The Industrial Structure Efficiency of Gansu Province since the Start of Reform and Opening up

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Abstract   According to the time series data of relevant industries from 1978 to 2008 in Gansu Province, the industrial structure efficiency of Gansu Province is studied from different perspectives based on the overview of the analysis methods and by applying the analysis models including comparative labor productivity, deviation degree of industrial structure and shift-share analysis model. The results show that, in Gansu Province, the comparative labor productivity is low in the primary and tertiary industries, while that in the second industry is high; the deviation coefficient of industrial structure is big and the industrial structure and employment structure is extremely asymmetric; the proportion of sunrise industry is large and has great contribution to economic growth. However, the competiveness of the three main industries is relatively weak and need further improvement.
Key words   Industrial structure efficiency, Comparative labor productivity, Deviation degree of industrial structure, Shift-share model, China

The quality of the industrial structure directly relates to the efficiency of resources distribution and economy. The reasonable industrial structure is conducive to the coordinated development among the three industries and the scientific allocation of resources. Besides, it is beneficial to advancing the industrial structure, realizing the benefit of industrial economy and realizing the maximum of social interests[1]. However, unreasonable industrial structure is the inevitable phenomenon during the process of economic development. In order to reduce the negative influence on economic development caused by the unreasonable industrial structure to a minimum level, whether the methods can be used correctly for analyzing the industrial structural efficiency or not is very important. The three analysis methods including comparative labor productivity, deviation degree of industrial structure and shift-share model can be concluded from the researches conducted by scholars both at home and abroad. On the strength of the time series data of the three industries of Gansu Province from 1978 to 2008, the industrial structure efficiency of Gansu Province is empirically analyzed by using the three methods and from different perspectives, so as to provide some information for the further study.

1   Data source and research method

1.1   The general situation of the study area   Since the start of the reform and opening up, the industrial structure of Gansu Province has been restructured and optimized continuously. From the perspective of economic power, it has been improved obviously. The gross domestic product has increased from 6.473 billion in 1978 to 317.611 billion in 2008. From the perspective of the changing trend, it sill has improved obviously, the industrial structure is moving to the rational side gradually(Fig. 1). The ranks of the three industries from "secondary

industry, primary industry, tertiary industry" in 1978 to "secondary industry, tertiary industry, primary industry" in 2008, and the industrial ratio has changed from 13.21:39.04:12.48 in 1978 to 1.56:36.79:31.06 in 2008[2]. But Gansu Province has not realized the higher economic development level with the industrial structure of "tertiary industry, secondary industry, primary industry". Generally speaking, the proportion of the primary industry to GDP drops continuously and the secondary industry shows the downward and upward trend successively, but it still has a large proportion in GDP with the percentage of higher than 40%. The proportion of the tertiary industry to the GDP has increased greatly, from 19.28% in 1978 to 38.04% in 2007[3], which basically conforms to the basic rule of Petty-Clark theorem on the variation of industrial structure.
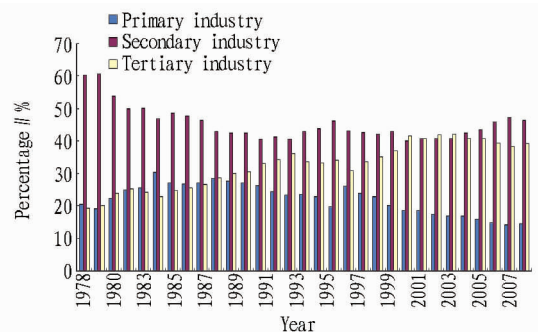

Fig.1   Structural variation of the output value of three industries in Gansu Province since the start of reform and opening up

1.2   Data source and processing   The data are from the *Gansu Statistical Yearbook* from 1979 to 2009 [2], *China Statistical Yearbook*[4]; relevant data in the statistical data in the county and city level, in which the GDP of the three industries and personnel involved are included; the time series data of the three industries of Gansu Province from 1978 to 2008. In order to eliminate the influence of currency inflation, we get the constant price data by conducting the reduction of the current price

of the price index on original data.

1.3 Research method

1.3.1 Comparative labor productivity analysis. The industrial comparative labor productivity refers to the ratio of the proportion of the output value of the industry and the proportion of employment, that is the production efficiency of a certain department under certain input of labor forces[5], the formula is as follows:

$$B_i = P_i/P = (Y_i/Y)/(L_i/L) \qquad (1)$$

In the formula, $P_i = Y_i/Y$ represents the proportion of the i industry in the region; $P = L_i/L$ is the comparative labor productivity of the i industry. If $B_i > 1$, it shows that the labor productivity is higher than the average value of the labor productivity of the whole industry, so the industry has comparative advantages. The bigger the value of B_i, the more obvious the comparative advantage. The closer the comparative labor productivity of the three industries, the more coordinated the industrial structure is. It is widely accepted that each industry with high efficient industrial structure, then the comparative labor productivity of it close to 1. But in the real economy, the comparative labor productivity in the agricultural and non-agricultural department varies hugely, and then its development varies hugely. At the same time, the comparative method among industries can be used to investigate the comparative labor productivity in the industries. In the first place, taking the average labor productivity of the i industry as standard for calculating the comparative labor productivity and then comparing it with the labor productivity of each industry in the i industry, then we can get the inner comparative labor productivity of the i industry. According to the formula(1), we can get the inner comparative labor productivity of the i industry, the formula is as follows:

$$B_i^* = P_i^*/P_i = (Y_i^*/Y_i)/(L_i^*/L_i) \qquad (2)$$

In the formula, Y_i and L_i are the industrial output and the number of people employed in the i industry according to the price of that year respectively, Y_i^* and L_i^* are the industrial output of each department of i industry and the number of people employed in the each industry.

In order to further reflect the dynamic variation in the inner side of the industrial structure of certain region, the differential index S of comparative labor productivity can be formed.

$$S = \sqrt{\sum_{1}^{n}(B_i - 1)^2/N} \qquad (3)$$

In the formula, S is the differential index of comparative labor productivity and it reflects the dispersion degree of comparative labor productivity of each industry and in the inner side of each industry. The big value of S indicates the imbalance of industry and industrial development and the low efficient of industrial structure interests; the small value of it and close to 1, indicates that the industrial structure efficiency is high. $N = 1, 2, \cdots, n$ when $n = 3$, S is the differential index of comparative labor productivity of the three industries. When n is the number of industries the inner side of the industry, S is the variation trend of comparative labor industry of each industry with the dispersion degree of 1, and it is used as the dynamic index for analyzing and evaluating the variation of the inner structure of the industry.

1.3.2 The industrial structure dispersion degree analysis. The dispersion degree of industrial structure refers to the sum of the absolute value of the differences of the three industries and the employment structure. The dispersion degree reflects the asymmetric state of output structure and employment structure of certain industry. The greater the asymmetric of the labor structure and output structure, the higher the dispersion degree, and the lower the industrial structure efficiency is. that is to say, the bigger the value of φ_1, the poorer the industrial structure φ_1. The formula for calculating the dispersion degree φ_2 and dispersion coefficient is as follows[6]:

$$\varphi_1 = (GDP_i/GDP)/(Y_i/Y) - 1 \qquad (4)$$

$$\varphi_2 = \sum_{i=1}^{n} |(GDP_i/GDP) - (Y_i/Y)| \qquad (5)$$

In the formula, GDP_i/GDP is the proportion taken by the GDP output of the i industry; Y_i/Y is the proportion of the number of people employed in the i industry. $\varphi_i > 0$ indicates that the ratio of output is larger than the ratio of employment, which means that the proportion of output is larger than the proportion of employment. And it means that the labor productivity in this industry is relatively high and there is the pressure of labor emigration; or else, it means that the industry has the pressure of labor immigration; the smaller the absolute value, the more balanced the industrial structure and employment structure, when the value is zero, the two aspects will be balanced. The bigger the value of φ_2, the difference between the industrial structure and the employment structure will be larger and the coordination relation between them will be poorer.

1.3.3 The shift-share analysis[7]. The shift-share analysis is an effective method for unveiling the changes of regional and urban industrial structure, analyzing the discrepancy of regional economic development, and ensuring the pillar industries for the future economic development. The specific ways are to take the variation of the regional economy as a dynamic process; take the economic development of the whole country as the reference frame; divide the whole economic components in a certain period into three parts, covering share components, structural deviation component and competitiveness component. And then use these components to explain the reasons of the economic development and economic recession; evaluate the quality of economic structural and competitiveness of the economy; find out the industries or departments with relative competitive advantages and then to ensure the reasonable direction of the future economic development and principles for the adjustment of industrial structure.

Supposing the i region has experienced the time $[0, t]$, the total volume and structure of economy has changed. Supposing the total economic volume of region i is $b_{i,0}$ (presented by the total output or personnel involved) in the primary period and the economic volume is $b_{ij,t}$ in the terminal year. Divining the regional economy into n industrial departments, and the $b_{ij,0}$ and $b_{ij,t}(j = 1, 2, \cdots, n)$ present the scale of the j industrial department in region i at the primary and terminal period. $B_{j,0}$ and $B_{j,t}$ is used to present the scale of the j industry in the region of the whole country at the primary period and the terminal period.

The variation rate of the j industrial department in the i re-

gion among the time period is as follows respectively:

$$r_{ij} = (b_{ij,t} - b_{ij,0})/b_{ij,0} \quad (j=1,2,\cdots,n) \quad (6)$$

$$R_{ij} = (B_{ij,t} - B_{ij,0})/B_{ij,0} \quad (j=1,2,\cdots,n) \quad (7)$$

Standardizing the scale of each industrial department according to the share of taken by the department in the region or in the whole nation, then we can get that:

$$b_{ij}^* = (b_{ij,0} \times B_{j,0})/B_0 \quad (j=1,2,\cdots,n) \quad (8)$$

Thus, the whole volume of economy G_i in the i region and the time period of $[0,t]$ can be divided in to three components N_i (the regional share component), P_i (structural deviation component), D_i (competitiveness deviation component), then the following formula can be obtained:

$$G_i = N_i + P_i + D_i \quad (9)$$

And the regional share component N_i, structural deviation component P_i and competitiveness deviation component D_i are as follows respectively:

$$N_i = \sum_{j=1}^{n} b_{ij}^* \times R_j \quad (10)$$

$$P_i = \sum_{j=1}^{n} (b_{ij,0} - b_{ij}^*) \times R_j \quad (11)$$

$$D_i = \sum_{j=1}^{n} b_{ij,0} \times (r_{ij} - R_j) \quad (12)$$

$K_{j,0} = b_{ij,0}/B_{j,0}$, $K_{j,t} = b_{ij,t}/B_{j,t}$ and are the proportion of the j department in the i region in the primary and terminal period to the relevant department in the region at the same period, then the relative growth rate of the i region to that in the whole nation or in the region is:

$$L = \{ [(\sum_{j=1}^{n} K_{j,0} \times B_{j,t})/\sum_{j=1}^{n} K_{j,0} \times B_{j,0}]/(\sum_{j=1}^{n} B_{j,t}/\sum_{j=1}^{n} B_{j,0}) \} \times$$
$$[(\sum_{j=1}^{n} K_{j,t} \times B_{j,t})/(\sum_{j=1}^{n} K_{j,0} \times B_{j,t})] = W \times U \quad (13)$$

In the formula,

$$W = [(\sum_{j=1}^{n} K_{j,0} \times B_{j,t})/\sum_{j=1}^{n} K_{j,0} \times B_{j,0}]/(\sum_{j=1}^{n} B_{j,t}/\sum_{j=1}^{n} B_{j,0}),$$

$$U = (\sum_{j=1}^{n} K_{j,t} \times B_{j,t})/(\sum_{j=1}^{n} K_{j,0} \times B_{j,t})$$

W and U represent the structural effect index and regional competitive effect index: $0 \le L \le 1$.

According to the formulas above we know that, in the first place, if G_i is big and L is larger than 1, then the regional growth of the industrial department is faster that in the nation or that in the whole region. In the second place, if P_j is big and W is larger than 1, it shows that in the region, the sunrise industry and the industries with rapid growth share a large proportion, the overall economic structural is reasonable and the structure has great contribution to economic growth; if W is smaller than 1, it shows that the declining industries and the sunset industries take a large proportion, and the economic structure needs to be restructured. In the third place, if the value of P_j is positive value, it shows that the industrial structure is good in the region, and it has promoted the growth of the total volume of economy; if the value of P_j is negative, it means that the industrial structure is bad, and it has bad effect on the growth of the total volume of economy. In the fourth place, the larger the value of D_j, the greater role played by the industrial competiveness of j industry in the region; if the value of D_j is big enough, it shows that in the region many industries develop rapidly and competitively, and they become more and more famous. Or else, the competiveness in weak and the position of them has the descending trend.

2　Results and analysis

2.1　Analysis form the perspective of comparative labor productivity　According to the original date, the comparative labor productivity of the three industries and differential indicators of the comparative labor productivity from 1978 to 2008 in Gansu Province can be obtained by using the formula(1) and formula(3).

Table 1　The comparative labor productivity and its differential index of Gansu Province

Year	The primary industry B_1	The secondary industry B_2	The tertiary industry B_3	S	year	The primary industry B_1	The secondary industry B_2	The tertiary industry B_3	S
1978	0.260 0	4.822 2	2.144 3	1.352 6	1994	0.351 8	2.453 9	1.950 8	0.618 1
1980	0.281 4	4.494 6	2.691 3	1.316 1	1996	0.412 1	2.274 8	1.726 0	0.526 8
1982	0.325 5	4.246 7	2.541 1	1.218 9	1998	0.381 4	2.086 2	1.760 0	0.487 6
1984	0.351 6	4.080 5	2.155 5	1.117 8	2000	0.309 1	2.113 4	1.939 2	0.537 4
1986	0.376 0	2.851 9	2.237 3	0.771 0	2002	0.295 3	2.195 2	1.880 6	0.547 8
1988	0.406 2	2.645 6	1.851 7	0.648 6	2004	0.290 0	2.256 7	1.795 7	0.549 4
1990	0.379 1	2.809 5	2.070 7	0.730 8	2006	0.231 9	3.097 2	1.798 3	0.790 6
1992	0.339 4	2.579 0	2.333 4	0.723 3	2008	0.233 4	3.064 8	1.735 9	0.774 1

Four conclusions can be obtained from Table 1. In the first place, from 1978 to 1988, the comparative labor productivity in Gansu Province has been increasing; after 1988, the overall trend showed downward trend, though in 1996, the index came to a maximum value of 0.412 1 and the index decreased from 0.406 2 in 1988 to 0.233 4 in 2008. The average proportion of the value of the primary industry only had 20.94%, but the average proportion of labor forces was 67.53%, which indicates that since the reform and opening up, the labor efficiency of the primary industry of Gansu Province was low and there were more laborers than needed. In the first place, the comparative

labor productivity began to descend since 1978, and in 2006, it showed the upward trend. Although it showed the V-shaped variation, the overall level was higher than the secondary and the tertiary industries of the same period, which indicates that the secondary industry had the comparative advantages. In the third place, although the comparative labor productivity showed the upward trend in some years, the overall trend was descending with wide range and the annual downward trend rate was 1%. The proportion of the tertiary industry is always larger than the proportion of labor force, which shows that the tertiary industry of Gansu Province stays in the underdeveloped stage

and can not push forward the employment of labors well. In the forth place, among 1980s and 1990s, the differential index of comparative labor productivity in Gansu Province has been descending, which shows that the efficiency of industrial structure has been improved. However, the comparative labor productivity index has been increasing continuously, from 0.537 4 in 2000 to 0.774 1 in 2008, which indicates that the industrial structure of the three industries is extremely imbalance. Besides, the differential index of comparative labor productivity is large, except for 1998, the index in the rest years are all bigger than 0.5, which indicates that the level of the industrial structure of Gansu Province is low and the industrial structure efficiency is descending.

2.2 Analysis from the perspective of deviation degree of industrial structure Based on the original data and the formula (4) and formula (5), the deviation degree of industrial strucutre and deviation coefficient of Gansu Province from 1978 to 2008 can be obtaiend(Fig. 2 and Fig.3).

It can be seen from Fig. 2 that, the deviation value of the employment structure in the primary industry of Gansu Province is negative and its absolute value shows the upward trend, which indicates that the proportion of the output is smaller than the proportion of employment and there is pressure of labor transformation. The deviation degree of the secondary industry

is positive and shows that downward trend, which indicates that the output proportion is larger than the employment proportion. It means that the labor productivity of the industry is relatively high and there is the pressure of labor immigration. The deviation degree of the tertiary industry varies hugely from 1978 to 1994, but from 1992 until now the variation is smooth and shows the downward trend slightly, which indicates that the balance degree of the industrial development is improving gradually. In Fig.3, the variation of the deviation coefficient of industrial structure reflects the changes of the balance degree between the employment structure and the industrial structure. At different developmental stages, the gaps between the employment and industrial development are different, but the deviation coefficient of industrial structure is relatively large. Although the differences between the industrial structure and the employment structure shows the slight downward trend, it is still relatively greater comparing with the whole nation, which shows that the coordination between them is poor and the structure restructuring will still be an important task in the future.

2.3 Shift-share analysis Selecting the three stages covering from 1978 to 1987, from 1988 to 1997and from 1998 to 2008, and then substituting the processed data into formulas from formula (6) to formula (13), the following Table 2 and Table 3 can be obtained.
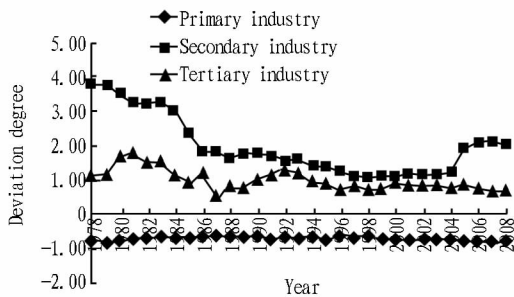

Fig.2 The deviation degree of the employment structure in the three industries of Gansu Province since the start of the reform and opening up
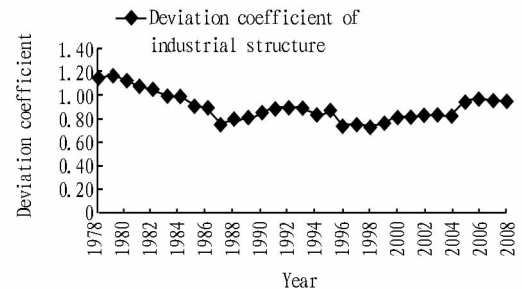

Fig.3 The differential coefficient of employment structure in the three industries of Gansu Province since the start of the reform and opening up

Table 2 The shift-share analysis of the primary, secondary and tertiary industry since the start of the reform and opening up

Time period	Industry	Total growth (G_i) ×10⁸ yuan	Regional share (N_i) ×10⁸ yuan	Structural deviation (P_i) ×10⁴ yuan	Competitive deviation (D_i) ×10⁸ yuan	Total deviation (PD_i) ×10⁸ yuan
1978 – 1987	The primary industry	11.636 9	2.534 8	7.266 9	1.835 2	9.102 1
	The secondary industry	6.487 9	27.673 4	16.829 1	−38.014 7	−21.185 6
	The tertiary industry	25.307 9	5.879 0	12.991 7	6.437 2	19.428 9
	Total	43.432 7	36.087 2	37.087 7	−29.742 3	7.345 4
1988 – 1997	The primary industry	13.832 1	1.447 4	10.847 1	1.537 6	12.384 7
	The secondary industry	89.833 1	43.183 7	87.848 1	−41.198 7	46.649 4
	The tertiary industry	88.887 6	11.868 6	49.056 3	27.962 6	77.018 9
	Total	192.552 8	56.499 7	147.751 5	−11.698 5	136.053
1998 – 2008	The primary industry	24.795 8	0.624 9	18.881 4	5.289 5	24.170 9
	The secondary industry	334.558 0	57.721 4	247.635 0	29.201 7	276.836 7
	The tertiary industry	340.147 0	22.400 3	249.552 0	68.194 6	317.746 6
	Total	699.500 8	80.746 6	516.068 4	102.685 8	618.754 2

The two tables can be analyzed from three perspectives. Firstly, from the perspective of the value of G_i and L, G_i increases gradually with high speed; although the increase of L is

slow, when entering the third period, L is larger than 1, which indicates that Gansu Province is always in the growth stage and in the third time period, the growth rate has surpassed the na-

tional level, that is the fruit of the Western Development. Secondly, from the perspective of P_i, the component of structural deviation, the three industries in the three time periods are all positive value, which shows that the industrial structure of Gansu Province is good. In addition, the value of W can prove this, for in the first stage, the W is bigger than 1 and in the following two periods, W is smaller than 1, which indicates that in the first time period of the development of Gansu Province, the proportion of the sunrise industry with rapid growth is large, the overall economic structure is good and the contribution rate to economic development is great. Thirdly, from the perspective of deviation component, each industry varies hugely in different time periods. From 1978 to 1987, the D_i of the secondary industry is negative and the whole deviation degree is negative, and the competitive effect index is smaller than 1, which indicates that the competitiveness of the primary industry and the tertiary industry is relatively weak. From 1988 to 1997, the competitiveness of the secondary industry is the same to that in the first time period, but the deviation of the total competitiveness has increased slightly, which means that comparing with the second period, the regional competitiveness of the first period has increased. Notably, in the third period, the effect is more obvious. The D_i is positive in the three industries and the competitive effect index U is bigger than 1, which shows the great increase of the competitiveness of the three period. But comparing with the component of structural deviation, the deviation component of competitiveness is still low and the task restructuring is still very hard. So the relevant department should provide some preferential policies in economy and policy, to improve the competitiveness of the three industries.

Table 3　The value of *L*, *W* and *U* of Gansu Province since the start of the reform and opening up

Time period	The relative growth rate (*L*)	The structural effect index (*W*)	The competitive effect index (*U*)
1978 – 1987	0.895 01	1.100 80	0.813 05
1988 – 1997	0.952 94	0.986 05	0.966 42
1998 – 2008	1.097 51	0.992 22	1.106 12

3　Conclusions

On the basis of the above analyses, we can draw the conclusion that since the start of reform and opening up, the restructure of the economic structure of Gansu Province has made great process and the joint developmental pattern of mutual development of diverse forms of ownership have formed. The industrial structure has tentatively formed the structural pattern of "the secondary industry, the tertiary industry and the primary industry" based on the primary industry, but the proportion of the tertiary industry to GDP still has wide gap with that of the secondary industry. The industrial structural interests of three industries in Gansu Province differ hugely to some degree not only in the comparative labor productivity of the three industry but also in the deviation coefficient of industrial structure, and the industrial structure is extremely asymmetry to the employment structure. The most important thing is that the sunrise industry has made great contribution to economic growth but the competeveness of three industries is relatively weak. Thus, there is still room for Gansu Province to further adjusting the optimizing its industrial structure.

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units of each province can be done by overlaying current maps of land utilization, landform maps and soil maps in areas with obvious terrain waving, not by method of guillotine cutting.

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