Factor Price Equalization and Economic Integration in China

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Abstract

A very preliminary draft.

1 Introduction

Since the economic reform in Mainland China, integration across regions within Mainland China has increased. This integration is manifested in the forms of inter- and intra-industry trade across the regions and interregional capital and labor movements. Although some of these integrations are not formally allowed by the Chinese government, many of the policies that oppose this integration have become less and less binding. For example, even though the *hukou system*—the system that restricts labor from moving across regions—have not yet been completely eliminated, the huge interregional labor movement is no longer an underground economic activity. The Chinese government even facilitates these movements by making special transportation arrangements during the beginning and the end of traditional festivals and holidays, when the workers worked outside their registered residential regions go back to their home region and then go back to their working region.

According to international trade theories, these kinds of integration will bring about factor price equalization across the regions. Factor movements across regions will, of course, force factor prices to converge. Even without perfect factor mobility, the Heckscher-Ohlin-Samuelson (HOS) model predicts that trade between trading regions will also cause factor prices of these regions to converge (Samuelson 1948, 1949). This paper examines the extent of regional integration in China through investigating the extent of factor price equalization across its regions.

2 The Literature

The Heckscher-Ohlin-Samuelson (HOS) theory predicts that international trade will bring about factor price equalization (FPE) across countries, if the factor endowments of all the countries fall in the same diversification cone. This prediction, unfortunately, was not supported even by casual observations. Trefler (1993) suggested that factors across countries are not directly comparable. They should be measured in terms of productivity-equivalent units. For example, in 2006, the labor force of China is almost five times that of the US.[1] If the average productivity of an American worker is twice that of their Chinese counterparts, then, when measured in productivity equivalent units, Chinese labor endowment is only 2.5 times of the American's.

Bernard, Jensen, and Schott (2001) and Bernard, Redding, and Schott (2005) extend the literature of testing FPE across countries to testing FPE across regions within a country. They introduced a methodology that controls for unobserved cross-regional differences in factor quality and total factor productivity. They applied their methodology to study the FPE within the US. Applying Bernard et al's (2005) methodology, Tomiura (2005) studies the FPE in Japan and Bernard, Redding, Schott, and Simpson (2008) study that in the UK. This study applies Bernard et al's (2005) methodology to study FPE across regions within Mainland China.

There is a huge literature of income disparity and wage inequality of China. Recent examples include Chang (2002), Meng (2005) and symposium articles in the same issue, Wan (2007) and articles in the same special issue, Kanbur, Qian, and Zhang (2008) and symposium articles in the same issue, and Knight (2008). This study is related to this literature in the sense that it also analyzes the factor price (in)equality. But it differs from the literature in the way that this study examines the factor prices of factors measured in productivity-equivalent units. For example, when a Beijing worker is twice as productive as a Shanxi worker, the salary of a Beijing worker may be roughly the double of the salary of a Shanxi worker. In the literature of income disparity in China, this is a phenomenon of wage inequality. But in this study, this is a phenomenon of FPE. This by no means claims that the view of the literature is wrong. Focusing on the observed wages of workers is important because the observed wages are what will affect the social and political stability in a country. But focusing on the productivity-adjusted wages of workers is also important because the productivity-adjusted wages reflect the extent of market integration and efficiency.

3 The Model

This paper extends the methodology introduced by Bernard, Redding, and Schott (2005 CEPR Discussion Paper No. 5126).

Suppose there are F factors. Let the *value-added* production function of industry

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i in region r be

$$Y_{ir} = A_{ir}\mathcal{F}_i\left(x_{1ir}, x_{2ir}, \ldots, x_{Fir}\right),$$

where A_{ir} is the total factor productivity and x_{fir} is the amount of *quality-adjusted* factor f employed. Since the factors x_{fir} are quality-adjusted, we may assume that the function $\mathcal{F}_i$ is identical across regions.

If the production function exhibits constant returns to scale, the corresponding cost function is

$$C_{ir} = A_{ir}^{-1}\mathcal{C}_i\left(w_{1ir}, w_{2ir}, \ldots, w_{Fir}\right)Y_{ir},$$

where w_{fir} is the factor price of quality-adjusted factor f.

Using Shephard's Lemma,

$$x_{fir} = A_{ir}^{-1}\frac{\partial \mathcal{C}_i\left(\cdot\right)}{\partial w_{fir}}Y_{ir}$$

If factor prices are equalized across regions, say region r and region b, we will have

$$w_{fir} = w_{fib} \tag{1}$$

and industries in different regions adopt the same *relative* factor usage, say between factor l and factor k.

$$\frac{x_{lir}}{x_{kir}} = \frac{x_{lib}}{x_{kib}} \tag{2}$$

The quality-adjusted factors equal the observed factors, $\tilde{x}_{fir}$, multiplying some quality adjustors, θ_{fir}. Therefore, the ratio (2) above becomes

$$\frac{\theta_{lir}\tilde{x}_{lir}}{\theta_{kir}\tilde{x}_{kir}} = \frac{\theta_{lib}\tilde{x}_{lib}}{\theta_{kib}\tilde{x}_{kib}} \tag{3}$$

The factor prices of observed factors, $\tilde{w}_{fir}$, should equal the factor prices of quality-adjusted factors multiplying the quality adjustors. Therefore, if factor price equalization holds, equation (1) gives us

$$\tilde{w}_{fir}/\theta_{fir} = \tilde{w}_{fib}/\theta_{fib} \tag{4}$$

Combining (4) and (3), we have

$$\frac{\tilde{w}_{lir}\tilde{x}_{lir}}{\tilde{w}_{kir}\tilde{x}_{kir}} = \frac{\tilde{w}_{lib}\tilde{x}_{lib}}{\tilde{w}_{kib}\tilde{x}_{kib}} \tag{5}$$

Factors care only about the *actual/observed* factor prices they received. If the observed factor prices differ across industries, and if factors are *perfectly mobile* across industries, then factors will move to industries that pay a higher observed factor price. This causes the observed factor prices to equalized across industries, say industry i and industry j, within a region:

$$\tilde{w}_{fir} = \tilde{w}_{fjr} = \tilde{w}_{fr}$$

$$\theta_{fir} w_{fir} = \theta_{fjr} w_{fjr} = \tilde{w}_{fr}$$

From (5), we have

$$\frac{\tilde{w}_{lr}\tilde{x}_{lir}}{\tilde{w}_{kr}\tilde{x}_{kir}} = \frac{\tilde{w}_{lb}\tilde{x}_{lib}}{\tilde{w}_{kb}\tilde{x}_{kib}} \tag{6}$$

$$\frac{\tilde{w}_{lr}\tilde{x}_{ljr}}{\tilde{w}_{kr}\tilde{x}_{kjr}} = \frac{\tilde{w}_{lb}\tilde{x}_{ljb}}{\tilde{w}_{kb}\tilde{x}_{kjb}} \tag{7}$$

Dividing (6) by (7)

$$\frac{\tilde{x}_{lir}}{\tilde{x}_{kir}} / \frac{\tilde{x}_{ljr}}{\tilde{x}_{kjr}} = \frac{\tilde{x}_{lib}}{\tilde{x}_{kib}} / \frac{\tilde{x}_{ljb}}{\tilde{x}_{kjb}} \tag{8}$$

To test for the extent of factor price equalization in China, we test equations (6) and (8).

4 Empirical Specification

Under the null of quality-adjusted factor price equalization across regions, the cross-industry ratio of unskilled to skilled workers is the same across regions. This means that, for industry i and j, the cross-industry ratio equals between any pair of provinces r and b.

To test the null hypothesis (equation (8)), we regress the cross-industry factor ratio for province r relative to the ratio for the aggregate China on a set of province dummies,

$$\frac{CIR_r^{i,j}}{CIR_{CN}^{i,j}} - 1 = \sum_{r=1}^{20} \alpha_r d_r + \varepsilon_r \tag{9}$$

where CIR is the cross-industry factor usage ratio and d_r is a dummy variable for province r.

Under the null hypothesis, the coefficient of a province dummy must be equal to zero, and a test of whether the coefficients are jointly equal to zero provides a test of the hypothesis. In essence, we are comparing the cross-industry factor usage ratio in each province to the country average. Thus the regression corresponds to a differences in means test.

We also test whether the null hypothesis holds within each region, by allowing geographic regions to be the base regions. We run a regression analogous to equation (9),

$$\frac{CIR_r^{i,j}}{CIR_s^{i,j}} - 1 = \sum_{r=1}^{20} \alpha_r d_r + \varepsilon_r \tag{10}$$

where s is the region of the province (eg. Beijing is in the Eastern region). This is equivalent to comparing the cross-industry factor usage ratio across all provinces to its regional average. Again, a test of whether the coefficients are jointly equal to zero provides a test of the hypothesis of factor price equalization at regional level.

Lastly, we test factor price equalization across regions. To do so, we run the following regression, using the Eastern region as the base.

$$\frac{CIR_r^{i,j}}{CIR_{East}^{i,j}} - 1 = \sum_{r=12}^{20} \alpha_r d_r + \varepsilon_r \tag{11}$$

Note that different from test for intra-regional equalization, the base now is the same for all provinces, even those in the Midland and Western regions. The idea is to examine the null hypothesis holds between the Eastern region and the rest of the country. A rejection of the coefficients jointly equal to zero is sufficient to reject the null hypothesis that factor prices are equalized across provinces to those of the Eastern region.

5 Data

Data on employment of skilled and unskilled workers for 1994 are drawn from the third wave of Industrial Census, for 2003 from 2004 Economic Census. Both datasets contain detailed information on the education level of employees, occupation and presence in one of 31 China Industrial Classification manufacturing industries. A total of 20 provinces are present in both datasets.

Because we are interested in testing the implication of factor price equalization on factor usage of skilled and unskilled workers, we construct employment of both types of workers, using education achievement as a proxy for skill level. Specifically, workers with schooling of twelve years or less are identified as unskilled, while workers with schooling of fifteen years or more are classified as skilled. Since the implication of factor price equalization requires the test of cross-industry factor usage ratio across provinces, we construct the cross-industry factor usage ratio by dividing usage ratio in industry i by that in industry j, and we do so for each possible combination of industries for each province, and also at both country and region level. To investigate regional pattern in factor price equalization, we divide the 20 provinces into three geographical regions: East, Midland and West. A breakdown of provinces by region is presented in Table 1.

For country level factor usage ratio in an industry, we experiment with two measures. One is a simple mean of factor usage ratio of all provinces, and the other is a weighted average, with total employment in the province as weight. For regional level factor usage ratio in an industry, we use only the weighted average of all provinces in that region, as this may be a more reasonable measure that reflects the average factor usage.

6 Empirical Results

In our first set of results, we test for the null hypothesis of quality-adjusted factor price equalization across China. We run the regression specified in (9), comparing each province's cross-industry factor ratio to the aggregate cross-industry ratio in China.

Table 2 and 3 present the estimation results, using the unweighted average and the weighted average as the aggregate ratio, respectively. Two findings emerge. First, the results reject the null hypothesis of quality-adjusted factor price equalization across regions in both 1994 and 2003. Secondly, since 1994, the deviation from the China base has declined significantly in over 60% of the provinces, the change being more pronounced when using unweighted mean, where 90% of the provinces show convergence toward the country level. Our estimation results thus seem consistent with the hypothesis that differences in factor price across regions are smaller and/or that differences in observed factor price across industries within a region are reduced.

We now turn to the findings on intra-regional test of factor price equalization. Table 4 reports the estimation results for regression (10). Here we compare each province's cross-industry factor usage ratio to its regional ratio. Table 4 reveals that provincial deviation from the regional base is generally smaller than that from the countrybase. We take this finding as evidence that factor prices are more equalized within a region than within a country.

As with the country level comparison, the results reject the hypothesis of relative factor price equalization within a region in both years. And again, we observe the general trend of convergence of provincial cross-industry factor usage toward regional average over time. Different from the comparison at the country level, however, the regional convergence is weak, and in the Western region, there is a fifty-fifty split between convergence and divergence. We note the pattern that deviation from regional average is usually smaller than from country level. In conclusion, our results are consistent with the hypothesis that China experienced weak intra-regional convergence between 1994 and 2003.

We run equation (11) to compare inter-regional convergence in cross-industry factor usage. Table 5 presents the estimation results, using the Eastern region as the base region. As evident from table 5, the West show substantial convergence in cross-industry factor usage ratio toward the East over time. The Midland, however, shows a mix of convergence and divergence. The findings are thus consistent with the hypothesis of factor price equalization between regions.

7 Conclusion

The above results show significant convergence in cross-industry factor usage ratio over time in China. This implies China is moving towasrds factor-price equalization.

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TABLE 1

Geographic Regions

Region	Province	Region	Province	Region	Province
East	Beijing	Midland	Henan	West	Tibet
	Hebei		Guangdong		Shaanxi
	Shanxi		Hainan		Ningxia
	Liaoning		Guizhou		Xinjiang
	Jilin		Yunnan		
	Jiangsu				
	Zhejiang				
	Anhui				
	Fujian				
	Jiangxi				
	Shangdong				

TABLE 2

Tests of common cross-industry relative factor usage across Provinces, China base in unweighted average.

Province	2003	1994
East		
Beijing	0.22***	0.72***
Tianjin	0.04	
Hebei	0.08***	0.63***
Shanxi	0.15***	0.27***
Liaoning	0.12***	0.90***
Jilin	0.30***	0.36***
Heilongjiang	0.23***	
Shanghai	0.08***	
Jiangsu	0.00	1.03***
Zhejiang	-0.04*	1.86***
Anhui	0.24***	1.85***
Fujian	-0.01	1.6***
Jiangxi	0.18***	2.41***
Shandong	0.01	0.69***

Midwest		
Henan	0.15***	0.41***
Guangdong	-0.06**	1.30***
Guangxi	0.04***	
Hainan	0.26***	0.14***
Guizhou	0.63***	1.55***
Yunnan	0.47***	0.37***
West		
Tibet	0.49***	0.75***
Shaanxi	0.58***	0.66***
Gansu	0.21***	
Ningxia	0.05	0.60***
Xinjiang	0.06	0.71***
F-stat	28.72	18.67
Observations	9,397	7,673

Notes: For 1995, the total number of observations is 406 per province for all provinces, except Jiangxi, Hainan and Tibet. For 2004, the total number of observations is 406 per province for all provinces, except Guangxi, Hainan, Yunnan, Tibet, Shaanxi, Ningxia and Xinjiang. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Statistical significance is based on standard errors that are robust to heteroscedasticity.

Source: Authors' calculation using The 3rd China Industrial Census and 2004 China Economic Census.

TABLE 3

Tests of common cross-industry relative factor usage across Provinces, China base in weighted average, where the weights are total employment.

Province	2003	1994
East		
Beijing	0.33***	0.43***
Tianjin	0.12***	
Hebei	0.19***	0.15**
Shanxi	0.28***	0.23***
Liaoning	0.21***	0.22***
Jilin	0.43***	0.08***
Heilongjiang	0.36***	

Shanghai	0.13***	
Jiangsu	0.06***	0.19**
Zhejiang	0.02	0.26***
Anhui	0.31***	0.44***
Fujian	0.05	0.37***
Jiangxi	0.24***	0.58***
Shandong	0.07***	0.11***
Midwest		
Henan	0.30***	0.15***
Guangdong	-0.02	0.18***
Guangxi	0.16***	
Hainan	0.32***	0.22***
Guizhou	0.74***	6.95***
Yunnan	0.68***	0.55***
West		
Tibet	0.61***	1.08***
Shaanxi	0.76***	0.05***
Gansu	0.32***	
Ningxia	0.18***	0.42***
Xinjiang	0.19***	0.34***
F-stat	49.29	31.31
Observations	9,397	7,673

Notes: See Table 2

TABLE 4

Tests of common cross-industry relative factor usage across Provinces, Region base in weighted average.

Province	2004	1995
East		
Beijing	0.28***	0.40***
Tianjin	0.08***	
Hebei	0.14***	0.10**
Shanxi	0.23***	0.34***

Liaoning	0.18***	0.12***
Jilin	0.36***	0.08***
Heilongjiang	0.32***	
Shanghai	0.10***	
Jiangsu	0.03***	0.04**
Zhejiang	-0.02	-0.03
Anhui	0.28***	0.17***
Fujian	0.03	0.09***
Jiangxi	0.22***	0.27***
Shandong	0.04***	0.02***
Midwest		
Henan	0.38***	0.66***
Guangdong	0.05	1.71***
Guangxi	0.24***	
Hainan	0.47***	0.18***
Guizhou	0.76***	1.46***
Yunnan	0.65***	0.58***
West		
Tibet	0.49***	0.83***
Shaanxi	0.14***	0.05***
Gansu	0.07***	
Ningxia	-0.14***	0.10**
Xinjiang	0.04	0.03
F-stat	40.00	26.13
Observations	9,397	7,673

Notes: See Table 2.

TABLE 5

Tests of common cross-industry relative factor usage across Provinces, the weighted average of the East Region as base

Province	2004	1995
Midwest		
Henan	0.25***	0.15***
Guangdong	-0.04*	0.00
Guangxi	0.12***	

Hainan	0.29***	0.26***
Guizhou	0.71***	29.69***
Yunnan	0.64***	0.95***
West		
Tibet	0.62***	1.11***
Shaanxi	0.71***	0.57***
Gansu	0.29***	
Ningxia	0.14***	0.44***
Xinjiang	0.15***	0.29***
F-stat	38.72	41.22
Observations	3,741	3,313

Notes: See Table 2.