United Nations University

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World Institute for Development Economics Research

Discussion Paper No. 2003/61

# International Trade, Location and Wage Inequality in China

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September 2003

**Abstract**

Models of economic geography predict that transportation costs directly affect demand for goods and the supply of intermediate inputs. One of the reasons that international trade is concentrated in the coastal provinces of China is that they have lower transportation costs in transporting goods to other countries than do provinces in the interior. This paper examines the relationship between the provincial wage rate and each province's access to international markets, and to suppliers of intermediate inputs. A gravity equation is first estimated to construct these 'market access' and 'supplier access' variables. In the second stage, the effect of market access and supplier access on the wage rate is estimated. It is found that about one quarter of the provincial wage differences in the coastal provinces and 15 per cent of the wage differences in the interior provinces can be explained by these economic geography variables.

Keywords: trade, China, regional disparities, wage rates
JEL classification: F14, O53, R12

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This study has been prepared within the UNU/WIDER project on Spatial Disparities in Human Development, directed by Ravi Kanbur and Tony Venables.

UNU/WIDER gratefully acknowledges the financial contribution to the project by the Government of Sweden (Swedish International Development Cooperation Agency—Sida).

**Acknowledgements**

This paper represents part of my Ph.D. dissertation. I would like to give special thanks to my advisor Robert Feenstra for his insightful guidance and comments. Discussions with Deborah Swenson and Lee Branstetter are gratefully acknowledged. I am grateful to Shuming Liang for providing useful materials and detailed information on China's geographic features. This paper has benefited from the comments of the participants in the Macroeconomics Workshop and the Macroeconomics International Seminar at the University of California, Davis.



UNU World Institute for Development Economics Research (UNU/WIDER)
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Camera-ready typescript prepared by Lorraine Telfer-Taivainen at UNU/WIDER
Printed at UNU/WIDER, Helsinki



ISSN 1609-5774
ISBN 92-9190-508-9 (printed publication)
ISBN 92-9190-509-7 (internet publication)

## 1 Introduction

Economists have long recognized the relationship between geographic location and income. Using international data, Moreno and Trehan (1997) provide evidence that being close to large markets contributes to income growth. Similarly, using a panel of US counties, Hanson (1998) finds that proximity to a large market has a positive effect on earnings. Recent literature on economic geography summarizes the channel through which location affects income (Overman *et al.* 2001). Location exerts its impact on both the demand and the supply side of an economy. On the demand side, when a location is far away from its target market, the potential demand for the goods and services in the location is less than in other locations closer to the market. On the production side, if a location is far away from the suppliers of intermediate inputs, the costs of production will be relatively high and value added is then reduced.

In this paper, we examine the link between each province's geographic location and provincial wage rates in China. In particular, we investigate the extent to which the increasing wage gap between the coastal and the interior regions is associated with each province's access to the international output markets and the suppliers of intermediate inputs. This study uses Redding and Venables' (2000) methodology, which examines the role of geography in shaping the evolution of the cross-country distribution of income.

The Chinese case is interesting for several reasons. First, income inequality has always been an important and sensitive political issue since the foundation of the People's Republic of China in 1949. Kanbur and Zhang (2001) examine fifty years of regional inequality in China and find that there have been three phases of rising inequality during the past fifty years. One appeared in the late 1950s, one was in the late 1960s, and one was in the 1990s. It is worth noting that the regional inequality in the 1990s is more serious than that experienced in the 1960s and is similar to that experienced in the 1950s. Many studies on China's income inequality suggest that foreign trade and investment might have caused China's income inequality in the 1990s.[1] To my knowledge, however, no research has been conducted to explicitly uncover the mechanism by which international trade affects regional wages. This paper is the first attempt to explore the relationship between regional wage rates and international trade.

Second, the increasing income inequality in China after its trade liberalization in the late 1970s has coincided with the international trend towards an increasing wage gap between high- and low-skilled workers. During the last two decades, increasing wage inequality has been observed in many industrialized countries (Freeman and Katz 1994; Katz and Autor 1999) and also Mexico (Cragg and Epelbaum 1996; Feenstra and Hanson 1997; Hanson

[1] Jian *et al.* (1996), Kanbur and Zhang (1999), Tsui (1998), Hussain *et al.* (1994), Chen and Fleisher (1996), Khan *et al.* (1993).

and Harrison 1999).[2] There are three explanations for the increasing wage gap. One is international competition from low-wage countries (Leamer 1993:57-162, 1994; Borjas and Ramey 1993; Wood 1994). The second is skilled-biased technological change due to the increased use of computers (Davis and Haltiwanger 1991; Lawrence and Slaughter 1993; Berman *et al.* 1994). The third is global outsourcing (Katz and Murphy 1992; Feenstra and Hanson 1996:89–127). However, most of the literature has focused on industrialized economies, while wage inequality in developing countries has not drawn much attention.[3] China, the largest developing country in the world, underwent economic reform in the late 1970s and actively engaged in global outsourcing. Hsieh and Woo (1999) provide evidence that outsourcing from Hong Kong to China has been associated with an increase in the wage gap between skilled and unskilled labour in Hong Kong. It is natural, then, to expect that similar wage movements would take place in China.

Instead of examining the wage gap between skilled–unskilled workers, we explore wage inequality in a different dimension—the wage gap between the coastal and the interior provinces. As illustrated in recent studies, the wage inequality in China is manifesting itself more in the form of regional inequality rather than in wage inequality between skilled and unskilled workers, and regional wage inequality is strongly associated with the regional distribution of international trade.

Another reason for considering province-level data is that we are not able to apply the standard classification of skill in the Chinese labour market. The conventional approach distinguishes skill levels by classifying workers into non-production and production. Unfortunately, this distinction is not reported in the China statistical yearbook. Instead, an education index appears. The fact that college-educated workers account for a small percentage of the workforce in China makes the education index a poor way to classify workers.

### 1.1 Market access

My work follows recent literature on economic geographic models which use market access as an important variable in determining income. Market access was first defined in Harris (1954), where he argues that the potential demand for goods and services in a location depends upon the distance-weighted GDP in all locations. Other related work includes papers by Hummels (1995), and Leamer (1997) and Hanson (1996a,b). Krugman and Venables (1995) draw special attention to the implications of increasing returns to scale and include it in their framework. Redding and Venables (2000) extend the Krugman and Venables (1995) trade theory model to include transportation costs in trade and intermediate goods in production. They define 'market access' as the proximity of an

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2 Feenstra and Hanson (2001).

3 Feenstra and Hanson (1997), Hanson and Harrison (1999) are two notable exceptions. Both examine the increase in relative wages for skilled workers in Mexico.

exporting country to its output market and, 'supplier access' as the proximity of an importing country to its supply of intermediate inputs.

As a prelude to the analysis, using data on the Chinese provinces for the period 1988-98, we first estimate a gravity equation to construct market access and supplier access variables. Second, we estimate the wage equation using the constructed market access and supplier access. Having estimated the model, we compare the predicted wage gap obtained in the model to the one obtained from the observed data, and evaluate the extent to which the gap in wages can be explained by differences in regional market access and supplier access.

The remainder of the paper is organized as follows. In the next section, we briefly introduce China's spatial economy. Section 3 presents the theoretical model. Section 4 explains the estimation strategies. We describe the data sources and measurement in Section 5. Section 6 reports the estimation results and robustness tests. We offer concluding remarks and policy implications in Section 7.

## 2 China's spatial economy

China is a very large country covering 6,000,000 square miles with 30 administrative divisions.[4,5] Geographic features in China differ greatly from one province to the next, though the variety of natural landscape is not the focus of this paper. Here, we mainly introduce stylized facts about the spatial distribution of economic activity in China.

First, regional income varies dramatically across provinces. Table 1 presents the income inequality in China in 1995. There are three alternative measures of income: the average real wage rate, GDP per capita, and the average real wage rate in the manufacturing sector. The first row in the table shows the national average for each measure of income. We divide the Chinese provinces into two groups: coastal and interior regions.[6] Among the coastal group, the real wage rates in most provinces are higher than the national average except Liaoning, Shandong and Hainan. Liaoning and Shandong are two provinces where there is much state-owned heavy industry, which used to play an important role in the local economy. Since China underwent economic reform, state-owned companies have faced competition from joint ventures and privately owned enterprises. The operation of state-owned enterprise is not as efficient as that of other enterprises. However, state-owned

[4] Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Hainan, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang.

[5] Tibet is excluded from our sample due to the lack of data.

[6] Coastal regions include Beijing, Tianjin, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. Interior regions include Hebei, Shanxi, Inner Mongolia, Heilongjiang, Jilin, Anhui, Henan, Hubei, Hunan, Jiangxi, Guangxi Shaanxi, Sichuan, Xinjiang, Ningxia, Gansu, Qinghai, Yunnan, and Guizhou.

Table 1: Income inequality across provinces in 1995

| Province | Wage* | GDP per | Wage in manufacturing sector** |
|---|---|---|---|
| | (CNY)*** | (CNY/person) | (CNY) |
| Average | 1514 | 1480 | 1437 |
| **Coastal** | | | |
| Beijing | 2287 | 3132 | 2126 |
| Tianjin | 1826 | 2889 | 1691 |
| Liaoning | 1379 | 1945 | 1270 |
| Shanghai | 2606 | 5315 | 2496 |
| Jiangsu | 1669 | 2049 | 1593 |
| Zhejiang | 1859 | 2256 | 1701 |
| Fujian | 1645 | 1918 | 1666 |
| Shandong | 1445 | 1614 | 1328 |
| Guangdong | 2317 | 2355 | 2222 |
| Hainan | 1500 | 1413 | 1443 |
| **Interior** | | | |
| Hebei | 1359 | 1243 | 1268 |
| Shanxi | 1326 | 997 | 1148 |
| Inner Mongolia | 1161 | 1024 | 1034 |
| Jilin | 1244 | 1243 | 1160 |
| Heilongjiang | 1164 | 1529 | 1019 |
| Anhui | 1294 | 938 | 1192 |
| Jiangxi | 1183 | 861 | 1106 |
| Henan | 1220 | 927 | 1133 |
| Hubei | 1316 | 1164 | 1258 |
| Hunan | 1347 | 971 | 1274 |
| Guangxi | 1434 | 993 | 1491 |
| Sichuan | 1304 | 889 | 1298 |
| Guizhou | 1257 | 502 | 1321 |
| Yunnan | 1446 | 850 | 1594 |
| Shaanxi | 1234 | 655 | 1149 |
| Gansu | 1543 | 795 | 1541 |
| Qinghai | 1616 | 638 | 1337 |
| Ningxia | 1426 | 965 | 1333 |
| Xinjiang | 1502 | 931 | 1466 |

Note: *Wage is the real wage rate of formal employees. **Wage in the manufacturing sector is the real wage rate of formal employees in the manufacturing sector. ***Wage rates are in China Yuan Renminbi.

Source: *China Statistical Yearbook* (various).

enterprises still account for a majority of these local economies. That may be the reason why the real wage rates in Liaoning and Shandong are lower than the national average. Hainan Island is a new province that split from Guangdong province in 1988. Statistical reports from Hainan to some extent are not consistent with its economic activity. Among the interior provinces, wage rates in most provinces are lower than the national average except in Gansu and Qinghai, two poor provinces in the far west which receive enormous subsidies from the central government every year.

The income gap between the coastal and the interior regions is not only large, but also increasing over the years. Figure 1 presents the wage difference between regional wage and national average wage level. Panel A shows the wage difference in the coastal provinces for 1988–98. Over the years, the wage rates have risen higher than the national average. In particular, the regional wages of Beijing, Shanghai, and Guangdong are much higher than the national average. Panel B presents the wage difference in the interior provinces for 1988–19. The wage rates are much lower than the national average. Comparing Panel A and Panel B, the wage gap between the coastal and the interior regions is increasing.

There is general consensus that China's income disparities in the late 1990s have been caused by the trade liberalization. Kanbur and Zhang (2001) argue that openness and global integration from the late 1970s is the key variable in explaining regional inequality during the reform period. The important feature of global integration in this period in China is the concentration of international trade along China's east coast. Table 2 shows the average distribution of international trade broken down by customs regimes across the regions from 1988 to 1998. Guangdong has the highest share in all kinds of trade shares, and in the share of processing trade in particular.[7] Guangdong is also in the leading position for ordinary trade. Other coastal provinces account for 30 per cent of processing trade, 57 per cent of ordinary exports, and 73 per cent of ordinary imports.[8] It is obvious that the interior provinces did not play any notable role in either processing exports or processing imports. The share of processing trade in each interior province is less than 1 per cent. In terms of ordinary trade, a few interior provinces account for between 2–4 per cent of national ordinary exports. Compared to the performance of the coastal provinces, it is not impressive. The share of ordinary import by the majority of the interior provinces is less than 1 per cent, except Jilin, Hubei, and Sichuan.

Figure 2 depicts the association between the regional real wage rates and share of total export, which indicates a region's degree of the openness. Most coastal provinces except Hainan are associated with high degrees of openness and high levels of real wage rates, whereas the interior provinces cluster around the low share of total exports and low-level real wage rates.

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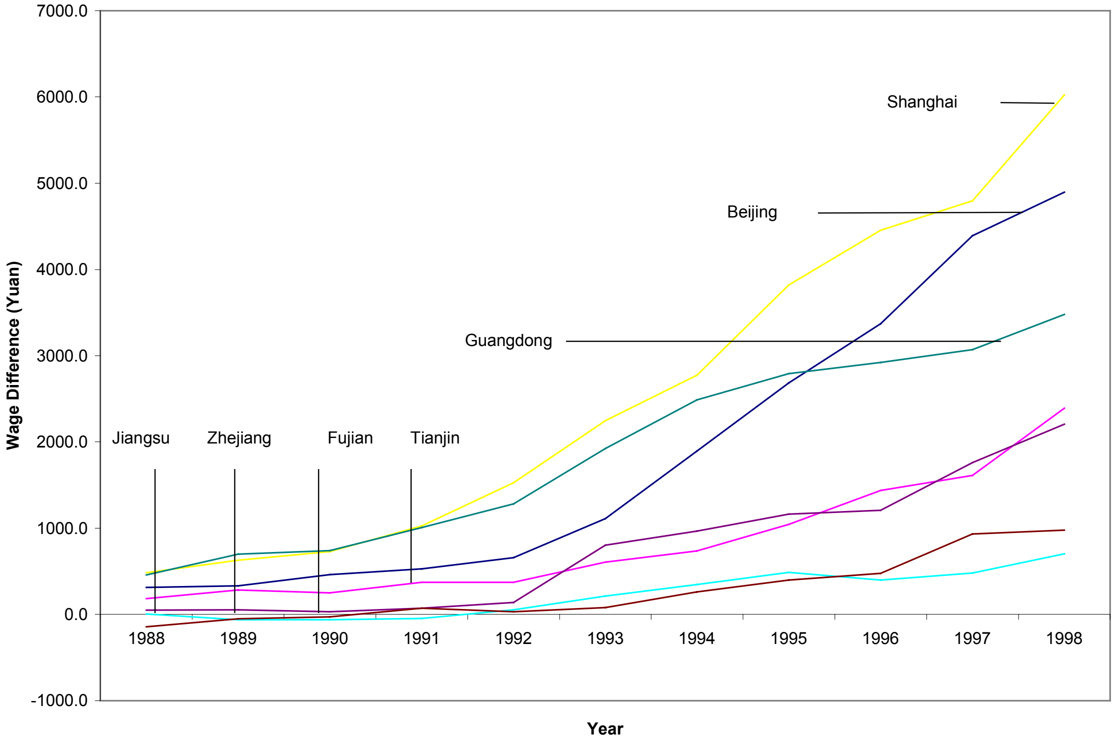
[7] In 1986, China established two foreign trade regimes: a processing trade regime, which is an export promoting regime; and an ordinary trade regime, which is an import substitution regime.

[8] Beijing outperformed all other provinces in the share of ordinary imports. This might be the result of the volume of trade generated by the national foreign trade companies assigned to Beijing for 1988–92.

Figure 1: Comparison of the provincial wage with the national average

Panel A: Coastal provinces




Panel B: Interior provinces

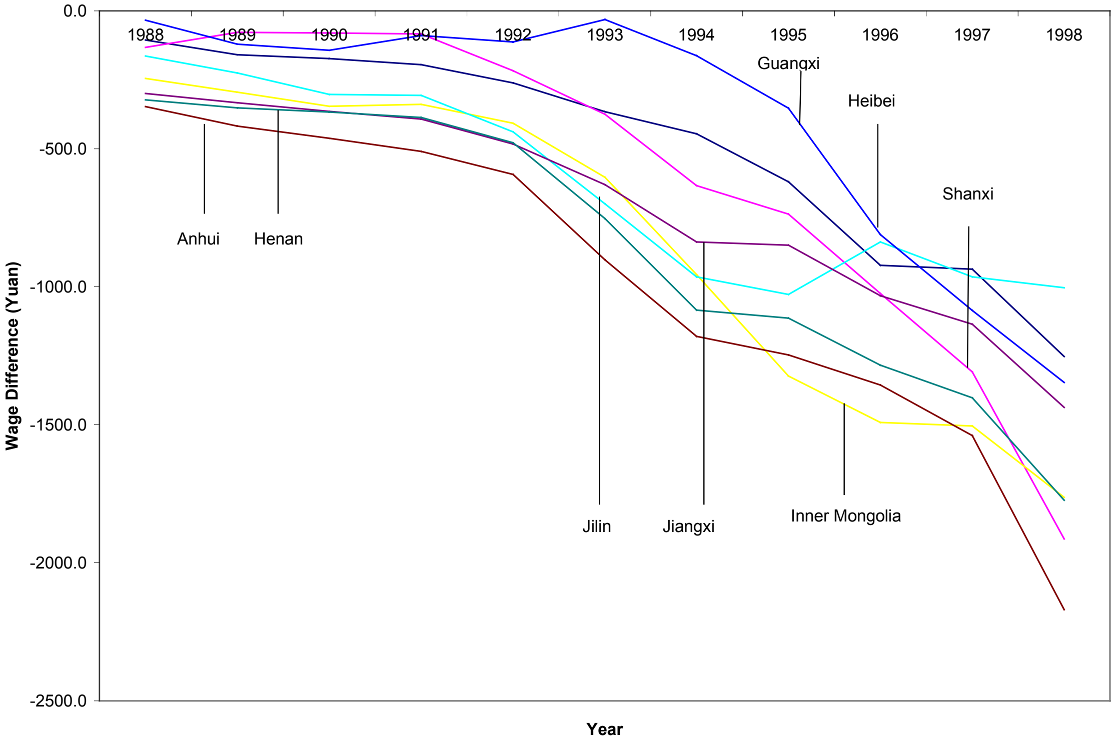


Table 2: Average distribution of international trade for 1988-98

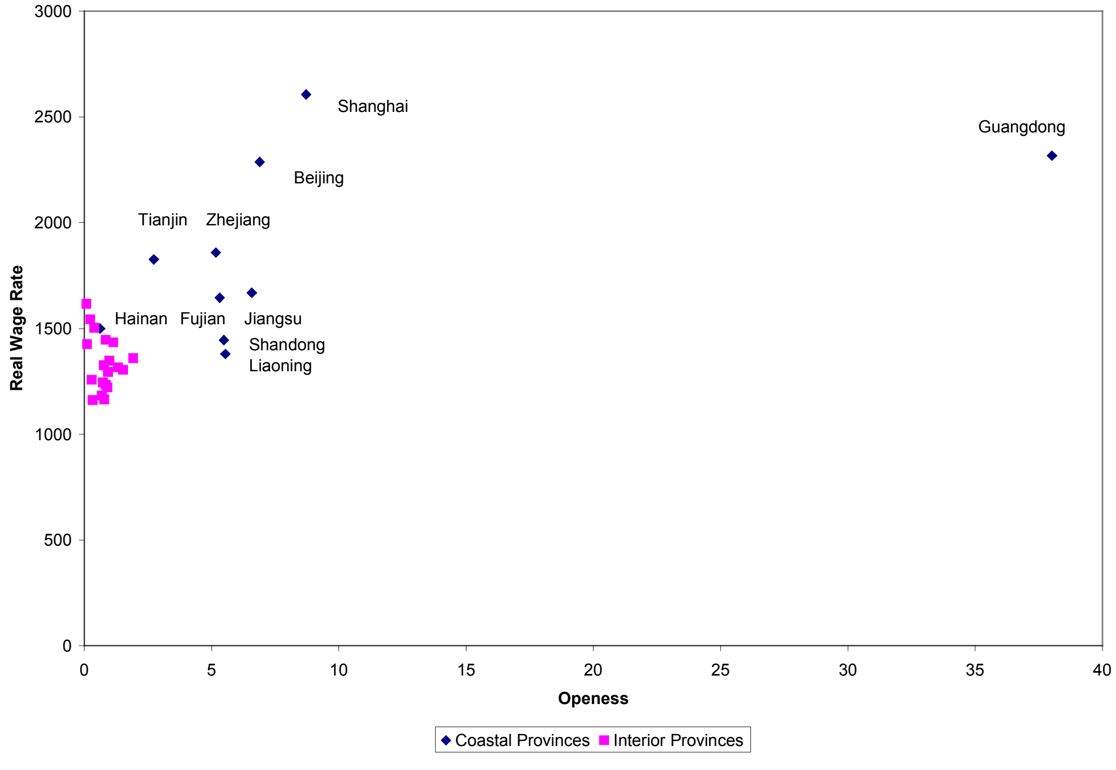
| Province | Share of processing export (%) | Share of ordinary export (%) | Share of processing import (%) | Share of ordinary import (%) |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Coastal** | | | | |
| Beijing | 2.72 | 9.57 | 4.28 | 52.45 |
| Tianjin | 2.70 | 2.83 | 2.63 | 1.80 |
| Liaoning | 3.54 | 8.77 | 3.49 | 2.45 |
| Shanghai | 8.87 | 8.26 | 7.13 | 7.92 |
| Jiangsu | 4.51 | 7.36 | 4.50 | 3.08 |
| Zhejiang | 2.34 | 7.04 | 2.18 | 1.81 |
| Fujian | 4.49 | 3.65 | 4.95 | 1.75 |
| Shandong | 3.74 | 6.95 | 3.53 | 1.84 |
| Guangdong | 62.31 | 19.22 | 62.75 | 14.95 |
| Hainan | 0.15 | 1.19 | 0.20 | 1.65 |
| **Interior** | | | | |
| Hebei | 0.68 | 3.99 | 0.54 | 0.64 |
| Shanxi | 0.13 | 0.93 | 0.10 | 0.19 |
| Inner Mongolia | 0.13 | 0.61 | 0.12 | 0.28 |
| Jilin | 0.20 | 1.57 | 0.21 | 1.17 |
| Heilongjiang | 0.25 | 1.75 | 0.31 | 0.75 |
| Anhui | 0.37 | 1.40 | 0.31 | 0.48 |
| Jiangxi | 0.17 | 1.25 | 0.20 | 0.39 |
| Henan | 0.30 | 1.65 | 0.28 | 0.48 |
| Hubei | 0.64 | 2.12 | 0.51 | 1.03 |
| Hunan | 0.29 | 1.94 | 0.23 | 0.61 |
| Guangxi | 0.45 | 1.63 | 0.61 | 0.60 |
| Sichuan | 0.46 | 2.31 | 0.39 | 1.43 |
| Guizhou | 0.08 | 0.40 | 0.08 | 0.20 |
| Yunnan | 0.13 | 0.97 | 0.10 | 0.67 |
| Shaanxi | 0.22 | 1.20 | 0.17 | 0.65 |
| Gansu | 0.07 | 0.42 | 0.09 | 0.13 |
| Qinghai | 0.01 | 0.17 | 0.01 | 0.02 |
| Ningxia | 0.02 | 0.17 | 0.02 | 0.04 |
| Xinjiang | 0.02 | 0.62 | 0.03 | 0.29 |

Source: Calculated from Chinese trade data in MOFTEC (various years).

Why does most trade take place in the coastal provinces? We argue that geographical location matters. The provinces that are located along China's east coast have advantages in trading with other countries because they are closer to China's major markets, such as Hong Kong and Japan, and have lower transportation costs.

Table 3 lists average regional export share to Hong Kong and Japan, and distance from each province to Hong Kong and Japan.[9] Guangdong is the province closest to Hong Kong, and it is the province that accounts for 69.7 per cent of national export to Hong Kong for 1988–98.

Figure 2: Regional real wage and openness




According to annual trade volumes, Hong Kong, Japan, and the USA are China's top three trading partners. Each province, however, has a different ordering of trading partners. Table 4 shows examples for a few provinces. For instance, Mongolia does not appear to be an important partner for most provinces except for Inner Mongolia, the province located at far north of China and neighbouring on Mongolia. Another example is the Jilin province; it shares a border with North Korea, and there is a Korean-Chinese autonomous region within the Jilin province. Even though North Korea trades very little with the rest of the world, it is the fourth most important trading partner of the Jilin province. In this paper, we find that distance strongly affects the volume of trade.

9 Distance is the arc distance. In terms of arc distance, some of the coastal provinces are further away from Hong Kong and Japan than the interior provinces are. In reality, however, the coastal provinces either have their own ports or are near to ports, and transport goods through shipment, which leads to lower transport costs than in the interior provinces.

Table 3: Average share of export and distance to major trading country

| Province | Export share to Hong Kong (%) | Export share to Japan (%) | Distance to Hong Kong (Mile) | Distance to Japan (Mile) |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Coastal** | | | | |
| Beijing | 2.4 | 6.5 | 1216 | 1308 |
| Tianjin | 1.2 | 3.6 | 1169 | 1261 |
| Liaoning | 1.3 | 19.2 | 1443 | 977 |
| Shanghai | 3.3 | 12.9 | 759 | 1098 |
| Jiangsu | 2.5 | 10.6 | 724 | 1229 |
| Zhejiang | 2.1 | 6.2 | 657 | 1196 |
| Fujian | 4.0 | 4.8 | 289 | 1507 |
| Shandong | 1.8 | 11.1 | 1015 | 1088 |
| Guangdong | 69.7 | 5.5 | 72 | 1811 |
| Hainan | 0.8 | 0.5 | 294 | 2087 |
| **Interior** | | | | |
| Hebei | 1.1 | 5.9 | 733 | 1405 |
| Shanxi | 0.2 | 0.5 | 1069 | 1510 |
| Inner Mongolia | 0.2 | 0.6 | 1279 | 1561 |
| Jilin | 0.5 | 1.9 | 1642 | 900 |
| Heilongjiang | 0.5 | 1.5 | 1759 | 978 |
| Anhui | 0.5 | 0.9 | 679 | 1317 |
| Jiangxi | 0.7 | 0.5 | 445 | 1475 |
| Henan | 0.8 | 0.9 | 851 | 1471 |
| Hubei | 1.4 | 1.1 | 561 | 1513 |
| Hunan | 1.1 | 0.7 | 404 | 1649 |
| Guangxi | 1.3 | 0.5 | 370 | 2083 |
| Sichuan | 1.1 | 1.5 | 680 | 1970 |
| Guizhou | 0.1 | 0.3 | 546 | 2045 |
| Yunnan | 0.4 | 0.6 | 778 | 2315 |
| Shaanxi | 0.5 | 0.7 | 875 | 1742 |
| Gansu | 0.2 | 0.3 | 1125 | 2006 |
| Qinghai | 0.0 | 0.3 | 1227 | 2110 |
| Ningxia | 0.1 | 0.1 | 1200 | 1848 |
| Xinjiang | 0.4 | 0.3 | 2114 | 2785 |

Source: First two columns are calculated using Chinese trade data in MOFTEC (various). Column (3) and (4) are constructed using the information on the longitude and latitude.

Table 4: Trade partners for some provinces

| Province | Partner | Province | Partner |
|---|---|---|---|
| Tianjin(12) | Japan | Inner Mongolia (15) | Japan |
| | Hong Kong | | Hong Kong |
| | US | | S.Korea |
| | S.Korea | | Mongolia |
| | Germany | | Italy |
| Liaoning(21) | Japan | Jilin(22) | Japan |
| | US | | S.Korea |
| | S.Korea | | Hong Kong |
| | Hong Kong | | N.Korea |
| | Netherlands | | US |
| Shanghai (31) | Japan | Shandong (37) | Japan |
| | Hong Kong | | S.Korea |
| | US | | Hong Kong |
| | S.Korea | | US |
| | Germany | | Germany |

Note and source: The partner is ranked according the volume of trade. The volume of trade is calculated using Chinese trade data from MOFTEC (various).

# 3 Theoretical model

## 3.1 Redding and Venables Model

In the context of the Chinese provincial trade, we present the outline of the Redding and Venables model (2000). It is based on a theoretical model in Fujita *et al.* (1999). In addition, it includes transportation costs in trade, and intermediate goods in production.

Consider international trade between the administrative provinces in China and the rest of the world.[10] There are i = 1,.., 29 provinces in China and the Chinese provinces are trading with j = 1,.., J countries.[11] Let $U_j$ denote the utility function in country j with CES form, $c_{ijk}$ refers to the consumption of good k exported from province i to country j. Suppose province i produces $N_i$ products. Then the representative consumer's utility function in country j is,

[10] Here we assume that there is no interprovince trade in China, and the rest of world is trading only with the Chinese provinces. Since our concern here is wage rates in China, the second assumption will not affect our results.

[11] The number of trading countries j has evolved over the years.

$$U_j = \sum_{i=1}^{29}\sum_{k=1}^{N_i} c_{ijk}^{\frac{\sigma-1}{\sigma}} = \sum_{i=1}^{29} N_i c_{ij}^{\frac{\sigma-1}{\sigma}}, \quad \sigma > 1, \tag{1}$$

The second equation arises the assumption that consumption in country j is equal over all products k=1,…, $N_i$ sold by province i, i.e., $c_{ijk} = c_{ij}$. Good k is used both in consumption and as an intermediate good, and in both uses there is a constant elasticity of substitution, σ. The problem facing a representative consumer in country j is to maximize (1), subject to budget constraints:

$$E_j = \sum_{i=1}^{29} N_i p_{ij} c_{ij} \tag{2}$$

where $E_j$ is country j's aggregate expenditure, $p_{ij}$ is the price of goods produced in province i and sold in country j. Solving the maximization problem, we can derive country j's demand for the product produced in province i,

$$c_{ij} = p_{ij}^{-\sigma} E_j P_j^{\sigma-1} \tag{3}$$

where $P_j$ refers to country j's general price index, which is defined as:

$$P_j = [\sum_{i=1}^{29} N_i p_{ij}^{1-\sigma}]^{\frac{1}{1-\sigma}} \tag{4}$$

Redding and Venables (2000) refer to the term $E_jP_j^{\sigma-1}$ in equation (3) as country j's market capacity, which depends on total expenditure in country j and overall price.

Turning to the production side, consider a single representative firm in province i with increasing returns to scale production technology, and an imperfect competitive market. The firm uses labour and intermediate input with share θ and 1- θ to produce output $y_i$, and then the firm's profit is,

$$\pi_i = p_i y_i - w_i^{\theta} P_i^{1-\theta}(\alpha + \beta y_i) \tag{5}$$

where $p_i$ is a free on board (f.o.b.) price in province i, $y_i = \Sigma_j c_{ij} T_{ij}$ , and $T_{ij}$ is a transport costs factor, indicating that $T_{ij}$ units of the product must be shipped to country j in order for one unit to arrive. The firm has fixed costs of α and marginal costs of β. Then the first term on the right hand side is revenue and the second term is total costs.

With demand function (3), profit maximizing firms set a single f.o.b. price, $p_i$, such that prices for the sales in different countries are $p_{ij} = p_iT_{ij}$. The price $p_i$ is a constant mark-up over marginal cost, and given by,

$$p_i = \frac{\sigma}{\sigma - 1} \beta w_i^{\theta} P_i^{1-\theta} \tag{6}$$

Substituting this pricing behaviour into the profit equation, profits of firm in province i are

$$\pi_i = \frac{w_i^{\theta} P_i^{1-\theta}}{\sigma - 1}[\beta y_i - (\sigma - 1)\alpha] \tag{7}$$

Therefore, the firm breaks even if the total volume of its sales equals,

$$\bar{y} = (\sigma - 1)(\alpha / \beta) \tag{8}$$

From the demand function, equation (3), it will sell this many units if its price equals,

$$p_i^{\sigma} = \frac{1}{\bar{y}} \sum_{j=1}^{J} E_j P_j^{\sigma-1} (T_{ij})^{1-\sigma} \tag{9}$$

At the equilibrium, combining equation (6) and equation (9), profit-maximizing firms have

$$\left(\frac{\sigma}{\sigma - 1} w_i^{\theta} P_i^{1-\theta}\right)^{\sigma} = \left(\frac{1}{\bar{y}}\right) \sum_{j=1}^{J} E_j P_j^{\sigma-1} T_{ij}^{1-\sigma} \tag{10}$$

Redding and Venables (2000) call this the 'wage equation', which implies that the break-even level of costs, for a provincial firm i, is a function of distance weighted market capacities.

Equation (10) can be further simplified using equation (4). Given the prices for sale in different countries, equation (4) can be rewritten as,

$$P_j = \left[\sum_i N_i (p_i T_{ij})^{1-\sigma}\right]^{\frac{1}{1-\sigma}} = \left[\sum_i N_i p_i^{1-\sigma} T_{ij}^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \tag{11}$$

The term $N_i p_i^{1-\sigma}$ measures an exporting province's supply capacity, as defined in Redding and Venables (2000). Substituting equation (11) into equation (10) and rearranging, we have,

$$\begin{aligned} w_i &= \left(\frac{1}{\bar{y}}\right)^{-\sigma/\theta} \left(\frac{\sigma - 1}{\beta \sigma}\right)^{1/\theta} \left[\sum_{j=1}^{J} N_j (p_j T_{ij})^{1-\sigma}\right]^{(1-\theta)/\theta(\sigma-1)} \left[\sum_{j=1}^{J} E_j P_j^{\sigma-1} T_{ij}^{1-\sigma}\right]^{1/\theta\sigma} \\ &= A(SA_i)^{(1-\theta)/\theta(\sigma-1)} (MA_i)^{1/\theta\sigma} \end{aligned} \tag{12}$$

where,

$$A = \left(\frac{1}{y}\right)^{-\sigma/\theta}\left(\frac{\sigma - 1}{\beta\sigma}\right)^{1/\theta}$$

$$SA_i = \left[\sum_{j=1}^{J} N_j p_j^{1-\sigma} T_{ij}^{1-\sigma}\right]^{(1-\theta)/\theta(\sigma-1)} \quad (13)$$

$$MA_i = \left[\sum_{j=1}^{J} E_j P_j^{\sigma-1} T_{ij}^{1-\sigma}\right]^{1/\theta\sigma}$$

The left-hand side of equation (12) is the wage rate, $w_{i.}$ The constant A on the right-hand side combines constants from equation (10). SA and MA in equation (13) are defined as 'supplier access' and 'market access'.

Supplier access is distance weighted supplier capacity and measures the proximity of an importing province i to the supplier of manufactured goods. Market access is distance weighted market capacity and measures the proximity of an exporting province i to its international markets. Then equation (12) implies that provinces with high market access and high supplier access pay relatively high wages because provinces with high market access face high demand for their products, and provinces with high supplier access can obtain intermediate goods at lower cost. Neither market access nor supplier access is observable and will be estimated from a gravity equation in the next section.

### 3.2 Gravity equation

The demand equation (3) gives the volume of sales from province i to each country j. Multiplying varieties and prices on the both sides, we obtain a gravity type trade equation,

$$N_i p_{ij} c_{ij} = (T_{ij})^{1-\sigma} N_i p_i^{1-\sigma} E_j (P_j)^{\sigma-1} \quad (14)$$

The left-hand side in equation (14) is simply the value of trade between province i and country j. The right hand side contains province information, trading country information, and transportation cost. The term $E_j(P_j)^{\sigma-1}$ is 'market capacity'. The term $N_i p_i^{1-\sigma}$ is 'supplier capacity', which depends on the number of firms and the prices they charge. Since we focus on the geographic features of trade, these two variables can simply take the form of regional fixed effects.[12] Using the export data from Chinese provinces to the rest of the world, we can estimate provincial market capacity, whereas the import data by Chinese provinces from the rest of world is used to obtain supplier capacity. Market capacity and supplier capacity will be weighted by the distance between province i and country j, which are market access and supplier access.

[12] Using the fixed effects still addresses the criticism of the conventional gravity equation made by Anderson and von Wincoop (2000).

## 4 Empirical strategy

### 4.1 Empirical specification

A two-stage estimation procedure is used. First a gravity equation is estimated using values of trade and distances between the Chinese province and its trading partners. The estimates of market access and supplier access for each province are then constructed using the estimated coefficients in the gravity equation. The gravity equation can be estimated by taking logs of equation (14),

$$\ln(N_i p_i c_{ij}) = (1-\sigma)\ln(T_{ij}) + \ln(N_i p_i^{1-\sigma}) + \ln(E_j P_j^{\sigma-1})$$
$$\ln(VOT_{ij}) = \alpha_0 + \beta_0 \ln(dist_{ij}) + \delta_i + \gamma_j + \omega_{ij} \tag{15}$$

where,

$VOT_{ij} = N_i\, P_i\, c_{ij}$, values of trade between province i and country j, (16)
$dist_{ij} = T_{ij}$, distance between province i and country j,
$\delta_i = \ln(N_i\, P_i^{1-\sigma})$, $\gamma_j = \ln(E_j\, P_j^{\sigma-1})$

$\delta_i$ is a provincial dummy and $\gamma_j$ is a trading country dummy. We have two measures of distance: arc distance, which is the minimum-length arc between two locations, and internal–external distance, which measures the distance within China and outside of China. Internal distance is measured by the arc distance between the province and its closest ports, and external distance is measured by the external arc distance between China's large and other international ports. Then the specification of the gravity equation is,

$$\ln(VOT_{ij}) = \alpha_0 + \beta_1 \ln(dist\_i_{ij}) + \beta_2 (\ln dist\_e_{ij}) + \delta_i + \gamma_j + \omega_{ij} \tag{17}$$

where dist_i and dist_e refer to internal and external distance, respectively.

In order to construct market access, we set the dependent variable as the value of exports from province i to province trading partner, country j. When we construct supplier access, the dependent variable is the value of imports by province i from country j. Market access and supplier access for equation (15) are constructed using the formula,

$$\hat{MA}_i = \sum_{j=1}^{J} e^{\hat{\gamma}_j} * distance_{ij}^{\hat{\beta}_0}, \; i=1,..,29, \; j=1,..,J$$
$$\hat{SA}_i = \sum_{j=1}^{J} e^{\hat{\delta}_j} * distance_{ij}^{\hat{\beta}_0}, \; i=1,..,29, \; j=1,..,J \tag{18}$$

Market access and supplier access for equation (17) are, thus,

$$\hat{MA}_i = \sum_{j=1}^{J} e^{\hat{\delta}_j} * dist\_i_{ij}^{\hat{\beta}_1} * dist\_e_{ij}^{\hat{\beta}_2}, i = 1,.., 29, j = 1,.., J$$
$$\hat{SA}_i = \sum_{j=1}^{J} e^{\hat{\gamma}_j} * dist\_i_{ij}^{\hat{\beta}_1} * dist\_e_{ij}^{\hat{\beta}_2}, i = 1, ,29, j = 1,..., J \quad (19)$$

We run the gravity equation annually since the number of trade partners, J, has increased over the years, as China has become more and more open to the outside world. The change in the number of trade partners directly affects the estimated coefficients on partner dummies. Therefore, provincial market access and supplier access evolve, given the fixed distance between each province and its trade partners. In the second step, given the provincial market access and supplier access, we specify the following log-linear wage equation in empirical estimation:

$$\ln w_i = \lambda_0 + \lambda_1 \ln SA_i + \lambda_2 \ln MA_i + u_i \quad (20)$$

where the dependent variable $w_i$ is the real wage rate, or the real wage rate in the manufacturing sector in province i. $\lambda_0$, $\lambda_1$, and $\lambda_2$ are the parameters to be estimated.[13] The error term includes technology differences and other forces that affect regional wage rates, such as spatial correlation. We will return to these forces in the following robustness section. The error term $u_i$ also includes the residuals in the gravity equation since the regressors, supplier access and market access, are generated from the gravity equation.

We decompose the Chinese export and import data into two trade regimes. Thus, we have processing exports, processing imports, ordinary exports, and ordinary imports. Applying the various export and import data into the gravity equation (15) and (17), and using definitions in (18) and (19), we arrive at the processing market access, the ordinary market access, the processing supplier access, and the ordinary supplier access.[14] Then the basic wage equation is:

$$\ln w_i = \varphi_0 + \varphi_1 \ln P\hat{M}A_i + \varphi_2 \ln O\hat{M}A_i + \varphi_3 \ln P\hat{S}A_i + \varphi_4 \ln O\hat{S}A_i + \varepsilon_i \quad (21)$$

where PMA and PSA refer to processing market access and processing supplier access, OMA and OSA are ordinary market access and ordinary supplier access.

We are also interested in the impact of the different trade regimes on the regional wage rates. Compared with the ordinary trade regime, processing trade is more concentrated along the coast. We expect the effects of processing trade on the wage rate to be higher

[13] Since market access and supplier access are generated from the gravity equation, the OLS standard errors are invalid. The standard errors are corrected by using the 'bootstrap technique'.

[14] Processing market access measures the proximity of a province exporting processed goods to its international markets. Ordinary market access measures the proximity of a province exporting ordinary goods to its international markets. Processing supplier access measures the proximity of a province importing processing materials from supplier of manufactured goods. Ordinary supplier access measures the proximity of a province importing ordinary goods from supplier of manufactured good.

than those obtained from ordinary trade, and processing trade can better explain the wage inequality than ordinary trade does. Thus, the alternative estimation is to separate processing market access and processing supplier access from ordinary market access and ordinary supplier access in the wage equation,

$$\ln w_i = \kappa_0 + \kappa_1 \ln P\hat{M}A_i + \kappa_2 \ln P\hat{S}A_i + \kappa_i \qquad (22)$$

$$\ln w_i = \nu_0 + \nu_1 \ln O\hat{M}A_i + \nu_2 \ln O\hat{S}A_i + \nu_i \qquad (23)$$

### 4.2 Robustness test

The error term in equation (21) includes technology differences across provinces and other factors that affect provincial wage rates. We need to examine the robustness of results with the inclusion of other factors.

The first experiment we conduct is adding provincial dummies into the wage equation to capture the differences across provinces. Then we explicitly consider the regional effects. We use educational level to indicate regional human capital development, and capture the technology differences. Historically, educational level is higher on the coast than in the rest of China, though after 1978, the gap increased. Investment on the coast is more than two times higher than investment in the interior. In particular, there is more foreign direct investment flowing into the coast because the central government policies favour the coastal areas. We thus use a preferential policy index to represent the preferential policy and explicitly consider the policy effect.[15]

The construction of market access and supplier access involves international trade, which implies that we are measuring the provincial market access and supplier access to the international market, and the domestic supply and demand are ignored.[16] Instead of taking the domestic forces into account in the computation of market access and supplier access, we address the effect of domestic demand in the wage equation. The dataset we use is a panel data, 29 provinces over 11 years. However, we will not consider the time dummies. In the process of estimating the gravity equation, we observed the increasing volumes of exports and imports over the years. We think the coefficients associated with regional dummies pick up the dynamic changes, and they are carried into the estimated market access and supplier access. Therefore the time dimensions are embodied in market access and supplier access. That is why we drop the time dummies in the robustness test.

[15] The preferential policy index is constructed in Démurger *et al.* (2001).

[16] This is due to the lack of information on the interprovincial transactions.

## 5 Data

We have three data sources. The first is disaggregate Chinese trade data obtained from the Customs General Administration, People's Republic of China, as part of the project described in Feenstra *et al.* (1998). This data source provides the value and quantity of exports and imports under the ordinary trade regime and the processing trade regime broken down by Chinese provinces for 1988-98. The trade data is 5-digit SITC for 1988-91 and 6-digit HS for 1992-6 and 8-digit HS for 1997-8.

The second is the China Statistical Yearbook (1989-99) which provides other economic variables for the provinces, such as average nominal wage rates, wage rates in the manufacturing sector, population, GDP, education level, and retail price deflators. The detailed definitions of these variables are presented in the appendix. The arc distance data is obtained from the internet.[17]

## 6 Estimation results

### 6.1 Gravity equation

The first stage of estimation is the gravity equation. We estimate the gravity equation (15) and (17) annually. For some of the small countries, we have not been able to obtain the longitude and latitude to calculate the distance and, therefore, these small countries and islands have been dropped from the sample. Given the detailed information on Chinese international trade, we aggregate export and import data up to the provincial level under two different trade regimes. The value of trade is converted into Chinese currency and deflated using the retail price index.

Table 5 reports the gravity equation estimation for 1995 using arc distance and internal–external distance. We are interested in the effect of different trade regimes; therefore, the dependent variables are the log values of processing exports, ordinary exports, processing imports, and ordinary imports, respectively. Independent variables include the distance between the Chinese province and its trading partner, Chinese province dummies, and each province's trading partner dummies. The estimated coefficients of distances, arc distance and internal–external distance, are correctly signed and statistically significant at the 1 per cent level. This is consistent with the notion that a location tends to trade more with the nearby markets. The model explains 80 per cent of the cross-section variation in the export data, 60 per cent of the variation in processing import data, and 70 per cent of the variation in ordinary import data. We use the estimated coefficients of trade partner dummies to construct market access and supplier access variables, which are used as the explanatory variables in the second stage regressions.

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[17] We obtain each location's latitude and longitude from www.mapblast.com/myblast/index.mb, and www.nau.edu/~cvm/latlongdist.html provides the distance calculation.

Table 5: Gravity equation in 1995

| | Log (value of processing export) | Log (value of ordinary export) | Log (value of processing import) | Log (value of ordinary import) |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| **Using arc distance** | | | | |
| Log(distance) | -1.139 | -0.605 | -1.508 | -0.982 |
| | [6.4]** | [4.5]** | [5.7]** | [3.3]** |
| **Using internal–external distance** | | | | |
| Log(distance_i) | -0.618 | -0.443 | -0.423 | -0.535 |
| | [9.4]** | [16.5]** | [3.9]** | [4.95]** |
| Log(distance_e) | -0.696 | -0.428 | -0.599 | -0.706 |
| | [4.6]** | [3.77]** | [2.73]** | [2.72]** |
| Province dummy | yes | yes | yes | yes |
| Partner dummy | yes | yes | yes | yes |
| Observations | 1805 | 2923 | 1031 | 1082 |
| R-squared | 0.8 | 0.8 | 0.6 | 0.7 |

Note: The table shows the estimation results in 1995. The estimated coefficients of external distance in other years are not all significant. T-statistics are in parentheses. *significant at 5%; **significant at 1%.

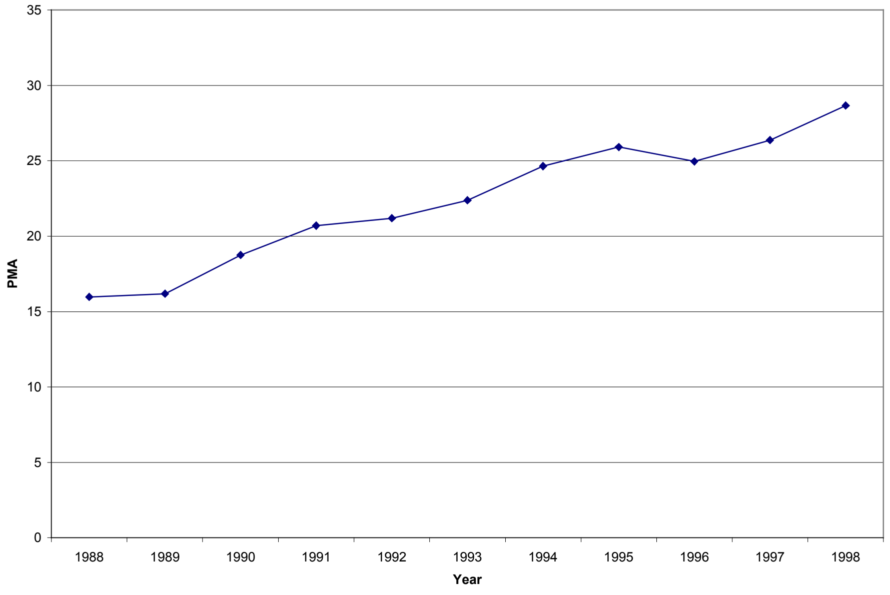
Source: author.

The constructed market access and supplier access increase over the years, given the fact that China is gradually integrating into the world economy. Using the results in Guandong as an example, Figure 3 depicts the evolution of market access and supplier access under the processing trade regime for 1988-98. And other provinces, especially the provinces on the coast, have very similar patterns. The results from the ordinary trade regime follow the same increasing trend.

Figure 4 presents the estimated market access across 29 provinces in 1995. Light columns refer to market access in the coastal provinces, whereas the dark columns refer to market access in the interior provinces. Panel A presents the processing market access index. Almost all the coastal provinces have higher level of processing market access than the interior provinces except Hainan Island. Panel B shows a similar pattern as Panel A, but the variation in ordinary market access across provinces is smaller than those in processing market access.

Figure 3: Processing indices in Guangdong for 1988-98

Panel A: Processing market access index in Guangdong for 1988-98




Panel B: Processing supplier access index in Guangdong for 1988-98

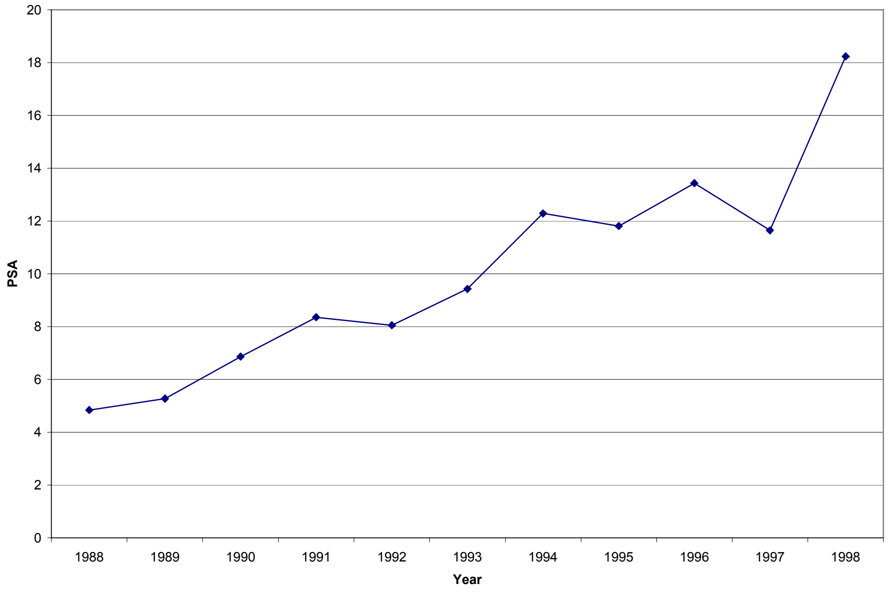
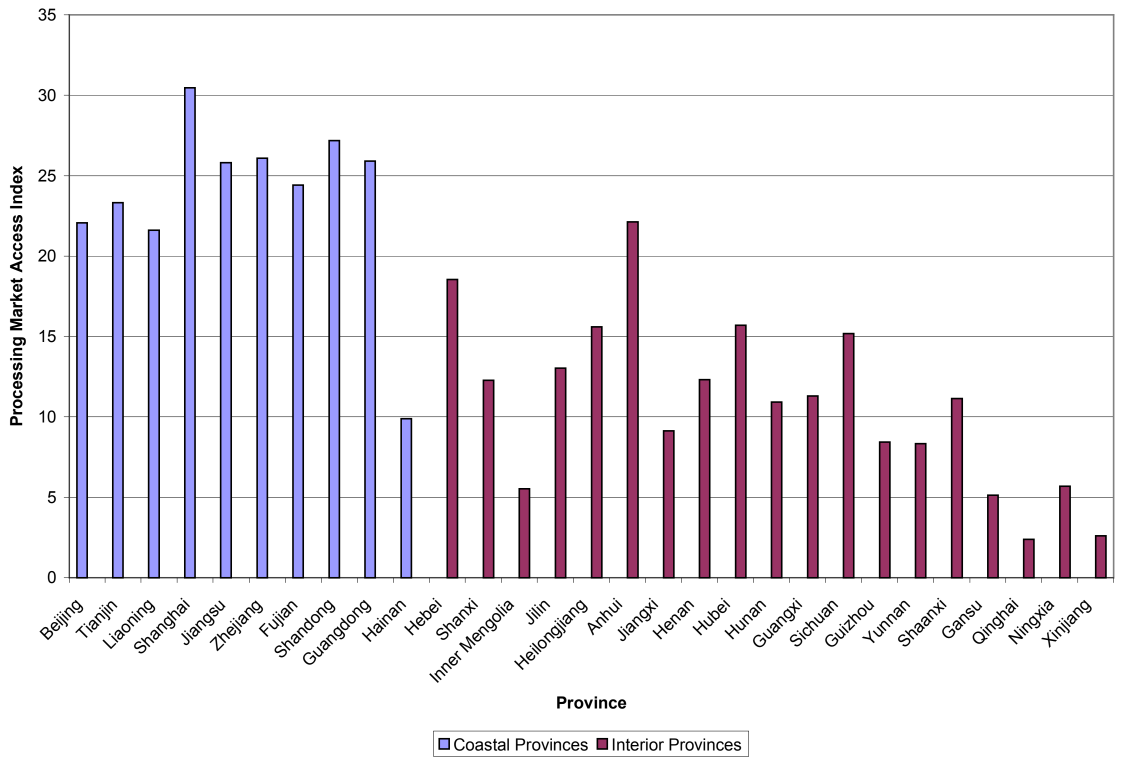



Figure 5 presents the estimated supplier access across 29 provinces in 1995. In both panels, the coastal provinces have a higher level of supplier access. The ordinary supplier access in Beijing reaches the highest level, which is consistent with our calculation in Table 3.

Figure 4: Market access index in 1995

Panel A: Processing market access index




Panel B: Ordinary market access index

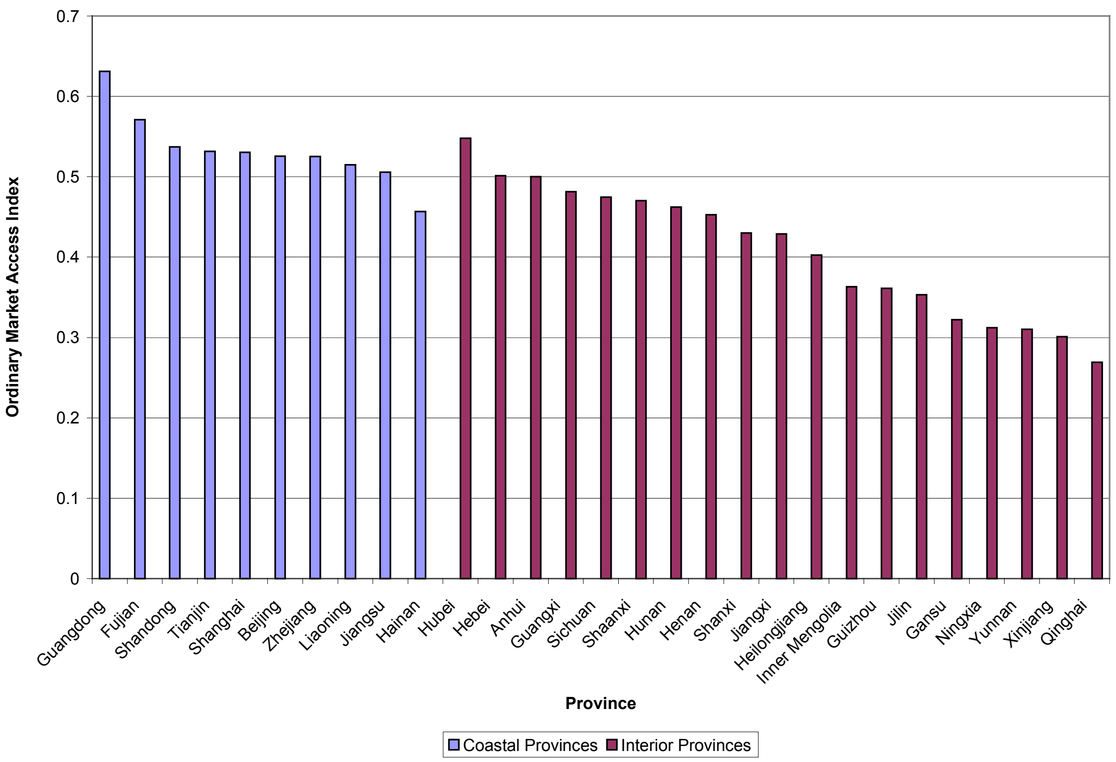
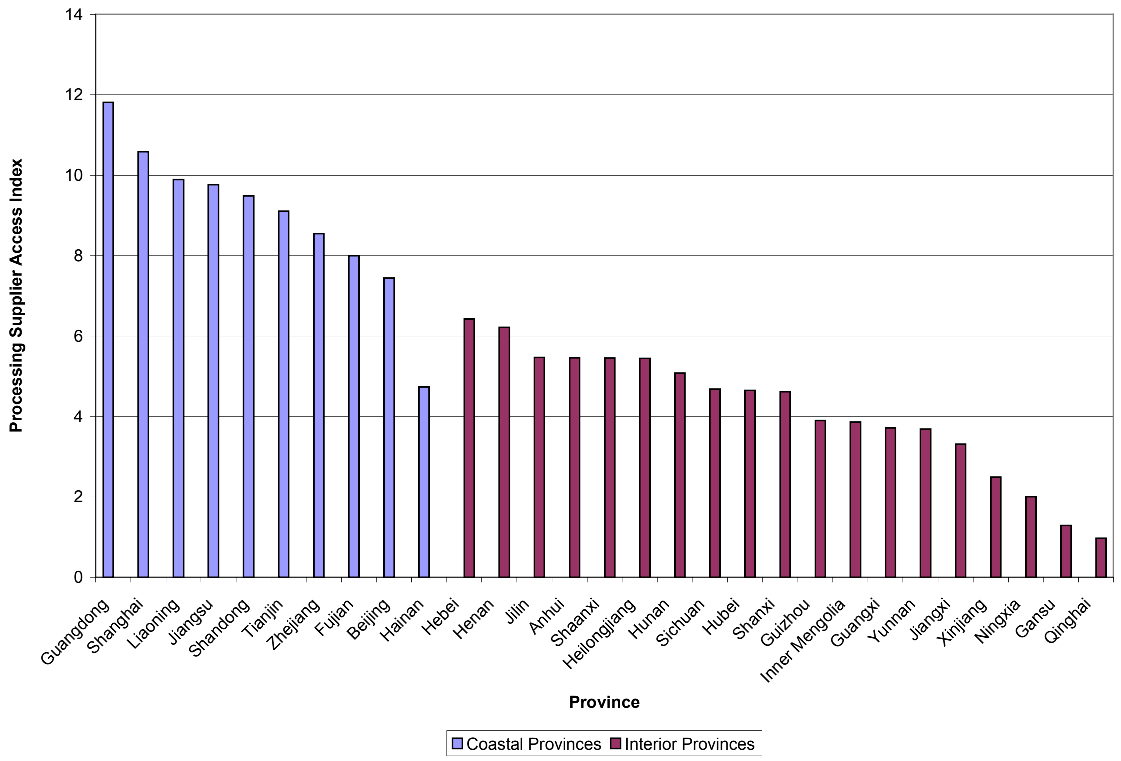
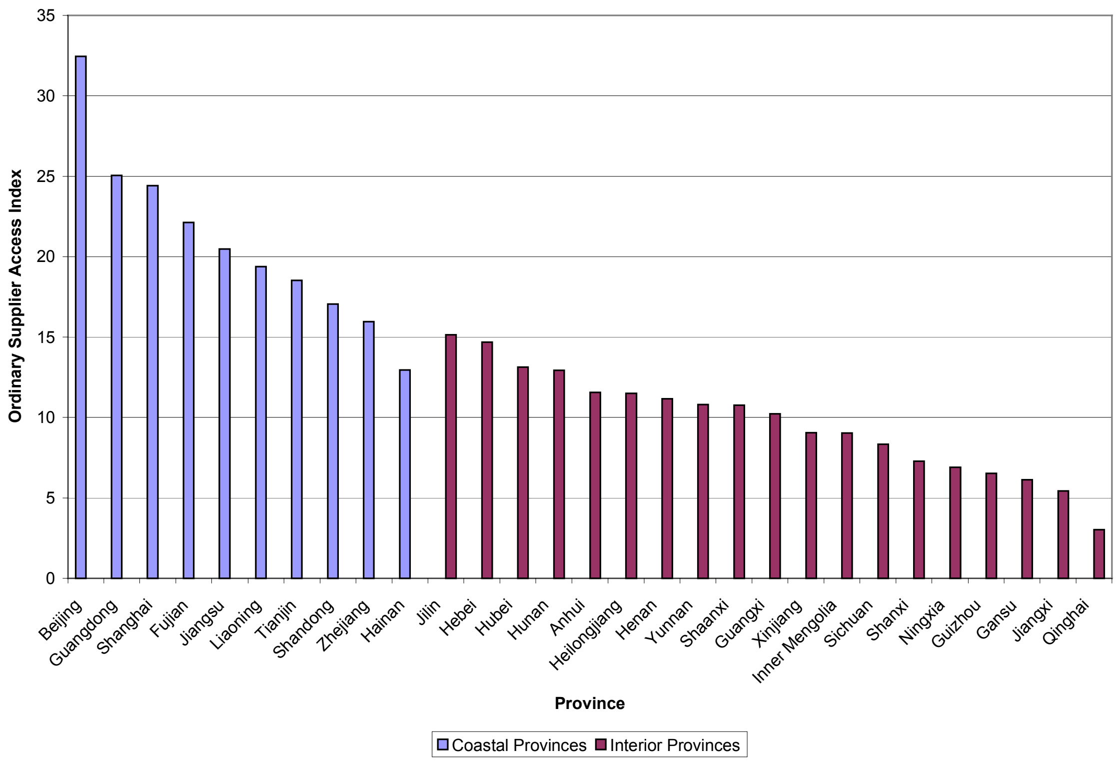


Figure 5: Supplier access index in 1995

Panel A: Processing supplier access index




Panel B: Ordinary supplier access index



### 6.2 Wage equation: basic model

The second stage of estimation is the wage equation. We use two different wage rate measures; the average provincial real wage rate, and the average real wage rate in the manufacturing sector. The independent variables are processing market access, ordinary market access, processing supplier access, and ordinary supplier access. In the first stage, we estimate the gravity equation using different measures of distance, therefore we have two sets of estimated market access and supplier access. One is from the arc distance, and the other from the internal–external distance. We also estimate the basic wage equation using only processing trade data or ordinary trade data.

Table 6: Basic wage equation: real wage rate

| | Using arc distance | | | Using internal–external distance | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Log(processing market access) | 0.022 | 0.027 | | 0.073 | 0.023 | |
| | [5.24]** | [5.40]** | | [8.94]** | [3.16]** | |
| Log(ordinary market access) | -0.01 | | 0.005 | -0.09 | | -0.01 |
| | [1.0] | | [0.63] | [0.31]** | | [1.15] |
| Log(processing supplier access) | 0.021 | 0.018 | | 0.023 | 0.022 | |
| | [7.0]** | [6.0]** | | [4.07]** | [4.78]** | |
| Log(ordinary supplier access) | 0.022 | | 0.024 | 0.042 | | 0.034 |
| | [3.67]** | | [4.86]** | [7.96]** | | [7.80]** |
| Constant | 7.309 | 7.213 | 7.139 | 7.44 | 7.06 | 7.219 |
| | [114.0]** | [323.80]** | [115.98]** | [101.93]** | [241.13]** | [103.35]** |
| Observations | 317 | 317 | 319 | 317 | 317 | 319 |
| R-squared | 0.20 | 0.12 | 0.08 | 0.35 | 0.19 | 0.1 |

Note: This table shows the estimation results for the basic wage equation. The dependent variable is the log of provincial real wage rate. Standard errors are corrected by using bootstrap techniques and t-statistics are in parentheses.

Source: author.

Table 6 presents the estimation results for the wage equation. The dependent variable is the log of average provincial real wage rate. The independent variables in the first three columns are market access and supplier access estimated using arc distance, and those in the rest three columns are from the internal–external distance. Columns (1) and (4) show the results of regressing provincial real wage rate on estimated processing market access, ordinary market access, processing supplier access, and ordinary supplier access using OLS. Columns (2) and (5) consider the effects under processing trade regime, while columns (3) and (6) present the results only for ordinary trade regime. The coefficients on processing market access, processing supplier access, and ordinary supplier access are positive and statistically significant at the 1 per cent level in all specifications of wage equations.

We think the internal–external distance is a more precise measurement of the transportation costs than arc distance does. And we do find that the market access and supplier access constructed using the internal–external distance have larger effects on the real wage rate than ones constructed using the arc distance. It holds for processing trade and ordinary trade. We also expect that processing market access and supplier access have stronger impact on the wage rate than ordinary market access and supplier access. This is because the processing trade is involved in labour-intensive industries. This is true for processing market access, not for ordinary market access.

Table 7: Basic wage equation: real wage rate in manufacturing sector

| | Using arc distance | | | Using internal–external distance | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Log(Processing Market Access) | 0.014 | 0.018 | | 0.057 | 0.021 | |
| | [3.5]** | [3.91]** | | [7.52]** | [3.24]** | |
| Log(Ordinary Market Access) | -0.004 | | 0.007 | -0.056 | | 0.007 |
| | [0.57] | | [0.92] | [0.25] | | [0.07] |
| Log(Processing Supplier Access) | 0.016 | 0.014 | | 0.015 | 0.019 | |
| | [5.33]** | [5.19]** | | [2.84]** | [4.8]** | |
| Log(Ordinary Supplier Access) | 0.018 | | 0.019 | 0.038 | | 0.03 |
| | [3.91]** | | [3.96]** | [7.83]** | | [7.63]** |
| Constant | 2.627 | 2.578 | 2.5 | 2.67 | 2.43 | 2.51 |
| | [43.76]** | [126.03]** | [44.56]** | [39.07]** | [92.35]** | [39.57]** |
| Observations | 316 | 316 | 318 | 316 | 316 | 318 |
| R-squared | 0.14 | 0.08 | 0.06 | 0.3 | 0.12 | 0.08 |

Note: This table shows the estimation results for the basic wage equation. The dependent variable is the log of provincial real wage rate in manufacturing sector. Standard errors are corrected by using bootstrap techniques and t-statistics are in parentheses.

Source: author.

Table 7 presents the estimation results for the wage equation using the average real wage rate in the manufacturing sector. The structure of Table 7 is the same as Table 6. We find that, in any specification, the coefficients in Table 7 are smaller than those in Table 6. This is because the trade data includes both manufacturing and non-manufacturing sectors. The estimated market access and supplier access obtained from the gravity equation reflect the potential demand for all kinds of goods, not only manufactured products. Thus, the effect of market access and supplier access on the provincial real wage rate, which reflects the general level of purchasing power during a certain period of time, is stronger than on the real wage rate in the manufacturing sector.

### 6.3 Robustness test

First, we consider the robustness of results including regional effects. The regional effects capture all the differences across the provinces. The dependent variable is the average provincial real wage rate and the independent variables are processing market access, ordinary market access, processing supplier access, and ordinary supplier access. Columns (1) and (3) in Table 8 copy the results in columns (1) and (4) of Table 6, which are the results in basic wage equation. Columns (2) and (4) report the estimation results including regional effects. The estimated coefficients on processing market access, processing supplier access, and ordinary supplier access are still highly statistically significant. In terms of the magnitude, the estimated coefficients are similar or slightly smaller than in their counterparts. This indicates the estimation results in Table 6 are robust. The estimated coefficients on most regional dummy variables are negative, and the dummies for the interior provinces are statistically significant at the 1 per cent level.

Table 8: Wage equation: robustness test a

| | Using Arc Distance | | Using Internal–external Distance | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Log(Processing Market Access) | 0.022 | 0.021 | 0.073 | 0.047 |
| | [5.24]** | [7.0]** | [8.94]** | [4.31]** |
| Log(Ordinary Market Access) | -0.01 | -0.008 | -0.09 | -0.107 |
| | [1.0] | [1.38] | [0.31]** | [-7.78] |
| Log(Processing Supplier Access) | 0.021 | 0.021 | 0.023 | 0.021 |
| | [7.0]** | [10.5]** | [4.07]** | [3.92]** |
| Log(Ordinary Supplier Access) | 0.022 | 0.021 | 0.042 | 0.027 |
| | [3.67]** | [5.25]** | [7.96]** | [4.19]** |
| Constant | 7.309 | 7.509 | 7.44 | 7.509 |
| | [114.0]** | [84.8]** | [101.93]** | [84.8]** |
| Observations | 317 | 317 | 317 | 317 |
| R-squared | 0.20 | 0.50 | 0.35 | 0.50 |

Note: This table presents the estimation results on wage equation after taking regional dummies into account. The dependent variable is the log of provincial real wage rate. Columns (1) and (3) are copied from Table 6. Columns (2) and (4) have the fixed effects.

Source: author.

Second, we consider the provincial level of education. The provincial educational level is measured by the ratio of the number of students enrolled in the institutions of higher education to the regional population. Table 9 presents the robustness results. Columns (1) and (3) reproduce the results in Table 6. Columns (2) and (4) present the estimated results after considering education level. The coefficients on market access and supplier access are still statistically significant at 1 per cent except ordinary market access. The magnitudes are smaller than their counterparts. As expected, the educational level positively and significantly affects the wage rate. The effect of educational level on the wage rate is larger than market access and supplier access, indicating that the level of education is the main factor determining the wage rate.

Table 9: Wage equation: robustness test b

| | Using Arc Distance | | Using Internal–external Distance | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Log(Processing Market Access) | 0.022 | 0.016 | 0.073 | 0.051 |
| | [5.24]** | [4.0]** | [8.94]** | [5.89]** |
| Log(Ordinary Market Access) | -0.01 | -0.011 | -0.09 | -0.09 |
| | [1.0] | [1.5] | [0.31]** | [-6.70]** |
| Log(Processing Supplier Access) | 0.021 | 0.018 | 0.023 | 0.019 |
| | [7.0]** | [6.0]** | [4.07]** | [3.54]** |
| Log(Ordinary Supplier Access) | 0.022 | 0.018 | 0.042 | 0.03 |
| | [3.67]** | [3.6]** | [7.96]** | [5.65]** |
| Log(Education) | | 0.182 | | 0.141 |
| | | [6.84]** | | [5.58]** |
| Constant | 7.309 | 7.579 | 7.44 | 7.73 |
| | [114.0]** | [114.5]** | [101.93]** | [89.07]** |
| Observations | 317 | 317 | 317 | 317 |
| R-squared | 0.20 | 0.4 | 0.35 | 0.42 |

Note: This table presents the estimation results on wage equation after taking education level into account. The dependent variable is the log of provincial real wage rate.

Source: author.

Third, we introduce policy dummies into the wage equation. We use the preferential policy index constructed in Démurger *et al.* (2001), and add dummy variables to the wage equation to capture the different degrees of deregulation, which are determined by the central government's preferential policy. Table 10 reports the results including the policy dummies. Main results are still robust including the policy dummies, and the effect on the wage rate is smaller than the counterparts in Table 6. Policy dummies are all statistically significant at 1 per cent, and positively affect the regional wage rates. Similar to educational level, the effect of preferential policy on the wage rate is larger than market access and supplier access, implying that preferential policy plays an import role in determining wage rate.[18]

Table 10: Wage equation: robustness test c

| | Using Arc Distance | | Using Internal–external Distance | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Log(Processing Market Access) | 0.022 | 0.013 | 0.073 | 0.05 |
| | [5.24]** | [3.25]* | [8.94]** | [6.15]** |
| Log(Ordinary Market Access) | -0.01 | -0.004 | -0.09 | -0.068 |
| | [-1.0] | [-0.44] | [0.31]** | [-4.87]** |
| Log(Processing Supplier Access) | 0.021 | 0.008 | 0.023 | 0.013 |
| | [7.0]** | [1.98]* | [4.07]** | [2.37]* |
| Log(Ordinary Supplier Access) | 0.022 | 0.013 | 0.042 | 0.031 |
| | [3.67]** | [2.16]** | [7.96]** | [6.12]** |
| Policy Dummy_1 | | 0.223 | | 0.186 |
| | | [4.4]** | | [4.36]** |
| Policy Dummy_2 | | 0.242 | | 0.194 |
| | | [5.5]** | | [0.037]** |
| Policy Dummy_3 | | 0.348 | | 0.374 |
| | | [6.3]** | | [6.95]** |
| Constant | 7.309 | 7.021 | 7.44 | 7.23 |
| | [114.0]** | [88.8]** | [101.93]** | [88.6]** |
| Observations | 317 | 317 | 317 | 317 |
| R-squared | 0.20 | 0.3 | 0.35 | 0.45 |

Note: This table shows the estimation results after taking the preferential policy into account. The preferential policy index is constructed in Démurger *et al.* (2001), which indicates the various degrees of preferential policies. They are expected to be positive.

Source: author.

Fourth, we consider the spatial correlations. Up to now, we mainly concern about market access and supplier access to the international market, ignoring market access and supplier access to the domestic market. This is due to the lack of information on the interprovincial trade. In the second stage, to some extent, we are able to pick up the domestic factors by

[18] We also conduct the robustness test by adding the level of foreign direct investment (FDI) to the wage equation. The effect of FDI overpowers all other variables. And FDI is closely associated with international trade, in particular, processing trade, which leads to the endogeneity. That is why we do not report the robustness test result using FDI.

considering the wage rates of the nearby provinces. For instance, we are interested in the real wage rate in province A. Then we choose another two provinces B and C that are mostly close to province A. We take provinces B and C's wage rates into account when we estimate the wage rate in province A besides market access and supplier access. Table 11 shows that the spatial correlation does play a role in explaining the real wage rate. At the same time, market access and supplier access still statistically affect the real wage rate.

Table 11: Wage equation: robustness test d

| | Using Arc Distance | | Using Internal–external Distance | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Log(Processing Market Access) | 0.022 | 0.02 | 0.073 | 0.055 |
| | [5.24]** | [2.22]* | [8.94]** | [7.22]** |
| Log(Ordinary Market Access) | -0.01 | -0.008 | -0.09 | -0.083 |
| | [-1.0] | [-0.7] | [0.31]** | [-6.21]** |
| Log(Processing Supplier Access) | 0.021 | 0.018 | 0.023 | 0.017 |
| | [7.0]** | [5.0]* | [4.07]** | [3.04]* |
| Log(Ordinary Supplier Access) | 0.022 | 0.017 | 0.042 | 0.042 |
| | [3.67]** | [2.4]** | [7.96]** | [10.33]** |
| Log(Wage_n1) | | 0.019 | | 0.013 |
| | | [0.44] | | [0.49] |
| Log(Wage_n2) | | 0.01 | | 0.048 |
| | | [0.86] | | [0.74] |
| Constant | 7.309 | 7.33 | 7.44 | 7.76 |
| | [114.0]** | [40.8]** | [101.93]** | [31.55]** |
| Observations | 317 | 317 | 317 | 317 |
| R-squared | 0.20 | 0.3 | 0.35 | 0.43 |

Note: This table shows the estimation results after considering the spatial correlation. The independent variables Wage_n1 and Wage_n2 refer to the wage rates in provinces that are close to the province we are interested.

Source: author.

### 6.4 Model prediction

The values of R-squared in Table 6 indicate that 20 per cent of wage differences from the national average real wage rate can be explained by market access and supplier access. Processing market access and supplier access explains 12 per cent, and ordinary market access and supplier access explains 8 per cent. We are also interested in the model's prediction on wage inequality for each individual province. Using the estimated coefficient in column (1) in Table 6, we predict the wage difference between provincial wage rate and the national average, and compare it with the wage difference obtained from observations.

Table 12: Wage differences explained by the model in 1995

| Province | Wage difference from observation (CNY/year) | Wage difference from model (CNY/year) | Ratio (%) | Variance (R-squared) (%) |
|---|---|---|---|---|
| | (1) | (2) | (3)=(2)/(1) | (4) |
| **Total coastal** | | | | 20 |
| Beijing | 674 | 136 | 20 | |
| Tianjin | 239 | 118 | 49 | |
| Liaoning | -181 | 99 | -55 | |
| Shaihang | 1045 | 159 | 15 | |
| Jiangsu | 142 | 110 | 77 | |
| Zhejiang | 250 | 117 | 47 | |
| Fujian | 214 | 165 | 77 | |
| Shandong | -124 | 136 | -110 | |
| Guangdong | 771 | 235 | 30 | |
| Hainan | -8 | -7 | 80 | |
| **Average** | | | 23 | 24 |
| | | | | |
| **Interior** | | | | |
| Hebei | -184 | 62 | -33 | |
| Shanxi | -304 | -45 | 15 | |
| Inner Mongolia | -418 | -128 | 31 | |
| Jilin | -291 | -93 | 32 | |
| Heilongjiang | -433 | -47 | 11 | |
| Anhui | -259 | 67 | -26 | |
| Jiangxi | -346 | -63 | 18 | |
| Henan | -319 | -14 | 4 | |
| Hubei | -194 | 87 | -45 | |
| Hunan | -178 | -9 | 5 | |
| Guangxi | 40 | 3 | 8 | |
| Sichuan | -1443 | 9 | -1 | |
| Guizhou | -1576 | -124 | 8 | |
| Yunnan | -1613 | -161 | 10 | |
| Shaanxi | -1457 | -5 | 0 | |
| Gansu | -1627 | -175 | 11 | |
| Qinghai | -1693 | -241 | 14 | |
| Ningxia | -1632 | -180 | 11 | |
| Xinjiang | -1649 | -197 | 12 | |
| **Average** | | | 5 | 15 |

Note and source: Column (1) is calculated using the real wage rate in *China Statistics Yearbook 1996*. Column (2) is calculated using the estimated coefficients in Table 6. Column (4) is the R-squares obtained from regression results using the whole sample and sub-subsample. CNY=China Yuan Renminbi.

Table 12 presents the results: column (1) is the wage difference obtained by observation; column (2) is the predicted wage difference using our model; and column (3) takes the ratio of the first two columns. The results show that the model can explain about 23 per cent of the wage difference in the coastal provinces and 5 per cent in the interior provinces. The model over-predicts the wage difference for a few provinces. Over-predicted provinces either have ports within the province or are located near a coastal province. According to the model, these provinces should have relatively high wage rates while in actuality, the wage rates in the over-predicted provinces are lower than the national average. This implies that other factors counteract the impact of geographic location.

Column (4) in Table 12 reports the variance explained by the whole sample and subsample sets. Using the subsample that only contains the observations on the coast, market access and supplier access can explain 24 per cent of the wage difference in 1995, whereas it is 13 per cent for the interior provinces. Compared with the average level in column (3), which is obtained from the model prediction, the coastal wage variance directly calculated from the sample is almost the same as the model prediction, and the interior wage variance is higher than the model prediction. This implies that the model captures the location advantage endowed by the coastal provinces and explains a significant portion of the wage differences for the coastal provinces.

## 7 Conclusion

Despite China's remarkable economic growth over the last two decades, a substantial increase in interregional wage inequality has occurred, which has depressed the economic growth and led to social tension. The empirical results of this paper support the model's prediction that geographic location matters in determining the returns to labour. In particular, about one quarter of the wage differences in the coastal provinces and 15 per cent of the wage differences in the interior provinces can be explained by the province's market access and supplier access. The results are robust after taking into account other forces that are also important in determining regional wage rates.

The international experience shows that industrialization can improve a location's market access and supplier access. Hanson (1998) provides strong evidence that wage differentials in Mexico declined after establishing new industry centres along the USA-Mexico border with Mexico's trade liberalization. China's government is now moving in this direction. A western region development office has been established, targeted at promoting economic development in the western region.[19] This study indicates that more specific efforts should be devoted to the forces that affect market access and supplier access, such as increasing infrastructure investment and reducing transportation costs.

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[19] The Western Region Development Office was established by the State Council in 2000 to launch a comprehensive development strategy and to coordinate its implementation.

## Appendix A: data description

This appendix describes data sources and explains variables used.

### Sources of data

I have three data sources. First is the Chinese trade data (1988–98) obtained from the Customs General Administration as part of the project described in Feenstra *et al.* (1998). This data source provides detailed information on Chinese international trade. It contains the commodity codes, countries of origin/destination, countries of purchase/sale, value, quantity, unit of quantity, customs regime, firm type, and province of import or export. Second is the *China Statistical Yearbook* (CSPH various) which provides retail price index, average wage of formal employees, and average wage of formal employees in the manufacturing sector. All these economic indicators are at the provincial level. Third is the *Almanac of China's Foreign Economic Relations and Trade* (MOFTEC various) which provides average exchange rate of the renminbi against the US dollar.

### Definition and explanation of relevant data

*Retail price index* reflects the general change in prices of retail commodities. The change and adjustment in retail prices directly affect living expenditure of urban and rural residents, government revenue, purchasing power of residents, and equilibrium of market supply and demand, and the proportion of consumption and accumulation.

*Average wage of workers and staff* refers to the average wage in money terms per person during certain periods of time for workers and staff of enterprises, institutions, and government agencies, which reflects the general level of wage income during a certain period of time.

*Exchange rate* is the average exchange rate of renminbi against the US dollar in the China Exchange Market.

*The total value of imports and exports at customs* refers to the value of commodities imported into and exported from China.

### Education level

The education level is indicated by the ratio of the number of students enrolled in institutions of higher education to the population. Institutions of higher education refer to establishments set up according to government evaluation and approval procedures, enrolling graduates from high schools and providing higher education courses and training for senior professionals. They include full-time universities, colleges, and higher/further education institutes.

**Appendix B: distance construction**

We construct two measures of distance. The first is a measure of arc distance, in which we assume that goods are directly transported along the minimum arc distance that connects two locations. The second is internal–external distance, in which we assume that goods are first delivered from a province to Tianjin, Shanghai or Guangdong, the three busiest harbours in China, and from there exported out of China.

*Arc distance* is the distance from the capital of a province to the capital of a country. To calculate arc distance, we first obtain the latitude and longitude points for each location at www.mpablast.com/myblast/index.mb. Then we input the latitude and longitude into the formula, which is provided at www.nau.edu/~cvm/latlongdist.html, and obtain the arc distance between any pair of locations.

*Internal–external distance* takes into account the fact that the interior provinces first transport the goods to the economic centre or harbours by rail, and from there the goods are exported out of China. This alternative distance measure corrects the arc distance measure (which ignores the geographic feature that the interior provinces are land-locked). The internal distance is the journey time[20] between the interior province and the economic centre (Beijing) or harbour cities (Tianjin, Shanghai, and Guangdong). The external distance is the shipping distance[21] from the harbour to the capitals of other countries.

[20] Journey times are published in the official state railway timetable.

[21] A world maritime transportation map was used for this purpose.

**References**


Almanac of China's Foreign Economic Relations and Trade, 1988 – 1999, China Foreign Economic Relations and Trade Publishing House, Beijing, P.R.China.

Anderson, J. and E. van Wincoop (2000). 'Gravity with Gravitas: A Solution to the Border Puzzle', *Boston College Working Papers in Economics 485,* Boston College Department of Economics: Boston.

Berman, E., J. Bound and Z. Griliches (1994). 'Changes in the Demand for Skilled Labour within US Manufacturing: Evidence from the Annual Survey of Manufactures', *Quarterly Journal of Economics* 104:367-98.

Borjas, G.J. and V.A. Ramey (1993). 'Foreign Competition, Market Power, and Wage Inequality: Theory and Evidence', *NBER Working Papers* 4556, National Bureau of Economic Research: Cambridge MA.

Chen, J. and B.M. Fleisher (1996). 'Regional Income Inequality and Economic Growth in China', *Journal of Comparative Economics* 22(2):141-64

Cragg, M.I. and M. Epelbaum (1996). 'Why Has Wage Dispersion Grown in Mexico? Is It The Incidence of Reforms or the Growing Demand for Skills?' *Journal of Development Economics* 51:99-116.

CSPH (China Statistical Publishing House) (various). *China Statistical Year Book*, China Statistical Publishing House: Beijing.

Démurger, S., J.D. Sachs, W.T. Woo, S. Bao, G. Chang and A. Mellinger (2001). 'Geography, Economic Policy and Regional Development in China,' *Asian Economic Papers* 1(1).

Feenstra, R.C. and G.H. Hanson (1996). 'Foreign Investment, Outsourcing and Relative Wages', in R.C. Feenstra, G.M. Grossman and D.A.Irwin (eds) *The Political Economy of Trade Policy: Papers in Honor of Jagdish Bhagwati,* MIT Press: Cambridge MA.

Feenstra, R.C. and G.H. Hanson (1997). 'Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras', *Journal of International Economics* 42:371–94.

Feenstra, R.C. and G.H. Hanson (2001). 'Global Production Sharing and Rising Inequality: A Survey of Trade and Wages', *NBER Working Papers* 8372, National Bureau of Economic Research: Cambridge MA.

Feenstra, R.C., H. Wen, W.T. Woo and S. Yao (1998). 'The US-China Bilateral Trade Balance: Its Size and Determinants,' *NBER Working Papers* 6598, National Bureau of Economic Research: Cambridge MA.

Freeman, R. and L.F. Katz (1994) 'Rising Wage Inequality: The United States vs. Other Advanced Countries', in R. Freeman (ed.) *Working Under Different Rules,* Russell Sage Foundation: New York.

Fujita, M., P. Krugman and A.J. Venables (1999). *The Spatial Economy: Cities, Regions, and International Trade*, MIT Press: Cambridge MA.

Hanson, G.H. (1996a). 'Localization Economies, Vertical Organization, and Trade', *American Economic Review* 86(5):1266-78.

Hanson, G.H. (1996b). 'Economic Integration, Intra-industry Trade, and Frontier Regions', *European Economic Review* 40(3-5):941-9

Hanson,G.H.(1998).'Market Potential, Increasing Returns, and Geographic Concentration', *NBER Working Papers* 6429, National Bureau of Economic Research: Cambridge MA.

Hanson, G.H. and A. Harrison (1999). 'Trade, Technology, and Wage Inequality', *Industrial and Labour Relations Review* 52(2)271-88.

Harris, C. (1954) 'The Market as a Factor in the Localization of Industry in the United States', *Annals of the Association of American Geographers* 44:315-48

Hsieh, C.-T. and Woo K.T. (1999) 'The Impact of Outsourcing to China on Hong Kong's Labour Market' (mimeo), Princeton University: New Jersey.

Hummels, D. (1995) 'Global Income Patterns: Does Geography Play a Role?', chapter 2 of Ph.D. thesis, University of Michigan: Ann Arbor.

Hussain, A., P. Lanjouw and N. Stern (1994) 'Income Inequalties in China: Evidence Form Household Survey Data', *World Development* 22(12):1927-57

Jian, T., J.D. Sachs and A.M. Warner (1996). 'Trends in Regional Inequality in China', *NBER working paper* 5412, National Bureau of Economic Research: Cambridge MA.

Kanbur, R. and X. Zhang (1999) 'Which Regional Inequality: Rural-Urban or Coast-Inland? An Application to China', *Journal of Comparative Economics* 27:686-701

Kanbur, R. and X. Zhang (2001). 'Fifty Years of Regional Inequality in China: A Journey Through Evolution, Reform and Openness', *CEPR Working Papers* 2887, Centre for Economic Policy Research: London.

Katz, L.F. and D. Autor (1999). 'Changes in the Wage Structure and Earnings Inequality', in Orley Ashenfleter and David Card' (eds.), *Handbook of Labour Economics* 3(A)1463–55.

Katz, L.F. and K.M. Murphy (1992). 'Changes in Relative Wages, 1963-1987: Supply and Demand Factors', *Quarterly Journal of Economics* 107:35-78

Khan, A.R., K. Griffin, C. Riskin and R. Zhao (1993). 'Sources of Income Inequality in Post-reform China', *China Economic Review* 4(1):19-35.

Krugman, P. and A.J. Venables (1995). 'Globalization and the Inequality of Nations', *Quarterly Journal of Economics* 101:857-80

Lawrence, R.Z. and M.J. Slaughter (1993). 'International Trade and American Wages in the 1980s: Giant Sucking Sound or Small Hiccup?', *Brooking Papers on Economic Activity: Microeconomics* 2:161-226.

Leamer, E.E. (1993). 'Wage Effects of A US-Mexico Free Trade Agreement', in P.M. Garber (ed.), *The US–Mexico Free Trade Agreement,* MIT Press: Cambridge MA.

Leamer, E.E. (1994). 'Trade, Wages and Revolving Door Ideas', *NBER Work Papers* 4716, National Bureau of Economic Research: Cambridge MA.

Leamer, E.E. (1997). 'Access to Western Markets and Eastern Effort', in S. Zecchini (ed.) *Lesson From the Economic Transition, Central and Eastern Europe in the 1990s,* Kluwer Academic Publisher: Dordrecht.

MOFTEC (Ministry of Foreign Trade and Economic Co-operation) (various). *Almanac of China's Foreign Economic Relations and Trade*, China Foreign Economic Relations and Trade Publishing House: Beijing.

Moreno, R. and B. Trehan (1997). 'Location and the Growth of Nations', *Federal Reserve Bank of San Francisco Working Papers in Applied Economic Theory* 97-02.

Overman, H., S. Redding and A.J. Venables (2001). 'Trade and Geography: a Survey of Empirics', *CEPR Working Papers* 2978, Centre for Economic Policy Research: London.

Redding, S. and A.J. Venables (2000). 'Economic Geography and International Inequality', *CEPR Working Papers* 2568, Centre for Economic Policy Research: London.

Tsui, K.-Y. (1998). 'Factor Decomposition of Chinese Rural Income Inequaltiy: New Methodology, Empirical Findings, and Policy Implications', *Journal of Comparative Economics* 26(3):502-28

Wood, A. (1994). *North-South Trade, Employment and Inequality*, Oxford University Press: Oxford.