Integrated Development of China's Agricultural Labor Market from the Perspective of Convergence of Planting Industry Marginal Labor Productivity

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Abstract Using *Compilation of National Cost Benefit Data of Agricultural Products* in 1990 - 2009 and based on the convergence of planting industry marginal labor productivity, this paper studies the integration of agricultural labor market in China. Firstly, it calculates labor output elasticity of each province for wheat, japonica rice and corn. Secondly, it builds indicators reflecting change level of marginal labor productivity. Researches show that in 1990 - 2000, the difference level of marginal labor productivity expands. From 2000, it starts to fall and becomes more and more stable. However, due to difference of crops and farming custom, the turning point of marginal labor productivity is not consistent with each other. Even so, it is still possible to reach the conclusion that agricultural labor market is gradually integrated from 2000.

Key words Integration of labor market, Resource allocation, Marginal labor productivity

1 Introduction

The integration level of labor market is an essential reference index reflecting development level of market economy. In recent years, researches on integration (or convergence) of labor market attract more and more attention. Scholars adopt different methods to study the integration of labor market. Barro and Sala - i - Martin[1] studied the market integration of 48 states in USA, proving consistency with new classical growth logical deduction and providing empirical method that is widely used in subsequent researches. Du Yang and Cai Fang[2], Sun Wenyuan and Pei Yu[3], Jia Yanjun and Li Xiaochun[4] used the above empirical method for reference, but all of these are from the perspective of changes in wage level. Yang Tao and Sheng Liugang[5] analyzed the development and integration of labor market from regional labor economics, and their starting point is also the convergence of wage level. Gong Liutang and Xiedanyang[6] studied the effectiveness of allocation of production factors from the marginal productivity, to reveal China's market integration process.

Though researches are abundant on China's market integration, there are drawbacks: (1) data source is single and there are few researches on regions of the whole country and many varieties of crops; (2) it lacks consideration of labor market integration of agricultural departments at provincial level. For the second drawback, relevant theories and methods of economic convergence can make up such defect, and can also be favorable for clarifying the proposition① of Young[7], and will play a significant role in promoting sustainable development of China's agriculture and integration of China's agricultural labor market. We will focus on convergence of marginal labor productivity for three major crops with the aid of panel data in *Compilation of National Cost Benefit Data of Agricultural Products*.

2 Analysis method

2.1 Relationship between marginal labor productivity and labor market integration

2.1.1 Logical relationship. For effectiveness of resource allocation, the final result of marginal return on every variety of resource is equal. In the process of transformation of dual economy to monistic economy, the trans-regional flowing of production factors will gradually rise and resource allocation efficiency will also rise. Labor, as major production factor, should also follow the above laws. In Lewis - Ranis - Fei Model, economic entity enters the shortage point, then enters the commercialization point. In this process, since there is fundamental change of wage determination mode of agricultural sector, the wage determination turns determination by marginal labor productivity. However, no matter whether there is change of productivity of modern sectors or not, the economic development stage is characterized by faster speed labor productivity of agricultural sector and catching up that of modern sectors at the commercialization point, and marginal labor productivity of agricultural sector in all areas will inevitably take on the same trend. Unlimited supply of agricultural sector labor turns to limited supply, so the labor shortage gradually deteriorates. In this situation, the state will abolish the system of restricting labor flow, to support sustainable development of non-agricultural sectors and

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Note: ① Young (2000) believed that China's progressive reform strategy deteriorates the market segmentation and makes China's economic growth tread on thin ice. One case is that labor allocation in agricultural sector does not conform to comparative advantage principle due to regional segmentation. This idea triggers off the proposition of whether China's reform promotes marketization or impedes marketization.

promote trans-regional and inter-trade flow of rural labor. As a result, the integration level of labor market in agricultural sector will rise along with evolution of economic development state. Based on the above analysis, it is believed that evolution of agricultural sector labor allocation makes marginal labor productivity become convergent and promotes integration of labor market. Nevertheless, as stated by Du Yang and Cai Fang[2], the integration of labor market for any economic entity is a long process. Thus, in certain period, we only can observe the level of labor market integration, but can not judge whether the labor market has realized integration.

2.1.2 Methods for measuring difference in marginal labor productivity. For economy with many regions, to observe whether the marginal labor productivity of agricultural sector is convergent, it should provide an index for measuring difference of marginal productivity. Generally, the difference of a group of data can be measured by many methods, but a good index should have following conditions[9]: (1) Anonymous: measurement result is only related to observation data, but irrelevant to status and position of observation object; (2) Homogeneous: it is irrelevant to dimension for measurement, and the index value is free from changes of measuring unit; (3) Independent: sample size does not influence measuring results. With reference to methods provided by Resa Corporation[8], we adopt simple and reasonable method. Assume the marginal labor productivity of n regions has been calculated, recorded as r_1, r_2, $\cdots$, r_n. We use following step to define their differences. Rank the r_1, r_2, $\cdots$, r_n from large to small, and record the marginal labor productivity as $\hat{r}_1$, $\hat{r}_2$, $\cdots$, $\hat{r}_n$. Then, the measure of dispersion is defined as:

$$D = \frac{2}{n^2 \bar{r}} \sum_{i=1}^{n} i\hat{r} - \frac{n+1}{n} \tag{1}$$

where, $\bar{r}$ is the mean value of r_1, r_2, $\cdots$, r_n. For purpose of calculation, the above formula can be changed into:

$$D = \frac{2}{n^2 \bar{r}} \sum_{i=1}^{n} i(\hat{r}_i - \bar{r}) \tag{2}$$

D reflects the overall deviation of marginal labor productivity of n regions from single marginal labor productivity in certain year, and increase and decrease of its value characterize convergence and divergence of marginal labor productivity level of all regions. If the marginal labor productivity of all regions is equal, D = 0. Higher D value means more divergent of marginal labor productivity of n regions.

3 Explanation of study data

This study mainly adopts data in the *Compilation of National Cost Benefit Data of Agricultural Products*. Cost benefit survey of national agricultural products started from 1953. The survey covers 31 provinces, autonomous regions, municipalities, 312 cities, 1 553 counties, and 60 000 farmer households. Agricultural products surveyed include grain, oilseed, cotton, flue-cured tobacco, silkworm cocoon, sugar crop, fruit, live pig, egg, milk, vegetable, traditional Chinese medicinal materials, and forestry products. We mainly surveyed material consumption, capital expenses, taxes, insurance, management fees, and financial expenses on seed, fertilizer, pesticide, agricultural machinery, irrigation, fuel and power, tools and materials, depreciation, and repair, as well as labor cost and land cost. Thus, our data is more truthful and reliable.

Due to difference in regional price level, the nominal index generally has no comparability. To observe changes of marginal labor productivity, we converted the monetary index in the production function into the price level of 1990 as per the price index of each province. The price index of each province was selected from *Price Yearbook of China* of each year, and the missing price index will be replaced with the national price index. In the selection of specific samples, this study mainly involves mainland 28 provinces and municipalities. For the purpose of analysis, Chongqing and Tibet were not considered②. Here, crops mainly include wheat, japonica rice and corn. From the sown area and yield of previous years, these crops take up high proportion among all crops, so they are highly representative. Since this study is to calculate the marginal labor productivity, we can direct use the average unit data given in *Compilation of National Cost Benefit Data of Agricultural Products*.

4 Inspection results

4.1 Calculation of marginal labor productivity of agricultural sector The calculation of marginal labor productivity still adopts Cobb – Douglas production function. We use following method to estimate the production function of three crops of each province:

$$\ln Y_{it} = \ln A + a\ln K_{it} + b\ln L_{it} + lt + u_{it} \tag{3}$$

where Y_{it}, L_{it}, K_{it} represent the output, labor input and capital input of i province in unit area in t year. t is the variable of time trend, and is error term. We assume the returns to scale are not changed, *i. e.* $a + b = 1$ and technical progress rate is λ. Under the assumption of Cobb – Douglas production function, the marginal labor productivity of the i-th province in the t-th year is as follows:

$$MPL_{it} = \frac{Y_{it}(1 - a_i)}{L_{it}} \tag{4}$$

Using the above formula, we can calculate the marginal labor productivity of each province. By the above methods, the production function of wheat, japonica rice and corn is calculated for each region, and the calculation results are listed in Table 1, 2, and 3.

4.2 Changes of difference in marginal labor productivity of agricultural sector Fig. 1, 2 and 3 illustrate the changes of marginal labor productivity of wheat, japonica rice and corn. "Element reward equalization" is an ideal status. Since there is difference in cultural and economic development and resource endowment of all regions, farming technologies, crop distribution and productivity level are different. Consequently, marginal labor productivity of provincial and regional agricultural production factors will certainly be different. From comparison, it can be found

② Chongqing Municipality was set in 1997, while this study analyzes the period from 1990, so its data is incomplete, and we omit Chongqing Municipality. Tibet is also omitted due to incomplete data.

that marginal return rate of wheat of Tianjin after 1992 remains the highest and keeps rising; Beijing ranks the second position in 1992 – 2000, and Shandong rises to the second position since 2003. From observation of japonica rice, it is seen that marginal labor productivity of Jiangsu Province is the highest, Tianjin and Zhejiang rank the second position alternately. The marginal labor productivity curve of corn indicates that Beijing keeps the highest before 1995. After 1997, the marginal labor productivity of Tianjin remains the highest. From the three figures, it is shown that marginal labor productivity of agricultural sector keeps rising in most provinces.

Table 1 Estimation of production function of wheat in each province

Code	Province or municipality	α_i	β_i
11	Beijing	0.603 1***	0.396 9**
12	Tianjin	0.082 9	0.917 1***
13	Hebei	0.545 1**	0.454 9*
14	Shanxi	0.697 9*	0.302 1
15	Inner Mongolia	0.754 2***	0.245 8*
23	Heilongjiang	0.965 8***	0.034 2
32	Jiangsu	0.641 0**	0.359 0
34	Anhui	0.847 8***	0.152 2
37	Shandong	0.235 3	0.764 7***
41	Henan	0.604 6	0.395 4
42	Hubei	#N/A	#N/A
51	Sichuan	0.984 4***	0.015 6
52	Guizhou	0.473 7*	0.526 3*
53	Yunnan	0.751 3	0.248 7
61	Shaanxi	0.530 9**	0.469 1**
62	Gansu	0.330 6	0.669 4**
63	Qinghai	0.305 3	0.694 7
64	Ningxia	0.275 4	0.724 6
65	Xinjiang	0.734 0***	0.266 0***

Note: * signifies that the coefficient of determination is significant at 90% confidence level; * * indicates that the coefficient of determination is significant at 95% confidence level; * * * means that the coefficient of determination is significant at 99% confidence level. The data is selected from *Compilation of National Cost Benefit Data of Agricultural Products*, and price index is selected from *China Statistical Yearbook*.

Table 2 Estimation of production function of japonica rice in each province

Code	Province or municipality	α_i	β_i
12	Tianjin	0.729 6***	0.270 4*
13	Hebei	0.953 9***	0.046 1
14	Shanxi	0.928 4**	0.071 6
21	Liaoning	0.860 2***	0.139 8
22	Jilin	0.957 0***	0.043 0
23	Heilongjiang	0.840 0***	0.160 0
31	Shanghai	0.987 6***	0.012 4
32	Jiangsu	0.603 1***	0.396 9**
33	Zhejiang	0.799 6***	0.200 4*
34	Anhui	0.601 3***	0.398 7*
37	Shandong	0.703 9**	0.296 1
41	Henan	0.871 8***	0.128 2
42	Hubei	#N/A	#N/A
53	Yunnan	0.290 2**	0.709 8***
64	Ningxia	0.947 7***	0.052 4

Note: * signifies that the coefficient of determination is significant at 90% confidence level; * * indicates that the coefficient of determination is significant at 95% confidence level; * * * means that the coefficient of determination is significant at 99% confidence level. The data is selected from *Compilation of National Cost Benefit Data of Agricultural Products*, and price index is selected from *China Statistical Yearbook*.

Table 3 Estimation of production function of corn in each province

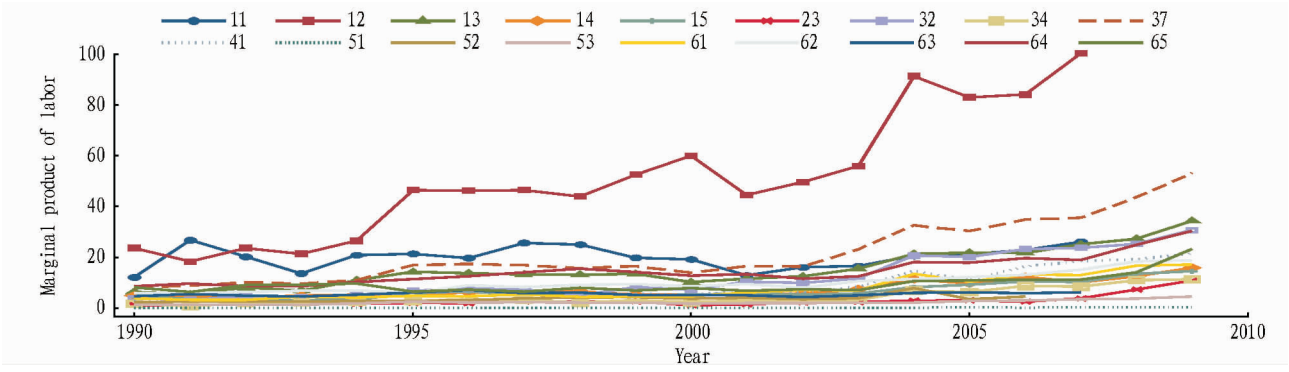
Code	Province or municipality	α_i	β_i
11	Beijing	0.425 6**	0.574 4***
12	Tianjin	0.250 4	0.749 6*
13	Hebei	0.744 3***	0.255 7***
14	Shanxi	0.838 9**	0.161 1
15	Inner Mongolia	0.660 8*	0.339 2
21	Liaoning	0.836 3	0.163 6
22	Jilin	0.673 0**	0.327 0
23	Heilongjiang	0.672 2***	0.327 8*
32	Jiangsu	0.171 1	0.828 9
34	Anhui	0.507 6	0.492 4
37	Shandong	0.401 8	0.598 2
41	Henan	0.938 7***	0.061 3
42	Hubei	0.030 4	0.969 6***
45	Guangxi	0.447 0**	0.553 0***
51	Sichuan	0.976 2***	0.023 8
52	Guizhou	0.252 3	0.747 7***
53	Yunnan	0.571 7	0.428 3
61	Shaanxi	0.971 1***	0.028 9
62	Gansu	0.648 5**	0.351 5
64	Ningxia	0.070 6	0.929 4
65	Xinjiang	0.641 7**	0.458 3**

Note: * signifies that the coefficient of determination is significant at 90% confidence level; * * indicates that the coefficient of determination is significant at 95% confidence level; * * * means that the coefficient of determination is significant at 99% confidence level. The data is selected from *Compilation of National Cost Benefit Data of Agricultural Products*, and price index is selected from *China Statistical Yearbook*.

Table 4 Difference level of marginal labor productivity of three major crops in China

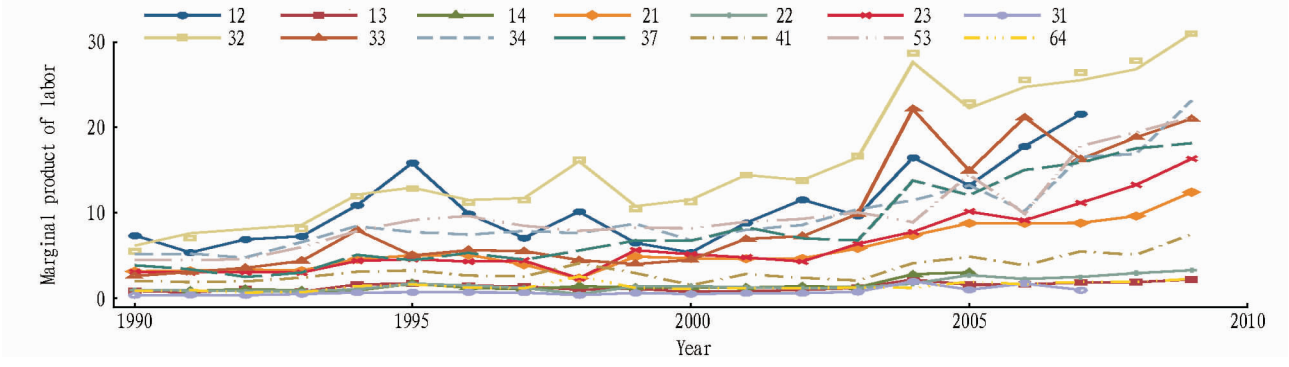
Year	Wheat	Japonica rice	Corn
1990	0.019 174 59	0.016 404 68	0.009 175 98
1991	0.020 849 03	0.014 832 10	0.012 612 26
1992	0.016 927 88	0.018 964 43	0.012 614 42
1993	0.016 198 42	0.014 167 71	0.012 495 17
1994	0.016 958 26	0.014 240 93	0.014 635 36
1995	0.027 966 76	0.019 889 14	0.012 663 72
1996	0.023 065 92	0.013 711 36	0.009 515 20
1997	0.022 589 50	0.016 682 48	0.011 191 93
1998	0.021 843 71	0.024 672 44	0.010 964 06
1999	0.026 446 94	0.013 322 36	0.009 997 30
2000	0.032 069 66	0.017 093 11	0.009 295 26
2001	0.023 803 87	0.018 179 92	0.008 901 79
2002	0.026 138 53	0.016 470 62	0.008 828 75
2003	0.025 138 37	0.018 324 21	0.010 825 55
2004	0.027 644 06	0.021 252 51	0.012 088 89
2005	0.026 787 77	0.016 018 06	0.011 831 23
2006	0.024 149 42	0.018 788 11	0.008 873 04
2007	0.028 779 23	0.015 792 64	0.011 812 87
2008	0.016 027 70	0.020 879 03	0.007 947 99
2009	0.016 27626	0.020 256 08	0.009 38771

The deviation of China's marginal labor productivity is shown in Table 4 and Fig. 4. It shows that the deviation of corn is the lowest (0.007 – 0.014), and the change is relatively stable. The change of japonica rice is higher (0.013 – 0.025). Wheat has the highest change (0.016 – 0.0321). Changes indicate that from



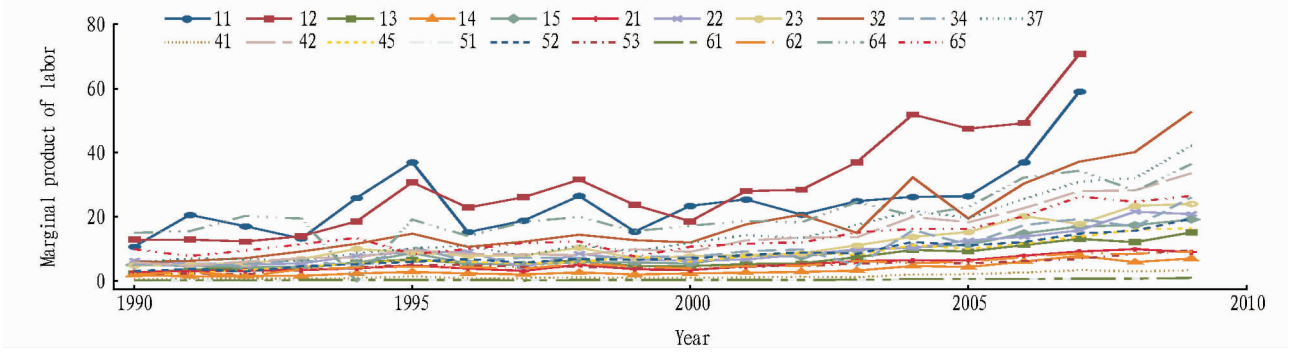
Note: the above numeric codes are codes of provinces and the specific contents are the same as that in the above tables.

Fig. 1 Changes in marginal labor productivity of wheat



Note: the above numeric codes are codes of provinces and the specific contents are the same as that in the above tables.

Fig. 2 Changes in marginal labor productivity of japonica rice



Note: the above numeric codes are codes of provinces and the specific contents are the same as that in the above tables.

Fig. 3 Changes in marginal labor productivity of corn

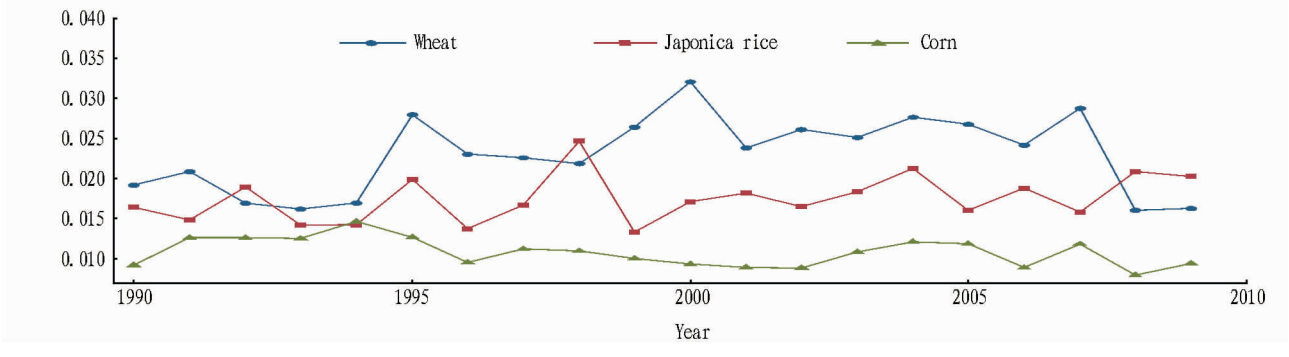


Fig. 4 Changes in marginal labor productivity

1990 to 1994, the deviation of marginal labor productivity of wheat is declining; in 1995, the deviation has certain rise, then it falls year by year; till 1998, it rises again, and reaches 0.032 by 2000. Later, it fluctuates in 0.025 – 0.032. In 2008, it drops to 0.016. The overall trend of changes is rising in 1990 – 2000. After 2000, it takes on a declining trend. The changes of japonica rice are consistent with overall trend of wheat, but the fluctuation amplitude is smaller. Compared with wheat and japonica rice, the corn has the smallest change (0 – 0.015), but the change trend is similar.

In 2000 – 2010, the difference level of marginal labor productivity of wheat falls but remains stable, indicating increase in efficiency of labor resource allocation. In 1990 – 2000, difference level of marginal labor productivity rises, indicating decrease in efficiency of labor resource allocation. Since 1990, labor market has gradually become open and household register system becomes further loose, labor flow achieves great improvement. Nevertheless, the business performance of state-owned enterprises starts dropping from the 1990s and many workers are laid off. These promote local government at all levels to formulate policies to restricting workers from other places. The integration of labor market is further hindered, and the difference level of marginal labor productivity expands. Later, with the realization of reform and anti – poverty objectives of state-owned enterprises, the labor demand increases, which promotes government to issue incentive policies for labor flow. Especially the breakout of shortage of migrant workers from 2008 leads to convergence of deviation of marginal labor productivity and integration of labor market starts quickening.

5 Conclusive comments

Through calculating production function of three major crops of each province, we obtain the change trend of difference in marginal labor productivity. It is found that the deviation of marginal labor productivity of japonica rice and corn is relatively stable, while that of wheat takes on rising trend from 1993 to 2000, and later it starts falling. According to experience of developed countries and theoretical assumption, we hope to see declining or stable deviation of marginal labor productivity. However, our conclusion is not totally consistent with the assumption due to no longer time series. This is directly related to labor flow policies. It can be supposed that with transformation of population structure and supply and demand of labor market elastic, as well as reform of household register system, the difference of marginal labor productivity of agricultural sector will certainly decline or tend towards stable. Therefore, with continuation of economic development, quickening of marketization process and extension of observable times series, it will certainly observe sound evidence of integration of China's labor market.

For transition economy of progressive reform, the process of labor market development is comparatively slow and lags behind marketization of other fields. The reform of agricultural sector is especially like this. At the early of 1980s, the household contract responsibility system stimulates farmers' enthusiasm for production from the property right and becomes the important transition point of China's rural land system reform, which greatly improves productivity. With establishment and gradual maturity of market economy, the advantages of this system are all gone, presenting many problems such as land segmentation marketization becoming slow. This also generates obstacle to integration of labor market in China's agricultural sector. We believe that the integration of labor market in China's agricultural sector relies on system innovation of issues concerning agriculture, farmers and rural areas, while the focus of reform of issues concerning agriculture, farmers and rural areas should also be the agricultural property right system.

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