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Labor Productivity Growth Effect of Industrial Structure Evolution in Guangdong Province during the Period 1978 -2008: An Empirical Test of "Structural Bonus Hypothesis"

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Abstract The labor flow promotes the industrial structure evolution, thereby affecting the growth of productivity. In the western industrialized countries, improvement in labor productivity has become an important source of economic growth. On the basis of analyzing changes of the industrial structure, changes of the structure of labor factor, changes of labor productivity and the growth rate in Guangdong Province in different periods, we use shift-share method to analyze the labor productivity effect of industrial structure in Guangdong Province, and put forward the following recommendations for the adjustment of industrial structure in Guangdong Province: (i) The adjustment of industrial structure should promote the reasonable and effective flow of labor between industries; (ii) Accelerating the optimization of the industrial structure is conducive to economic growth and improvement in labor productivity; (iii) In addition to structural optimization, the improvement in labor productivity should also focus on the improvement in intra-industry technology.

Key words Industrial structure, Labor productivity, Structural bonus hypothesis

The improvement in labor productivity has become an important impetus to economic growth of the western industrialized countries. The data show that in the initial stage of stepping into post-industrialization society, the labor productivity of the developed countries and regions played 70% to 100% of role in promoting economic growth. With the further development of the post-industrialization, the role of labor productivity declined slightly, but always in a dominant position. For example, during the 1980s, the contribution rate of labor productivity to economic growth was 100% in Germany, and 86% in Japan (Tian Chengshi *et al.*[1], 2004).

In fact, the industrial structure evolution plays an important role in promoting productivity growth, presenting the stage characteristics. Chenery *et al.*[2] (1989) found that in the process of industrialization, the importance of economic structural changes affecting economic growth was different along the differences in the level of development, and this feature was more prominent in developing countries. The reason is that various sectors have different levels of productivity and growth rate of productivity. Therefore, when the input factors flow from the sectors with low level of productivity or low growth rate of productivity to the sectors with high level of productivity or high growth rate of productivity, the overall productivity growth will be promoted (Peneder[3], 2002). This contribution of changes in the industrial structure arising from the flow of factors to productivity growth is "structural bonus hypothesis". Guo Kesha[4] (1993), Hu Yongtai[5] (1998), Cai Fang[6] (1999), Li Xiaoping[7] (2007), and Gan Chunhui[8] (2009), conducted research on the impact of factor flow between China's agriculture and non-agriculture, between manufacturing and the three industries, on the productivity growth; their conclusions all affirmed the role of industrial structure evolution for productivity growth.

Since the reform and opening up, Guangdong has been carrying out the adjustment of the industrial structure, to promote sound, continuous economic development. In the period 1978 - 2008, the industrial structure in Guangdong Province evolved from the mode of "secondary industry - primary industry-tertiary industry" (the beginning of industrialization) to the mode of "secondary industry - tertiary industry - primary industry" (medium - term industrialization); the level of labor productivity increased from 8.17 (100 yuan/person) to 156.32 (100 yuan/person). Based on the empirical test of "structural bonus hypothesis", this study explores the effects of changes in industrial structure in Guangdong Province on the growth of labor productivity, to provide a reference for the current adjustment of industrial structure.

1 Industrial structure evolution and changes in labor productivity in Guangdong Province

In accordance with "structural bonus hypothesis", some prerequisites are needed for the changes in the industrial structure to promote the growth of labor productivity. First, there is the transfer of factors between industries, causing the relative changes in the industrial labor share. Second, there are differ-

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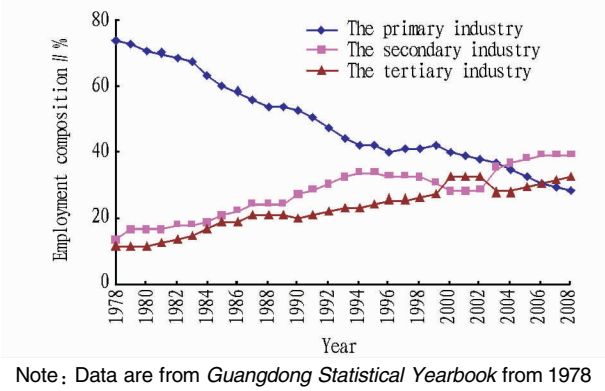
ences in the level of productivity or the growth rate between industries. Therefore, there is a need to examine the evolution of industrial structure in Guangdong Province and changes in labor productivity.

1.1 Variation trend analysis of employment and output value composition of three industries The change trend of employment structure in Guangdong Province is stable. Basically, the proportion of employment in the primary industry declines year by year, while the proportion of employment in the secondary and tertiary industries increases year by year.

From the primary industry, the proportion of employment decreased significantly year by year after 1978, down to 44% in 1993. But after 1993, the decline was slowed down. In 2008, the proportion of employment dropped to 29%. The likely reason is that prior to the 1990s, small and medium-sized enterprise in Guangdong Province developed by leaps and bounds, and the labor-intensive industries predominated, requiring little on the quality of the labor force; the enterprises' ability to absorb is strong, and a lot of labor quickly shifted from the primary industry. After the 1990s, the new round of investment was mainly focused on capital and technology-intensive industries, and the industrial development showed the tendency of heavy chemical industry; such enterprises were characterized by high requirements on the quality of labor and relatively limited capacity to absorb labor (Li Xiangsheng[9], 2009). The proportion of employment in the secondary and tertiary industries basically showed a trend of rise year by year. The proportion of employment in the secondary industry began to decline in the mid-1990s, and was not improved until 2002; subsequently, there was a conspicuous upward trend. The proportion of employment in the tertiary industry exceeded that in the secondary industry for the first time in 2000, and it was maintained for three years (Fig.1).

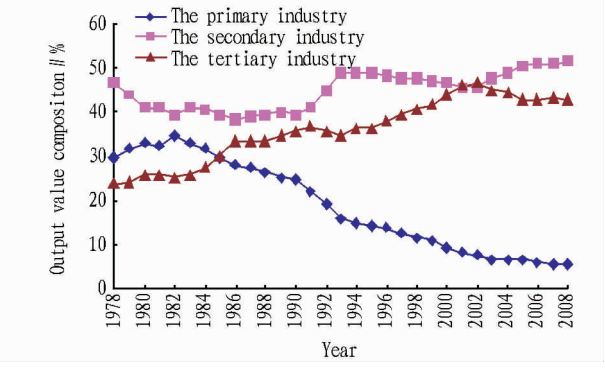


Note: Data are from *Guangdong Statistical Yearbook* from 1978 to 2009.

Fig.1 Employment composition of three industries during the period 1978 – 2008

In terms of the output value structure, Guangdong Province has experienced great changes since the reform and opening up. Overall, the change trend of three industries is consistent with the general law of evolution of industrial structure, that is, with the improvement in the level of per capita income, the share of the primary industry in the national economy constantly declines; the share of the secondary and tertiary industries gradually climbs. In the period 1978 – 2008, the share of the primary industry decreased from 30% to 6%; the share of the primary industry increased from 47% to 52%; the share of the tertiary industry increased from 24% to 43% (Fig.2).

The evolution of industrial structure in Guangdong Province also presents its own characteristics. The share of output value of the primary industry showed an increasing trend prior to 1982, but subsequently, it showed a declining trend. This may be related to the fact that the implementation of the household contract responsibility system since the reform and opening up has mobilized the enthusiasm of farmers. The output value of the secondary industry declined year by year or kept basically stable before 1992. From 1992, it began to rise, but soon it showed a steady downward trend. Until 2003, it rose again. The output value of the tertiary industry rose steadily before 2003, but it began to decline after 2003. The industrial structure experienced transformation in 1985, from the mode of "secondary industry – primary industry – tertiary industry" to the mode of "secondary industry – tertiary industry – primary industry".



Note: Data are from Guangdong Statistical Yearbook from 1978 to 2009.

Fig.2 Output value composition of three industries during the period 1978 – 2008

1.2 Analysis of changes in the employment and output value structure of three industries The variation degree of the average structure of employment and output value can better reflect the variation and characteristics of employment and output value in various periods. Table 1 is the composition and variation of employment and output value of three industries in various periods.

In terms of the changes in the structure of employment and output value, during the period 1978 – 1988, the proportion of employment in the primary industry decreased by 20.02% while the share of output value decreased by 3.23%; the proportion of employment in the secondary industry rose by 11.09% while the share of output value decreased by 6.78%; the proportion of employment in the tertiary industry rose by 8.92% while the share of output value rose by 10.07%.

At the same time, it can be seen from Table 1 that the average structural variation degree of employment in each period is greater than the average structural variation degree of output value; the average structural variation degree of the primary industry is greater than the average structural variation degree of the secondary and tertiary industries. Overall, the magnitude of

change is getting smaller and smaller, and the level of industrial structure is constantly optimized.

Table 1 The composition and variation of employment and output value of three industries

Indicator	Time	Employment//%				Output value//%			
		Overall	The primary industry	The secondary industry	The tertiary industry	Overall	The primary industry	The secondary industry	The tertiary industry
Structural composition	1978	100	73.68	13.75	12.57	100	29.76	46.61	23.63
	1988	100	53.66	24.84	21.49	100	26.53	39.83	33.70
	1998	100	41.08	32.11	26.81	100	11.66	47.68	40.60
	2008	100	28.80	39.00	32.20	100	5.52	51.55	42.93
The average structural variation degree	1978 – 1988	4.00	−2.00	1.11	0.89	2.01	−0.32	−0.68	1.01
	1988 – 1998	2.52	−1.26	0.73	0.53	2.96	−1.49	0.78	0.69
	1998 – 2008	2.46	−1.23	0.69	0.54	1.23	−0.61	0.39	0.23
	1978 – 2008	2.99	−1.50	0.84	0.65	1.62	−0.81	0.16	0.64

Note: (i) The employment composition of industry i (%) = The employed population in industry i/Total employed population; The output value composition of industry i (%) = The output value of industry i/Total output value. (ii) The average structural variation degree of industry $i = (S_{it} - S_{i0})/t$; The overall average variation degree of industrial structure = $\sum_{i=1}^{3} | S_{it} - S_{i0} |/t$, where S is the industrial output value composition or employment composition, S_{it} is the industrial composition of industry i at the end of study period, S_{i0} is the industrial composition of industry i at the early study period, $i = 1, 2, 3$.

1.3 Analysis of changes in labor productivity in Guangdong Province Peneder (2002) believes that " structural bonus hypothesis" is valid based on that there are differences in the level of productivity and the growth rate between the industrial sectors, thereby resulting in the transfer of input factors between sectors. Therefore, it is necessary to examine the labor productivity and the growth rate in various industries.

Changes in the industrial labor productivity in Guangdong Province during the period 1978 – 2008 can be shown in Fig. 3. We can find that the overall level of labor productivity and the level of labor productivity in three industries both show an upward trend; only the growth rate differs. The labor productivity in the secondary industry is close to that in the tertiary industry, both above the overall level. In terms of growth rate, the labor productivity in the primary industry grows gently. The labor productivity in the secondary and tertiary industries and the overall labor productivity grew slowly in the period 1978 – 1990, but after 1990, the growth rate started to increase. From 1990, there was a widening gap between the labor productivity in the secondary and tertiary industries and the labor productivity in the primary industry.

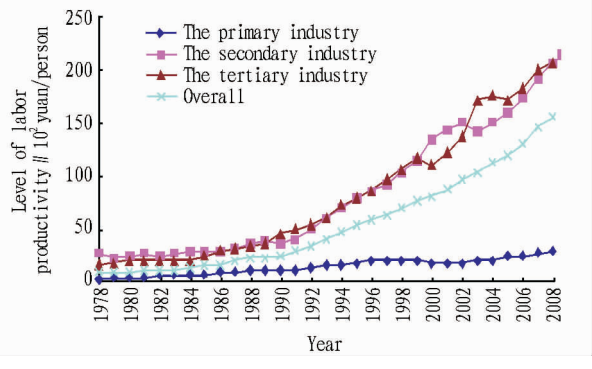


Fig. 3 Changes in the labor productivity

Table 2 Changes in the labor productivity

Time	The level of productivity//100 yuan/person				Time	The growth rate of productivity//%			
	Overall	The primary industry	The secondary industry	The tertiary industry		Overall	The primary industry	The secondary industry	The tertiary industry
1978	8.17	3.30	27.68	15.36	1978 – 1988	10.36	12.61	2.40	8.37
1988	21.88	10.82	35.08	34.30	1988 – 1998	12.24	6.18	11.38	11.85
1998	69.39	19.69	103.04	105.08	1998 – 2008	8.46	4.29	7.22	7.07
2008	156.32	29.96	206.88	208.09	1978 – 2008	10.72	7.91	7.18	9.40

Note: (i) The labor productivity is the ratio between industrial output value and industrial employed person, which represents the value created by each person. (ii) The growth rate of productivity in each time period is the average growth rate in this period.

Table 2 reflects the growth of industrial labor productivity in Guangdong Province. In 1978, the labor productivity in the secondary industry was 8.39 times that in the primary industry; the labor productivity in the tertiary industry was 4.65 times that in the primary industry; the labor productivity in the secondary industry was nearly 2 times that in the tertiary industry.

However, from 1988, the labor productivity in the tertiary industry was close to that in the secondary industry; from 1998, the labor productivity in the tertiary industry exceeded that in the secondary industry. There was a great gap between the labor productivity in the secondary and tertiary industries and the labor productivity in the primary industry, and this gap was the largest in 1978. There were differences in the labor productivity among three industries. In terms of the growth rate of productivity, during the period 1978 – 1988, the growth rate of productivity of the primary industry was higher than that of the secondary and tertiary industries.

In the period 1988 – 1998 and 1998 – 2008, the growth rate of productivity of the primary industry was lower than that of the secondary and tertiary industries; the growth rate of productivity of the secondary and tertiary industries was about two times that of the primary industry, indicating that there are differences

between industries. The differences in the labor productivity and growth rate between industries make the " structural bonus" realized through factor flow possibly exist.

2 Analysis of the growth rate effect of changes in Guangdong's industrial structure

Shift-share method is used by most scholars to consider the impact of changes in the industrial structure caused by factor flow on productivity, because this method can better separate the productivity growth arising from changes in the industrial structure. Shift-share analysis was first developed by Fabricant[10] (1942); Dunn, Perloff, Lampard, Muth extended it in the 1960s (Gan Chunhui, *et al.*, 2009).

The extended model decomposes the productivity growth into two parts: the contribution of structural changes and the contribution of growth within the industrial sectors. And the contribution of structural changes can be subdivided into the static transfer effect of factors and dynamic transfer effect of factors.

Assuming that l is labor, Y is GDP, g is the overall growth rate of labor productivity, G is the overall level of labor productivity, the subscript 0 is the beginning of the period, t is the end of the period, i is industry ($i=1, 2, 3$), and S_i is the share of industry i in the three industries. Then,

$$g = (G_t - G_o)/G_o = [(Y_t/a_t) - (Y_0 - a_0)]/G_0 = \sum_{i=1}^{3}[(Y_{it}/a_t) - Y_{i0}/a_0]/G_0$$

And $(Y_{it}/a_t) - (Y_{i0}/a_0) = (Y_{it}/a_{it}) \times (a_{it} - a_t) - (Y_{i0}/a_{i0}) \times (a_{i0}/a_0) = G_{it}S_{it} - G_{i0}S_{i0}$

Conducting further transformation, then:

$$G_{it}S_{it} - G_{i0}S_{i0} = G_{i0}S_{it} - G_{i0}S_{i0} + G_{it}S_{it} - G_{i0}S_{it} - G_{it}S_{i0} + G_{i0}S_{i0} + G_{it}S_{i0} - G_{i0}S_{i0} = G_{i0}(S_{it} - S_{i0}) + (G_{it} - G_{i0})(S_{it} - S_{i0}) + (G_{it} - G_{i0})S_{i0}$$

Substituting it into expression of g, then there is the theoretical model of shift-share analysis:

$$g = (G_t - G_o)/G_o = [\sum_{i=1}^{3} G_{i0}(S_{it} - S_{i0})]/G_o + [\sum_{i=1}^{3}(G_{it} - G_{i0})(S_{it} - S_{i0})]/G_o + [\sum_{i=1}^{3}(G_{it} - G_{i0}) - S_{i0})]/G_o \quad (1)$$

In equation (1), the first term on the right signifies the static transfer effect of labor, which reflects the growth effect of labor productivity arising from the shift of labor factor from the industrial sectors with low level of productivity to the industrial sectors with high level of productivity, when the level of labor productivity is constant, namely the changes in productivity brought about by changes in the industrial structure.

The second term signifies the dynamic transfer effect of labor, reflecting the growth effect arising from the flow of labor factor into the industrial sectors with higher growth rate, which is the combined effect of changes in the industrial structure and changes in the productivity.

The sum of the first term and second term is the structural effect, reflecting the productivity growth effect of changes in the industrial structure.

The third term is the growth effect within the industrial sectors, which signifies the weighted sum of factor productivity growth of various industrial sectors when the industrial structure does not change.

In this study, we use the annual data on *Guangdong Statistical Yearbook*, to analyze the labor productivity effect of industrial structure in Guangdong Province in the period 1978 – 2008. The growth rate of the productivity is the average growth rate during this period; the labor productivity is the ratio between industrial output value and the number of industrial employees; the output value uses the region's GDP data; the number of industrial employees uses the indicator data on workers in three industries.

The decomposition results of growth factors of labor productivity in Guangdong Province during the period 1978 – 2008 can be shown in Table 3. Overall, 53.76% of the labor productivity growth comes from structural effects, and 46.24% of the labor productivity growth comes from the growth effect within the industry. In the structural effects, the dynamic transfer effect, namely the effect of labor shifting from the industries with low growth rate of productivity to the industries with high growth rate of productivity, reaches 48.01%; the static transfer effect is 5.75%. Therefore, the changes in labor industrial structure show prominent characteristics of " structural bonus", and the structural effect of labor transfer is an important factor promoting productivity growth.

Table 3 Decomposition of factors of labor productivity growth

Time	Total growth rate // %	The contribution of the various effects // %						
		Structure			Internal growth			
		Effect	Static transfer effect	Dynamic transfer effect	Effect	The primary industry	The secondary industry	The tertiary industry
1978 – 1988	167.93	34.88	27.54	7.34	65.12	40.36	7.41	17.35
1988 – 1998	217.17	22.33	6.35	15.98	77.67	10.04	35.57	32.05
1998 – 2008	125.27	62.27	5.99	56.29	37.73	2.44	19.30	15.99
1978 – 2008	1814.34	53.76	5.75	48.01	46.24	13.26	16.63	16.35

There are some differences in " structural bonus" and the growth effect within the industry in different time periods. In the period 1978 – 1988, the growth effect within the industry accounted for 65.12%, and the growth effect within the primary industry reached 40.36%. The " structural bonus" in this period was 34.88%, and the static transfer effect was predominant. In the period 1988 – 1998, the growth effect within the industry was further increased, reaching 77.67%, mainly in the secondary and tertiary industries, and the growth effect within the primary industry was only 10.04%. The " structural bonus"

dropped to 22.33% in this period, and the dynamic transfer effect was predominant. In the period 1998 – 2008, the " structural bonus" was significantly increased, reaching 62.27%, and the dynamic transfer effect was 56.29%. The growth effect within the industry dropped to 37.73% in this period, mainly in the secondary and tertiary industries, and the growth effect within the primary industry was only 2.44%.

The " structural bonus" of labor and stage characteristics of the growth effect within the industry in Guangdong Province are related to the characteristics of industrial development. In the period 1978 – 1988, the labor was first released from the primary industry into other industries. The free flow of labor makes the employment structure have strong flexibility, and match with the industrial structure, to achieve high structural effects. In the period 1988 – 1998, the industrial structure was developed steadily, and the productivity growth in this period was mainly from the improvement in the intra-industry technology. In the period 1998 – 2008, Guangdong Province vigorously implemented the industrial restructuring policy, which promoted the free flow of the labor factor, and achieved the optimization of industrial structure. During this period, the " structural bonus" was also improved.

3 Conclusions and recommendations

On the basis of analyzing changes of the industrial structure, changes of the structure of labor factor, changes of labor productivity and the growth rate in Guangdong Province in different periods, we use shift-share method to analyze the labor productivity effect of industrial structure in Guangdong Province, and draw the following conclusions:

(i) The labor factor has been flowing from the primary industry to the secondary and tertiary industries, but the structural variation degree is gradually reduced; the average structural variation degree of employment in each period is greater than the average structural variation degree of output value.

(ii) Since the reform and opening up, the labor productivity has been continuously improved, with an average annual growth rate of 10.72%; in the period 1978 – 1988, the growth rate of the primary industry was higher than that of the secondary and tertiary industries, but subsequently, the growth rate of the primary industry was lower than that of the secondary and tertiary industries.

(iii) Overall, 53.76% of the labor productivity growth comes from structural effects, and 46.24% of the labor productivity growth comes from the growth effect within the industry; there are some differences in " structural bonus" and the growth effect within the industry in different time periods (In the period 1978 – 1998, the growth effect within the industry was predominant; in the period 1998 – 2008, the " structural bonus" was beyond the growth effect within the industry); the " structural bonus" of labor and stage characteristics of the growth effect within the industry in Guangdong Province are related to the characteristics of industrial development.

Based on this, we put forward the following recommendations for the adjustment of industrial structure in Guangdong Province:

(i) The adjustment of industrial structure should promote the reasonable and effective flow of labor between industries. The " structural bonus" stems from the differences in the level of productivity and the growth rate between industrial sectors, thus making the input factors transfer between the sectors. Therefore, the free flow of labor factor is vital to the play of industrial structure effect.

(ii) Accelerating the optimization of the industrial structure is conducive to economic growth and improvement in labor productivity. With the development of industrialization, the role of labor productivity declines slightly, but it is always dominant. The industrial structure of Guangdong Province is in the stage of " secondary industry – tertiary industry – primary industry" (medium term of industrialization). Accelerating the optimization of the industrial structure, and improving labor productivity, is still of important significance to the economic growth.

(iii) In addition to structural optimization, the improvement in labor productivity should also focus on the improvement in intra-industry technology. The growth effect within the industry is a part that can not be ignored, for improving the labor productivity. Speeding up the technological innovation within the industry (especially the technological innovation within the secondary and tertiary industries) plays an important role for the improvement in labor productivity.

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