			(0.0571)	(0.0505)
Constant	0.371***	0.375***	0.372***	0.355***
	(0.0649)	(0.0651)	(0.0617)	(0.0643)
TFP in 2000	Yes	Yes	Yes	Yes
△Prefecture controls	Yes	Yes	Yes	Yes
Observations	260	239	258	237
R-squared	0.659	0.658	0.619	0.621

Note: Standard errors in parentheses are cluster in region.
[*] $p < 0.05$, [**] $p < 0.01$, [***] $p < 0.001$

Table 9: The effects of export exposure on migration across sectors and space(county level)

	(1)	(2)	(3)	(4)
Dependent Variable	△Agriculture share		△Migrants ratio	
	OLS	2SLS	OLS	2SLS
△Export exposure per worker	-0.0106**	-0.0492**	0.0230***	0.0503***
	(0.00440)	(0.0247)	(0.00590)	(0.0185)
Constant	0.0553	0.229**	-0.0178*	-0.0387*
	(0.0448)	(0.0985)	(0.00932)	(0.0229)
Agriculture share 2000	No	Yes	No	Yes
△Prefecture controls	No	Yes	No	Yes
Region dummies	Yes	Yes	Yes	Yes
Distance to coastline	Yes	Yes	Yes	Yes
Observations	1,730	1,631	1,730	1,631
R-squared	0.334	0.253	0.297	0.227

Note: Standard errors in parentheses are cluster in region.
[*] $p < 0.05$, [**] $p < 0.01$, [***] $p < 0.001$

Table 10: Robustness checks

	(1)	(2)	(3)	(4)
	A. △Agriculture share			
△Export exposure per worker	-0.0432*	-0.0424*	-0.0458*	-0.0162
	(0.0223)	(0.0228)	(0.0244)	(0.0124)
Constant	0.222**	0.304***	0.320***	0.176**
	(0.105)	(0.0714)	(0.0697)	(0.0730)
Agriculture share 2000	No	Yes	No	Yes
△Prefecture controls	No	Yes	No	Yes
Region dummies	Yes	Yes	Yes	Yes
Distance to coastline	Yes	Yes	Yes	Yes
Observations	259	228	238	213
R-squared	0.493	0.690	0.475	0.590
	B. △Migrants ratio			
△Export exposure per worker	0.138**	0.105**	0.109**	0.0493
	(0.0567)	(0.0414)	(0.0471)	(0.0361)
Constant	-0.0660	-0.0717**	-0.0703*	-0.0939*
	(0.0588)	(0.0356)	(0.0363)	(0.0548)
Migrants ratio 2000	No	Yes	No	Yes
△Prefecture controls	No	Yes	No	Yes
Region dummies	Yes	Yes	Yes	Yes
Distance to coastline	Yes	Yes	Yes	Yes
Observations	259	228	238	213
R-squared	0.163	0.881	0.109	0.853

Note: Standard errors in parentheses are cluster in region.
[*] $p < 0.05$, [**] $p < 0.01$, [***] $p < 0.001$

Appendix

A. Solve the model

Equation (1) implies that $y_{ij} = \tau_{ij}^{-\frac{\rho}{1-\rho}} y_{ii}(\frac{Y_i}{Y_j})^{-\frac{\rho-\alpha}{1-\rho}}$, given $p_{ij} = \tau_{ij}p_{ii}$. Therefore, the general form of total revenues of a firm with productivity θ reads

$$R_i(\theta) = \theta^\rho h_i(\theta)^\rho \big[Y_i^{-\frac{(\rho-\alpha)}{1-\rho}} + \sum_{j\neq i} I_{ij}(\theta)\tau_{ij}^{-\frac{\rho}{1-\rho}} Y_j^{-\frac{(\rho-\alpha)}{1-\rho}}\big]^{1-\rho} \tag{27}$$

Following Felbermayr et al. (2011), the first condition of dynamic problem in equation (7) leads to

$$\frac{\partial R_i(l;\theta)}{\partial l} = \frac{c}{q(\varphi_i)}\frac{r+\psi}{1-\delta} + w_i(l:\theta) + \frac{\partial w_i(l;\theta)}{\partial l} l \tag{28}$$

Therefore,

$$\frac{\partial J_i(l;\theta)}{\partial l} = \frac{1}{\psi+r}\big[\frac{\partial R_i(l;\theta)}{\partial l} - w_i(l:\theta) - \frac{\partial w_i(l;\theta)}{\partial l} l\big] \tag{29}$$

Additionally, solving the problem in (5) yields

$$(1-\beta)[E_i(l:\theta) - U_i] = \beta\frac{\partial J_i(l;\theta)}{\partial l} \tag{30}$$

while in steady state the equations in (6) can be written as

$$rE_i(l:\theta) = w_i(l;\theta) - \psi[E_i(l:\theta) - U_i]$$

$$rU_i = \varphi_i q(\varphi_i)[E_i(l:\theta) - U_i] \tag{31}$$

Combining equation (30) with (31) leads to

$$\frac{\partial J_i(l;\theta)}{\partial l} = \frac{1-\beta}{\beta}\frac{1}{r+\psi}(w_i(l;\theta) - rU_i)$$

Substituting this expression into the left hand side of equation (29) and solving the the differentiate equation, $w_i(l;\theta)$ can be written as

$$w_i = (1-\beta)rU_i + \beta\frac{\sigma}{\sigma-\beta}\frac{\partial R_i(l;\theta)}{\partial l} \tag{32}$$

Take derivative of equation (32) with respect to l, we obtain

$$\frac{\partial w_i(l;\theta)}{\partial l} l = \beta\frac{\sigma}{\sigma-\beta}(-\frac{1}{\sigma})\frac{\partial R_i(l;\theta)}{\partial l}$$

Reinserting it into equation (28) gives

$$w_i(l;\theta) = \frac{\sigma}{\sigma - \beta}\frac{\partial R_i(l;\theta)}{\partial l} - (\frac{r+\psi}{1-\delta})\frac{c}{q(\varphi_i)} \tag{33}$$

Combined with equation (32), the above equation yields the expression of wage

$$w_i(l;\theta) = rU_i + \frac{\beta}{1-\beta}\frac{r+\psi}{1-\delta}\frac{c}{q(\varphi_i)}$$

which is equation (9) in the main text.

With the wage curve in equation (9) and the relation between $R_i(l:\theta)$ and w as shown in equation (33), we have

$$a(\varphi_i) = \frac{\beta}{1-\beta}\frac{1}{1-\delta}\frac{\sigma-\beta}{\sigma}[\varphi_i c + \frac{r+\psi}{\beta}\frac{c}{q(\varphi_i)}]$$

Let $l_{ii}(\theta)$ and $l_{ij}(\theta)$ denote the employment for domestic and export sales to market j respectively. With the expression of $R_i(l:\theta)$ in equation (27) and the optimal allocation rule between the employment for domestic sale and export sales, we can solve for

$$l_{ii} = \rho^{\frac{1}{1-\rho}} Y_i^{-\frac{\rho-\alpha}{1-\rho}} \theta_i^{\frac{\rho}{1-\rho}} a(\varphi_i)^{-\frac{1}{1-\rho}}$$

$$l_{ij} = \tau_{ij}^{-\frac{\rho}{1-\rho}} \rho^{\frac{1}{1-\rho}} Y_j^{-\frac{\rho-\alpha}{1-\rho}} \theta_i^{\frac{\rho}{1-\rho}} a(\varphi_i)^{-\frac{1}{1-\rho}} \tag{34}$$

Next solve the zero profit cutoff conditions. Since firms pay fixed cost and vacancy posting cost first and start production in the next period, the profits earned in market j in each period $\pi_{ij}(\theta)$ satisfies

$$\frac{1}{1+r}\sum_{t=0}^{\infty}(\frac{1-\delta}{1+r})^t \pi_{ij}(\theta) \equiv \sum_{t=1}^{\infty}(\frac{1-\delta}{1+r})^t([R_{ij}(l:\theta) - w_{Mi}(l;\theta)l_{ij} - cv_i - f_{ij}] - \frac{c}{q_i(\varphi)}l_{ij} - f_{ij} \tag{35}$$

where $R_{ij}(l:\theta)$ represents the total revenue from the sales to market j from location i, l_{ij} is the employment for the sales to market j. Therefore, the productivity threshold θ^*_{ij} satisfies

$$\sum_{t=1}^{\infty}(\frac{1-\delta}{1+r})^t([R_{ij}(l:\theta^*_{ij}) - w_{Mi}(l;\theta^*_{ij})l_{ij} - cv_i - f_{ij}] = \frac{c}{q_i(\varphi)}l_{ij} - f_{ij}$$

Combining this equation with equation (33) leads to

$$R_{ij}(\theta^*_{ij}) = \frac{1+r}{1-\delta}\frac{\sigma-\beta}{1-\beta}f_{ij} \tag{36}$$

We can obtain the expression of productivity threshold (11) in the main text using the expression of R_{ij}, equation (34) and condition (36).

Next solve the free entry condition. For any two firms with productivity θ_1 and θ_2, we have $\frac{R_{ij}(\theta_1)}{R_{ij}(\theta_2)} = (\frac{\theta_1}{\theta_2})^{\frac{\rho}{1-\rho}}$. Combined with equation (36), this condition implies

$$R_{ij}(\theta) = (\frac{\theta}{\theta^*_{ij}})^{\frac{\rho}{1-\rho}}(\frac{1+r}{1-\delta}\frac{\sigma-\beta}{1-\beta})f_{ij}$$

Hence, the free entry condition can be simplified as

$$\sum_j f[(\frac{\tilde{\theta_{ij}}}{\theta^*_{ij}})^{\frac{\rho}{1-\rho}} - 1] = \frac{(r+\delta)}{(1+r)}\frac{f_e}{1-G(\theta^*_{ii})}$$

B. Proof of lemma 1 and lemma 2

In the model with symmetric regions, equation (14) can be reduced to

$$\frac{\theta^*_d}{\theta^*_x} = (\frac{f_d}{f_x})^{\frac{\rho}{1-\rho}}\tau^{-1}$$

Therefore, the impact of variable trade cost τ on cutoffs satisfies

$$\hat{\theta}^*_x = \tau + \hat{\theta}^*_d$$

In addition, differentiating the free-entry condition leads to

$$\sum_j \{\frac{f_{ij}}{\theta^*_{ij}}\int_{\theta^*_{ij}.}^{\infty}\theta^{\sigma-1}dG(\theta)\hat{\theta}^*_{ij}\} = 0$$

Combining the above two equations yields the expression of changes in productivity thresholds (18) in the main text. Lemma 1 follows the sign of coefficients in equation (18).

To see why lemma 2 holds, total differentiating equation (15) yields

$$\frac{dN_M}{d\varphi} = \frac{\beta}{1-\beta}\frac{1}{1-\delta}cw'^{-1}_A(N_M) > 0 \quad (37)$$

Additionally, substituting (14) into (17) and total differentiating the equation yield:

$$\frac{dN_M}{d\varphi} = -\frac{x'(\varphi)/[x(\varphi)+\psi]^2\psi N_M + [\alpha\rho/(\rho-\alpha)+1]a^{-2}(\varphi)a'(\varphi)\rho Y^\alpha}{x(\varphi)/(x(\varphi)+\psi)} < 0 \quad (38)$$

The above results imply that the wage curve in equation (15) and labor flow function (17) are monotonic and intersect with each other at a unique point. Therefore, given the value of productivity threshold, there exists an unique solution of N_M and φ. In addition, combining equation (37) and (38) yields the relation between φ and θ^*_d as: $\hat{\varphi} = \phi\hat{\theta}^*_d$, where $\phi = \frac{\rho}{a(\varphi)}Y^\alpha\frac{\alpha\rho}{\rho-\alpha}/\{\varphi\{\frac{x'(\varphi)\psi N_M}{(x(\varphi)+\psi)^2}+(\frac{\alpha\rho}{\rho-\alpha}+1)a^{-2}(\varphi)a'(\varphi)\rho Y^\alpha+\frac{x(\varphi)}{x(\varphi)+\psi}w'^{-1}_A(N_M)\frac{\beta}{1-\beta}\frac{1}{1-\delta}c\}\} > 0$. Therefore, reduction in trade cost increases φ by raising the value of θ^*_d.

C. The planner's problem

The planner's problem is to maximize total net revenue by choosing the appropriate number of vacancy posted by firms in the manufacturing sector and allocating workers across firms and sectors. The corresponding Bellman equation is

$$V(L,D) = \max_{l(\theta),\varphi,N_A} \frac{1}{1+r}\Big[\int_{\theta_d^*}^{\infty} R(\theta,l)dG(\theta) + F(N_A) - c\varphi D + V(L';D')\Big]$$

$$\text{s.t.} \quad \int_{\theta_d^*}^{\infty} l(\theta)dG(\theta) = L$$

$$L' = (1-\psi)L + x(\varphi)D$$

$$D = \psi(\bar{N} - N_A - D) + (1 - x(\varphi))D$$

where L is the total employment in the manufacturing sector and D is the total unemployment. The first order conditions leads to equal marginal product across firms and the two equations in (19).

D. Procedures to compute the measure of TFP

To get the firm level TFP, equation (25) is estimated with the augmented semi-parametric "Olley-Pakes" method following Pavcnik (2002). Specifically, I first get $\hat{\beta}_1$and $\hat{\beta}_2$in equation (25) by estimating

$$\ln y_{it} = \beta_0 + \beta_1 \ln w_{it} + \beta_2 \ln m_{it} + \lambda(\ln k_{it}, I_{it}, EX_{it}, SOE_{it}) + \epsilon_{it} \tag{39}$$

where $\lambda$is a third order polynomial series expansion in capital, investment, firm's export dummy EX and state owned dummy SOE. I then estimate the coefficient for capital with the following equation

$$R_{it} = \beta_3 \ln k_{it} + \phi(\hat{\lambda}_{i,t-1} - \beta_3 k_{i,t-1}, \hat{P}_{i,t-1}) + \epsilon_{it} \tag{40}$$

where R_{it} is the residual in equation (39) and it's calculated as

$$R_{it} = \ln y_{it} - \hat{\beta}_1 \ln w_{it} - \hat{\beta}_2 \ln m_{it}$$

$\hat{P}$ is fitted value of the probability at which a firm will stay in the market in the next period. I estimate this survival probability with a third order polynomial in capital and investment and use a third order polynomial series expansion in $\hat{P}$ and $\hat{\lambda}_{i,t-1} - \beta_3 k_{i,t-1}$ to approximate ϕ. Equation (40) is estimated with non-linear least squares since the coefficient of capital in the first term and second term are the same.

Data used to estimate TFP comes from the Annual Survey of Industrial Production (1998-2007). The panel of firms and variables for estimation are constructed following the approach in the online appendix of Brandt et al. (2012).