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Research Article

The Dilemma of Factor Allocation and Wage Difference under the Constant Region-Wide Returns to Scale

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In the model setting of multiregional macroeconomic research, the constant return on scale of all production functions and the free flow of all production factors cannot be combined. Otherwise, the potential theoretical conflict, that is, the problem of contradiction equations, may arise. If there is a unified capital interest rate in the market and the return on scale of production in all regions remains unchanged, it is necessary to set restrictions on the flow of labor force in order to realize the differential wages among regions. When the interest rate is not too high, the regional wage increases with the larger output capital elasticity.

1. Introduction

What explains the generally large differences in average wages between developed regions and economically backward regions in large economies? It is natural to think that this is due to the different production efficiency of the two regions, but this is not very compatible with the neoclassical liberal economic theory. This is because, according to classical economic theory, large economies in modern societies generally have a uniform interest rate and a free flow of labor, and it stands to reason that when an economic system reaches general equilibrium, wages should be equal to the marginal productivity of labor and interest rates equal to the marginal productivity of capital, and there should be no differences. If there is a significant wage differential, labor is bound to flow to places with high marginal productivity until there is no difference in marginal productivity across places. In particular, the labor income share is also constant under the Cobb-Douglas production function and the assumption of perfect competition [1]. Therefore, the classical theory cannot explain regional wage differences. However, the allocation of factors is sometimes crucial and concerns the welfare of the whole economy. The mobility of labor factors affects not only intraeconomy but also trade welfare [2].

In the general equilibrium theory of classical microeconomics, the vector of commodity prices, the vector of factor prices, and the vector of commodity quantities form a system of equilibrium coordination, and the prices of various commodities essentially become "reconcilers" for reaching general equilibrium. At the same time, the "net exhaustion theorem of output distribution" derived from the "assumption of constant returns to scale of the production function" also provides a harmonious vision of capitalist economic theory that is both fair and efficient.

When macroeconomics was introduced, it followed the analytical framework of microeconomics theory and developed an elaborate theoretical system by assuming analytical models such as socially representative manufacturers and their production functions and representative consumer utility functions and widely using mathematical tools. It is a common method in macroeconomic research to describe the overall and regional economy by representative manufacturers and their production functions. The optimal allocation of production factors such as capital and labor in the economic system is also one of the focuses of academic discussion [3, 4]. Representative manufacturers abstract the

mesoscopic region, industry, or the entire macro economy into a micromanufacturer and construct production functions to solve the corresponding problems. But, unlike the manufacturer theory of microeconomics, there is a price vector, and the output of representative manufacturer can only be an abstract single product of "GDP" in macroscopical and regional economy.

Here lies the problem: while the price system of microeconomics is a multidimensional vector of multiple commodities, the output of macroeconomics is a single product, "GDP," and also a single price, i.e., the legal tender of the country. In this way, the degree of freedom of the variables of the "economic mathematical system" is significantly reduced, unlike the general equilibrium system of microeconomics. The degradation of this price system may result in potential conflicts set by the model, especially between the constant returns to scale of the whole region and the optimal allocation of the factor markets.

In classical economics, if the production function has the property of constant returns to scale, it will not only bring convenience to formula derivation but also theoretically support the property of the marginal distribution of Euler Theorem. Therefore, in the research process of regional and macroscopical economy, scholars often habitually apply the hypothesis of constant return to scale of production function. In this regard, the question we put forward is, if the returns to scale of the production function in all regions are constant, can the equilibrium of the free-flowing factor market be realized? [5]. In other words, can (1) optimal allocation of labor and capital markets and (2) constant returns to scale of production functions in all regions be theoretically achieved at the same time?

This paper is a fundamental theoretical study in the field of economics, using the theory of representative firms in macroeconomics and the general equilibrium theory in microeconomics to classify macroeconomics into regions, set representative firms and production functions, and establish economic and mathematical models for logical derivation. The whole process is an algebraic argument designed to provide theoretical support for empirical studies exploring the causes of systematic wage differences in regional economies and so forth. Originally, there was no need to use specific data, but we still use the average wage differences across China and the corresponding policies for appropriate analytical illustration.

This study has both theoretical and policy implications. Theoretically, it reveals that, in multiregional or multivendor economic studies, the three conditions of classical perfect competition economic theory of full factor mobility and constant payoffs of scale of production function are incompatible and generally cannot be fully satisfied, which in turn gives new guidelines for the accuracy of macroeconomic modeling in practice. At the same time, the theoretical study of regional wage differentials provides an operational modeling direction. In practice, the model contributes to the empirical study and policy recommendations for eliminating wage differentials and achieving common wealth.

2. Model Framework

Macroeconomic system is composed of m small regions, every region has a certain population, and there is one manufacturer in each region as the most basic unit of macroeconomics. When "GDP" is a unified abstract product, these vendors have different production functions: where K_i and L_i are the capital and labor input of the i-th manufacturer, respectively. Three hypotheses and one proposition are given, in order to study the ideal state of questions related to the return to scale hypothesis when factors of production can flow freely.

Hypothesis 1: Across the regions of a macro economy, capital and labor can flow freely, and labor and capital are sufficient.

Hypothesis 2: The functions of production across regions in the economy are different, and all comply with the rule that the "returns to scale" remain unchanged.

Hypothesis 3: The final products across regions are homogeneous "GDP" and the price unit is unified as 1.

Topic 1: in the economic system, uniform market interest rates and wages make it difficult for representative manufacturers in all regions to achieve profit optimization in the general case, if the production functions of all regions are constant returns to scale and their parameters differ from each other.

To prove the proposition, the per capita production function (intensive production function) of a region can be determined:

$$f_i(k_i) = \frac{F_i(K_i, L_i)}{L_i} = F_i\left(\frac{K_i}{L_i}, 1\right). \tag{1}$$

Even in underdeveloped regions, the regional economy has nonzero output, so its capital and labor are generally nonzero. Because of the free flow of capital and labor markets, there is a unified wage and interest rate in the market. Otherwise, ideally, spontaneous actions by workers and capital seeking high returns will also eliminate the difference between wages and interest rates.

Related to the entire macro economy, the power of individual region is negligible and labor wages and market capital interest rates can only be regarded as fixed and then determine the amount of capital and labor employment, followed by determining the output. Without loss of generality, consider the optimization problem for region 1:

$$\max \quad F_i(K_i, L_i) - rK_i - wL_i. \tag{2}$$

In this problem, the output price is no longer the price of goods but is abstracted as the unified GDP measurement price, namely, unit 1. The optimal selection naturally meets the first-order condition:

$$\begin{cases} \dfrac{\partial F_i(K_i, L_i)}{\partial K_i} = r, \\ \dfrac{\partial F_i(K_i, L_i)}{\partial L_i} = w. \end{cases} \tag{3}$$

The region takes wages and interest rates as given parameters. If the production function is not required to satisfy the nature of constant return to scale, two unknown variables, capital and labor, can be completely determined based on interest rate and wage according to the above conditions.

Per capita capital $k_i = K_i/L_i$. Since the scale return of production function remains unchanged, the above first-order condition can be expressed as

$$\begin{cases} r = f_i'(k_i), \\ w = f_i(k_i) - k_i f_i'(k_i). \end{cases} \tag{4}$$

This creates potential problems: the market interest rate can determine the capital input per capita, but the market wage of labor force can also determine the capital input per capita, so if these two are not equal, there will be a potential contradiction between them, that is, whether there is a problem of contradictory equations. In order to see this problem, we gradually analyze the following.

When $i = 1$, we consider $\{r, w, k_1\}$ as the three variables of the following system:

$$\begin{cases} r = f_1'(k_1), \\ w = f_1(k_1) - k_1 f_1'(k_1). \end{cases} \tag{5}$$

Obviously, when the market has only one region and its representative manufacturers, wage, interest rate, and capital per capita will not conflict with each other. There are three variables, two equations, and one variable degree of freedom.

When there are two vendors in the market, there will be

$$\begin{cases} \begin{cases} r = f_1'(k_1), \\ w = f_1(k_1) - k_1 f_1'(k_1), \end{cases} & \begin{cases} r = f_2'(k_2), \\ w = f_2(k_2) - k_2 f_2'(k_2). \end{cases} \end{cases} \tag{6}$$

In this way, the total variables of the economic system are $\{r, w, k_1, k_2\}$, and there are four equations in total. The economic system can have only certain possibility, and there is still no logical contradiction in mathematics.

The problem arises. If there are three regions with different production functions, the first-order condition has six equations:

$$\begin{cases} r = f_i'(k_i), \\ w = f_i(k_i) - k_i f_i'(k_i), \\ i = 1, 2, 3. \end{cases} \tag{7}$$

In fact, for each region, interest rate and wage determine a capital level per capita, respectively, but there is no necessity for two capital levels per capita to be equal.

To put it another way, if we regard all the economic variables as the system determined by the system of equations at the same time, then, in the economic system, there are five macroscopic and microscopic variables $\{r, w, k_1, k_2, k_3\}$, but there are six equations; in this case, there is the possibility of contradictory equations.

Furthermore, when there are four regions of the economy, the macro and micro variables are six in total $\{r, w, k_1, k_2, k_3, k_4\}$, but there are eight equations.

$$\begin{cases} r = f_i'(k_i), \\ w = f_i(k_i) - k_i f_i'(k_i), \\ i = 1, 2, 3, 4. \end{cases} \tag{8}$$

Similarly, when there are m regions in the economy, the system has a total of $m + 2$ variables $\{r, w, k_1, k_2, k_3, \ldots, k_m\}$ but $2m$ equations.

Thus, the number of variables is one less than the total number of equations for each additional region. As the number of equations far exceeds the number of variables, the problem of potentially contradictory equations will become more prominent. The roots lie in the assumption that the return to scale of the production function is constant.

Of course, for nonlinear equations, sometimes the number of variables is allowed to be less than the number of equations without the problem of contradictory equations, but the particularity does not guarantee the general. For some very special functional forms, there may be equivalent equations where there are more equations than variables, and there may be noncontradictory solutions. However, the general framework is studied in this paper. Our functions are not defined in a definite form. According to the mathematical logic, if a contradictory example appears, the model framework will be difficult to stand on in the most general case.

Theoretically, if the macro market has the same capital interest rate, the per capita capital input in this region can be determined by $r = f_i'(k_i)$, and then the wage in this region can be calculated according to $w_i = f_i(k_i) - k_i f_i'(k_i)$ according to the per capita capital input. A salary can be calculated for each region, but these salaries are not necessarily equal. In this way, if the macroeconomic labor force can move freely, then the labor force is bound to flow to the region with the highest wage, so that only the region with the highest wage can produce in the end. Macroeconomic degradation into a single regional economy. In fact, this is

mathematically a degenerate boundary solution. In reality, although the economy has the phenomenon of unbalanced regional development, few national economies degenerate into a single regional state.

Generally, due to the monetization and informatization of modern society, capital is more liquid than labor, and a relatively uniform interest rate system exists in an economy. If all manufacturers decide the amount of capital input according to the interest rate, the following inference can be drawn:

> Implication 1: In the market where there is a uniform capital interest rate, if the regional production function is to be paid in the same way as the constant rate and the multiple regional representative manufacturers of different production technology make the profit maximization in accordance with the uniform interest rate, then the labor wage of the macro market uniform is not existent, so all the representative manufacturers in all regions reach the optimal amount of labor input, which meets the maximum profit maximization condition.
>
> Similarly, if the market has the same wage, if the region chooses capital input per capita according to the wage, it is difficult to reach an agreement on the optimal capital interest rate. In other words, region i determines the amount of capital according to $w = f_i(k_i) - k_i f_i'(k_i)$ and then calculates its own most suitable interest rate according to $r_i = f_i'(k_i)$; then these interest rates cannot be guaranteed to be equal; that is, the macro market is "all tastes," and it is difficult to form a unified interest rate that is optimal for all regions, thus inferring 2.
>
> Implication 2: In the presence of unified labor market wages, if the regional production function is paid the same scale and different production technology of multiple regional representative manufacturers is carried out in accordance with the unified wage profit maximization decisions, generally there are no unified macro market interest rates, making all regional representative manufacturers achieve the optimal capital investment required by the profit maximization.

Why cannot the consistent factor price maximize the profits of all regions at the same time? The reason is the problem caused by the differentiation of multiregional production function and single product. In the traditional multimanufacturer and multiproduct microeconomic system, the final economy is expected to have general equilibrium through the determination of each commodity price system, and many theorems of microeconomics are based on the demonstration. However, when we consider the multilevel macro and regional economic problems, the system loses the multiprice determining system due to the abstract homogeneity of GDP (output), and the optimization problem is caused by friction between a single product and many regions of the differential production function.

In other words, in the real economic system, the differentiated products and varying prices of each manufacturer are independent variables, providing sufficient freedom for the economic system. However, in macroeconomics, the products of the representative manufacturers in each region are all GDP, which is the total value calculated by money itself, and there is no price vector with different high and low prices like commodities, so the freedom of the model is naturally limited. That is, the macro model forces GDP as the output of the production function but lacks the invisible hand of the "price mechanism." With such a limited degree of freedom, the model is prone to logical conflicts, so it is easy to understand. In practice, the governments and central banks of large countries such as China may have recognized this problem in their long-term governance, so they often set interest rates differently across regions and industries. Sometimes there are preferential interest rates or subsidies for loans to poor areas, and there are interest rate preferences for industries that need support for the introduction of talents. However, there has been a lack of theoretical research in this area, and our model derivation explains exactly these phenomena.

3. Particular Case

To explain the above-mentioned conclusions, we conduct the simulation verification of Conclusion 1 with a specific form of functional calculus. Take the most commonly used Cobb-Douglas production function with unchanged returns to scale. Namely, it is assumed that the production function of the manufacturer i is $F_i(K_i, L_i) = K_i^{\alpha_i} L_i^{1-\alpha_i}$; then $f_i(k_i) = k_i^{\alpha_i}$, $f_i^{-1}(x) = x^{1/\alpha_i}$, and $f_i'(k_i) = \alpha_i k_i^{\alpha_i - 1}$. It is assumed that a unified interest rate r exists on market; the capital is reversely solved by (4):

$$k_i = f_i'^{-1}(r) = \left(\frac{r}{\alpha_i}\right)^{1/(\alpha_i - 1)}. \tag{9}$$

And then

$$\frac{\partial F_i}{\partial L_i} = (1-\alpha_i) K_i^{\alpha_i} L_i^{-\alpha_i} = (1-\alpha_i) k_i^{\alpha_i} = (1-\alpha_i)\left(\frac{r}{\alpha_i}\right)^{1/(\alpha_i - 1)}. \tag{10}$$

The capital usage per capita $k_i = (r/\alpha_i)^{1/(\alpha_i - 1)}$ of each area is the function related to a company's output elasticity of capital on technology. However, the marginal product of labor $\partial F_i/\partial L_i$ of each area is the function $(1-\alpha_i)(r/\alpha_i)^{\alpha_i/(\alpha_i - 1)}$ of a company's output elasticity of capital on technology and varies much in each area. Inevitably, these $\partial F_i/\partial L_i$ cannot be equal to a unified labor market wage. In other words, it may be impossible to realize an optimum equilibrium wage in all areas.

Theoretically, if $U(\cdot)$ refers to the utility function of representative consumers, ρ refers to the subjunctive discount factor, and n refers to the growth rate of population; it can be proven, in Ramsey model of macroeconomic growth aiming at $\max \int_0^\infty U(C_i(t)/L_i) e^{-\rho t} \mathrm{d}t$, that the actual interest corresponding to steady state is

$$r = \delta + n + \rho. \tag{11}$$

It is the sum of capital depreciation rate, growth rate of population, and subjunctive discount factor. Therefore, in case of equilibrium,

$$\frac{\partial F_i}{\partial L_i} = (1-\alpha_i)\left(\frac{\delta+n+\rho}{\alpha_i}\right)^{\alpha_i/(\alpha_i-1)}. \quad (12)$$

Obviously, the marginal product of labor varies in different areas and hardly equals a unified wage.

So far, we have been clear about that potential inconsistency existing between the assumption of unchanged returns on scale of the production function and the optimum allocation of market elements in all areas.

To illustrate the problem more visually, we simulate the equilibrium wage calculation with several representative values. Assign the population growth rate, the capital depreciation rate, and the competent discount rate as

$$\begin{aligned} n &= 0.004, \\ \delta &= 0.08, \\ \rho &= 0.02. \end{aligned} \quad (13)$$

Then substitute 9 different values of capital elasticity; we find that the wages vary greatly, and the wages become larger as the capital elasticity of output increases, and the work grows exponentially very fast when the capital elasticity of output approaches 1, as detailed in Table 1.

4. The Difference between the Marginal Output of Labor and Wages

The above-mentioned inconsistency partly explains the causes of labor wage difference among areas in reality.

If in the optimum decision of representative manufacturers in an area the marginal product of labor exactly equals the social labor wage, it cannot be better. When the marginal product of labor of the optimum decision is more than social wage, in this area, workers are still be employed normally as per its optimum conditions. In this case, the regional wage can exceed the social wage. Such area is definitely attractive and hot on market and shall be able to theoretically set a high standard to pick up labors.

Based on Classical Economics, it is assumed that when the marginal product of labor of the regional optimum decision is less than the social wage, in this area, less workers may be employed and the employment only will be controlled to make the marginal product equal to the social wage. However, in the case of Part 3, this area lacks such capability. Therefore, in Classical Economics, the Law of Diminishing Marginal Returns of capital and labor has been broken. The marginal product of labor in (12) is a constant, is not decreased along with increasing employment, and is an algebraic expression $(1-\alpha_i)(r/\alpha_i)^{\alpha_i/(\alpha_i-1)}$ irrelevant to labor variables. If the marginal product of labor in an area is less than the social wage, the marginal product of labor is still not enough for wage payment whatever the labor is downsized. So this area may suffer from loss.

In consequence, when the labor is allowed to freely flow without cost, it is bound to that all the labor will tend to migrate to the area with the highest marginal returns of labor, leading to unbalance. That is to say, only the area with the highest marginal product of labor has output. Therefore, though the labor freely migrates, the regional wage difference in the same economy cannot be solved theoretically in reality. Moreover, labor force migration is often uncompromising and even defies constraints such as high housing prices. To this end, Thomas [6] analyzed the factors that influence the choice of destination for domestic migration in the UK using labor force survey data. The analysis reveals that jobs are attracted by high wage regions but not by high house prices in these regions [6].

But imagine if labor cannot move freely between regions, then differentiated regional wages can be satisfied (12). At that point, each region determines its own submarket wage according to (12), making the marginal output of labor consistent with the wage. Of course, in aggregate, it seems that if labor or capital is not mobile, it leads to lower efficiency of the whole economic system [7]. Perhaps this is compensated for in terms of equity.

To sum up, in the regional economy modeling, we have to make a choice between all-element free flow and unchanged returns on scale of all production functions.

Topic 2: if all production elements of the economic system fully flow and freely compete, in study, the assumption that returns on scale of all regional production functions are not changed cannot be adopted. Otherwise, if the assumption that returns on scale of all regional production functions are not changed is adopted, one production element at least needs to be fixed and cannot be changed.

We can also study the fluctuation of the marginal product of labor $\partial F_i/\partial L_i$ on variations like output elasticity of capital α_i and market interest rate r to explain the real wage difference. With (12), we can calculate to get the following:

$$\begin{aligned} \frac{\partial(\partial F_i/\partial L_i)}{\partial r} &= \alpha_i r^{-1/(1-\alpha_i)} \alpha_i^{\alpha_i/(1-\alpha_i)} > 0, \\ \frac{\partial(\partial F_i/\partial L_i)}{\partial \alpha_i} &= \frac{\ln(\alpha_i/r)}{1-\alpha_i}\left(\frac{1}{r}\right)^{\alpha_i/(1-\alpha_i)} \alpha_i^{\alpha_i/(1-\alpha_i)}. \end{aligned} \quad (14)$$

Now, the change rate of the regional wage on the actual interest rate is more than 0; it means the wage is homonymously fluctuated with the capital price.

The derivative of the regional wage on the output elasticity of capital is not always 0 and can be changed; thus it may be difficult to determine a balanced wage on macro market. Only at $\alpha_i = r$ is the derivative of $\partial F_i/\partial L_i$ on α_i expected to be 0. In a word, it is very rigorous to form the conditions of a unified marginal product of labor.

When $\alpha_i > r$ and $(\partial(\partial F_i/\partial L_i)/\partial \alpha_i) > 0$, the output elasticity of capital of marginal product of labor is progressively increased; otherwise it is decreased. Generally, the output elasticity of capital α_i indicates the production technology is capital-intensive. Therefore, when the interest rate is not high, the wage which can be borne by manufactures with

Table 1: Wage assignment under 9 capital elasticities.

	α_i	$\partial F_i/\partial L_i$
1	0.1	0.90
2	0.2	0.94
3	0.3	1.10
4	0.4	1.47
5	0.5	2.40
6	0.6	5.54
7	0.7	25.66
8	0.8	700.26
9	0.9	$2.72^{*}10^{7}$

high output elasticity is high and will increase along with increasing capital elasticity. We have the following empirical example: in the long run, capital inflows can reduce wage inequality between skilled and unskilled workers. An increase in agricultural prices can reduce wage inequality between skilled and unskilled workers in the short run [8].

When the interest rate is too high, even over the output elasticity of capital, $\alpha_i < r$, the wage that can be borne by manufactures with high output elasticity is low. However, generally, the interest rate is one order of magnitude less than the output elasticity of capital. For example, the actual interest rate rarely exceeds 5% and the output elasticity of capital is rarely less than 10%. As a result, the wage in common capital-intensive area is higher than that in labor-intensive area. In fact, scholars have calculated that the average capital elasticity of the Chinese economy from 1978 to 2001 was 0.559 and the average labor output elasticity was 0.444, both much larger than the capital interest rate [9].

If labor mobility is allowed, the model should be extended with the two following ideas: one, make interest rates differentiated by setting their appropriate rates for each region or manufacturer to ensure that each region's allocation captures the marginal output of labor and capital. In fact, interest rates can be differentiated in economies with strong government policies, such as China, where the government often formulates regional or industrial support policies in which financial policies permanently set some interest rate differences or preferences. Second, the assumption of constant returns to scale is abandoned and the production function is reset so that the model will have an endogenous unemployment rate. In fact, the explanation of unemployment has been a difficult problem in macroeconomics. If the scale payoff of the production function is allowed to decrease or increase, the problem of unemployment can be analyzed. However, the model is computationally large and difficult, and we place it in a subsequent research paper due to the limitation of space.

5. Discussion of Related Economic Phenomena in Mainland China

Regarding the phenomenon of regional wage differences and the reasons behind them, an example is the data on the average wage of employed persons in urban units in each province of mainland China, as shown in Table 2, where the average wage varies significantly across provinces, with the capital Beijing and the economic center Shanghai having significantly higher wages than other regions and more than twice the average wage of the lowest province, Henan. In past scholarly studies of production functions in Chinese provinces, the assumption of constant returns to scale has also been mostly used to estimate parameters such as the output elasticity of capital. According to our previous derivation, factor markets in mainland China cannot be in equilibrium, and labor is bound to scramble to high-income cities with relatively prosperous economies. Indeed, after the reform and opening up, the phenomenon of "peacocks flying to the southeast" has been incessant, and, with the loosening of the national policy on talent and market, as well as the traditional ideas of "settling down and relocating" and "it is difficult to move to the homeland," talents generally prefer to move to the southeast. With the loosening of the national policy on talent and market, as well as the traditional idea of "settling down and moving" and "hometown is hard to move," talents generally like to flock to developed areas such as the southeast coast. With such a big difference in wages, if there is no restriction, labor mobility will aggravate the imbalance of development levels between regions.

Although some scholars point out that labor mobility has an important balancing effect on the income levels of countries with different initial incomes [10], no concrete evidence is seen in reality. We have the following example of empirical evidence: Yue and Xiaomin used a nonparametric additive model to empirically analyze the impact of cross-regional labor mobility on industrialization and economic growth in the eastern, central, and western regions of China. The results show that the large labor flow from the central and western regions into the eastern region significantly contributes to the industrialization process and economic growth in the east, while the labor outflow from the central and western regions has a significant inverted U-shaped nonlinear relationship on the regional economy. The uneven labor mobility across regions has widened the regional economic gap in China. It has also been shown that China's regional per capita income levels did not converge from the mid-1990s to 2008, despite the significant increase in labor mobility [11].

China's policy response was the traditional "household registration system" that fixed a large number of workers in "state-owned units" in their work areas to avoid regional imbalances in development. In fact, China's long history of economic development over thousands of years has often fixed labor in areas where development was needed with a system of land, jobs, and household registration, contributing to the overall coordinated development of a large area of the country. For example, for cities like Beijing, the capital, and Shanghai, the economic center, there are high thresholds for settling in, purchasing housing, and joining state units; generally, foreigners who have earned a Ph.D. and have postdoctoral work experience are allowed to have a Beijing household registration. If viewed in terms of traditional economic theory, this appears to limit the development of the free market, but, according to our previous analysis, this is perhaps necessary.

Table 2: Average wages of employed persons in urban units in China by province (RMB yuan).

	Years								
	2019	2018	2017	2016	2015	2014	2013	2012	2011
Beijing	166803	145766	131700	119928	111390	102268	93006	84742	75482
Tianjin	108002	100731	94534	86305	80090	72773	67773	61514	55658
Hebei	72956	68717	63036	55334	50921	45114	41501	38658	35309
Shanxi	69551	65917	60061	53705	51803	48969	46407	44236	39230
Inner Mongolia	80563	73835	66679	61067	57135	53748	50723	46557	41118
Liaoning	72891	67324	61153	56015	52332	48190	45505	41858	38154
Jilin	73813	68533	61451	56098	51558	46516	42846	38407	33610
Heilongjiang	68416	60780	56067	52435	48881	44036	40794	36406	31302
Shanghai	149377	140400	129795	119935	109174	100251	90908	78673	75591
Jiangsu	96527	84688	78267	71574	66196	60867	57177	50639	45487
Zhejiang	99654	88883	80750	73326	66668	61572	56571	50197	45162
Anhui	79037	74378	65150	59102	55139	50894	47806	44601	39352
Fujian	81814	74316	67420	61973	57628	53426	48538	44525	38588
Jiangxi	73725	68573	61429	56136	50932	46218	42473	38512	33239
Shandong	81446	73593	68081	62539	57270	51825	46998	41904	37618
Henan	67268	63174	55495	49505	45403	42179	38301	37338	33634
Hubei	79303	73777	65912	59831	54367	49838	43899	39846	36128
Hunan	74316	70221	63690	58241	52357	47117	42726	38971	34586
Guangdong	98889	88636	79183	72326	65788	59481	53318	50278	45060
Guangxi	76479	70606	63821	57878	52982	45424	41391	36386	33032
Hainan	82227	75885	67727	61663	57600	49882	44971	39485	36244
Chongqing	86559	78928	70889	65545	60543	55588	50006	44498	39430
Sichuan	83367	77686	69419	63926	58915	52555	47965	42339	37330
Guizhou	83298	78316	71795	66279	59701	52772	47364	41156	36102
Yunnan	86585	75701	69106	60450	52564	46101	42447	37629	34004
Tibet	118118	116015	108817	103232	97849	61235	57773	51705	49464
Shaanxi	78361	71983	65181	59637	54994	50535	47446	43073	38143
Gansu	73607	70695	63374	57575	52942	46960	42833	37679	32092
Qinghai	90929	85379	75701	66589	61090	57084	51393	46483	41370
Ningxia	83947	78384	70298	65570	60380	54858	50476	47436	42703
Xinjiang	79421	75457	67932	63739	60117	53471	49064	44576	38238

Note: data source is National Bureau of Statistics of China website (https://data.stats.gov.cn/easyquery.htm?cn=E0103).

A negative phenomenon is the hollowing out of China's inland countryside, where rural laborers are flocking to coastal cities to work and live in the cities, causing an overall decline in rural prosperity. This is because, unlike the aforementioned "state-owned" units that restrict the flow of people to household registration and jobs, rural labor is relatively free, reflecting that the flow of factors of production under free economic market conditions tends to degenerate. Despite the relative size degradation of the Chinese countryside in the past decades, the silver lining is that rural per capita income is rising relatively; that is, the urban-rural income differential is decreasing. Simulations by Hertel T et al. suggest that reforms in China's rural land rental market and household registration system, as well as increased rural labor mobility, will significantly reduce the urban-rural income ratio [12, 13]. To clarify, urban-rural income convergence is not regional income convergence, as each region has its own urban and rural areas, and, as mentioned earlier, the income gap between regions actually widens.

The classical model of the market has perfect substitutability among all individual workers. In this setup, wages must be equal between labor types and sectors, as each difference in wages causes an adjustment that eventually equalizes wages again. In contrast, empirical research data report typically large wage differences between labor types, which scholars argue can only stem from imperfect labor markets. Another reason is the weak possibility of labor substitution between different labor types and the inability to estimate the elasticity of substitution in most cases. In reality, labor types usually vary by age, gender, skill level, or occupation. When labor types are differentiated along these dimensions, wage differentials become possible [13, 14].

Of course, in modern society, the division of labor is highly specialized, and the free movement of labor is not an easy task when "one line of work is separated from another." Specialization distinguishes various people with different endowments and abilities, so that they can each do their best and get what they want, and, to a certain extent, it plays the role of fixing labor factors. This is also a common explanation used by scholars [15]. In fact, labor mobility as a factor of production entails costs. Dickie M et al. found that younger, better educated, native English speaking workers, who are likely to have better information and lower mobility costs, seem to have the smallest interregional wage differences [16]. Also, the presence of monopolies contributes to wage differences. Pi and Zhou found that differences in

production cost components of the monopolistically competitive sector matter for the impacts of international factor mobility on the skilled-unskilled wage inequality [17].

We argue that China has a more developed low- and middle-end manufacturing sector, with a large labor force employed in small- and medium-sized enterprises, whose workers do not require much expertise and are highly substitutable, so that the above reasons are not sufficient to explain the wage differentials, so additional government restrictions on their mobility are needed to safeguard against regional imbalances in development. In the United States, the economic development is more mature, and there is no more large-scale urbanization and labor migration. Although there is a difference in economic strength between regions, the difference in per capita income is not large [18, 19], and the labor force may not have the income drive to migrate in bulk, so there is no need for such a management method as "household registration system." Finally, the production of modern enterprises and regional economies often has externalities that no longer fit into classical forms of free competition, and thus factor allocation is affected. For example, the promotion of green production methods that address ecological externalities cannot be achieved without government regulation, subsidies, and guidance [20, 21], without which higher initial production costs would discourage producers. These governmental actions can also generate mobility restrictions and wage differentials. In recent years, China has attached great importance to ecological improvement, closing down a large number of small- and medium-sized manufacturers with high energy consumption and high pollution and subsidizing many large enterprises capable of green production in terms of capital, labor, and technology, which inevitably creates income differences.

6. Conclusion

In the model setting of macroeconomic and regional economic theory research, if the representative manufacturer theory research is used, the two hypotheses of "free flow of production factors" and "constant returns to scale of production functions in all regions" cannot occur simultaneously. If all production functions are set to have the constant returns to scale, then the flow setting of capital or labor between regions must be restricted. If both capital and labor flow freely, the production function cannot be set to the same as the constant returns to scale.

If the labor mobility between regions is limited, the wage difference between different regions may be derived from the difference in labor marginal output of production functions in different regions; and, generally, when interest rates are not too high, regional wages increase with the increase in output capital elasticity in the region. Of course, if the government sets differentiated market rates according to the equilibrium characteristics of each region, labor mobility can also be liberalized. In short, there is a theoretical basis for the government's fine management and macroregulation of human and capital.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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