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Study on the dynamic relations among economic growth, industrial structure change and employment in Guizhou province of China

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Abstract
Through the analysis of output value and employment number of three major industries in Guizhou Province of China, it is found that the industrial structure and employment structure of Guizhou Province, through the construction of VAR model, has carried out Johansen cointegration test and Granger causality test on the relationship between economic growth, output structure change and employment structure change and employment structure change in Guizhou Province. The study finds that there is a long-term co-integration relationship among the three variables of economic growth, industrial structure change and employment. However, the employment structure of Guizhou Province is earlier than the industrial structure change, and later lags behind the industrial structure change. The contradiction between employment structure and industrial structure is very prominent. Therefore, it is necessary to design industrial development and employment promotion from the perspective of promoting the transfer of agricultural labor force. Policies to promote Guizhou Province in the process of industrialization to achieve double economic and employment growth and coordinated development of structural adjustment.

Keywords: industrial structure, employment structure, Cointegration test, causality test

Introduction

Economists all over the world have revealed a law from different perspectives that the largest proportion of a country's gross national product and the transfer of labor resources from the primary industry to the secondary industry, and then to the tertiary industry in the process of human social and economic development. Research shows that the change of industrial structure will not only affect the mode and speed of economic growth, but also affect the employment situation.

In the early period, the relationship between employment and economic growth was first concerned by the academic circles, "Okun's Law" and Phillips Curve and other theoretical achievements have been recognized by most scholars. Now it is generally believed that economic growth can promote the increase of employment, while economic growth also depends on the increase of employment. As the carrier of employment, industry structure has a close relationship with employment structure. Early empirical studies have concluded that, with the continuous advancement of industrialization, the employment proportion of the primary industry has been declining, and the employment proportion of the secondary and tertiary industries has been rising. When industrialization reaches a certain stage, the secondary industry can not absorb more labor force. Only the tertiary industry has a strong adsorption capacity for labor force, reflecting a strong employment elasticity.

Chinese researchers paid more attention to the impact of economic growth on employment in the early stage. Anping Chen and Xunlai Li (2004) used cointegration analysis and Granger causality test to study the relationship between employment and economic growth in China from the perspective of effective employment. The results shows that there is a long-term stable equilibrium relationship between China's economic growth and employment. Economic growth promotes employment, and the increase of effective employment also promotes economic growth. However, recent studies have indicated that the driving force of economic growth on employment is weakening (Zhen Chen, 2008). Xin Sheng (2009) took the use of data from 1952 to 2007 to analyze the relationship between China's economic growth and employment growth. The results illustrated that economic growth is increasingly weak in stimulating employment creation, and employment pressure has not been fundamentally alleviated.

Meanwhile, many scholars have focused on the impact of industrial structure changes on employment, in order to promote employment by adjusting the industrial structure. Chuanzhong Du and Jianbiao Li (2001) analyzed the correlation between industrial structure upgrading and employment, pointed out that the two are interdependent and mutually restrictive.In they opnion, the focus of industrial structure upgrading should be rationally selected and vigorously develop the tertiary industry. Li Xiaojia and Liu Peng (2006) studied the deviation of industrial structure and employment structure. They pointed out that the main reason of employment contradiction in China was that the industrial structure and employment structure were not commensurate, the employment structure lagged behind the development of industrial structure, and the development of tertiary industry was insufficient. Other researchers have drawn similar conclusions by comparing the ability of industries to absorb employment.

With the in-deepth relevant research, the relationship among economic growth, industrial restructuring and employment has come into notice of academia. Economic growth will not only lead to the adjustment of industrial structure, but also lead to changes in employment structure (Guoxun Luo, 2000) [1]. Liu Waterfall (2010) made an empirical study on economic growth, industrial development and employment in Henan Province. From the results, economic growth, industrial development and employment have a long-term co-integration relationship, and economic growth can directly

lead to employment growth. At the same time, it promotes the adjustment of output structure in industrial development, and the adjustment of output structure also promotes economic growth and the increase of total employment. But the distortion of output structure and employment structure makes it difficult to exert the structural effect and has limited effect on the increase of total employment. Wang Zhongping and Shi Nailiang (2010) also studied the situation of Jiangsu Province. They found that the employment structure of Jiangsu Province lagged behind the change of industrial structure for a long time, thus separating the interaction between economic growth, industrial development and employment.

It can be seen that most previous studies focused on the relationship between economic growth, industrial structure changes and employment, and a few researchers began to put the three under the same analytical framework. Relevant data show that there are serious asynchronism between economic growth and employment growth, industrial structure change and employment growth in Guizhou Province. Taking Guizhou Province as an example, this paper studies the relationship between economic growth, industrial structure changes and employment from 1978 to 2012. The analysis of the reasons for the asynchronism of economic growth, industrial structure change and employment growth has certain practical significance for Guizhou Province in the process of industrialization to achieve double economic growth, employment growth and coordinated development of structural adjustment.

Methods

Generally, there are two kinds of indicators to measure changes in industrial structure: industrial structure change value and Moore structure change value. The value of industrial structure change simply adds the absolute value of each industry share change, does not reflect the situation of a specific industry change, nor does it distinguish the direction change of each industry in the structural evolution. In contrast, Moore's structural change value divides industry into n sectors by space vector measurement, and forms a set of n-dimensional vectors. The angle between two vectors during the two periods is taken as the index of industrial structure change, which reveals the process and degree of industrial structure change more carefully and sensitively (Liu Zhibiao, An Tongliang, 2002). The calculating formulas are gived:

$$M_t^+ = \sum_{i=1}^{n} w_{i,t} / (\sum_{i=1}^{n} w_{i,t}^2)^{1/2} \bullet (\sum_{i=1}^{n} w_{i,t+1}^2)^{1/2}$$

$$\theta = \arccos M_t^+$$

In the formula, Mt+ denotes the change value of Moore structure; Wi, t denotes the proportion of *i* industry in *t* phase;$W_{i,\,t+1}$ denotes the proportion of I industry in *t+ 1* phase. The angle θ between W_{t1} and W_{t2} can be regarded as the value of structural change in the time interval *[t1, t2]*. The larger θ is, the greater the rate of structural change is, and its maximum value is 90 degrees.

Based on the data of output structure and employment structure of Three Industries in Guizhou Province of China from 1978 to 2012, this paper calculates the Moore structure change value of output structure and employment structure of three industries since the reform and opening up, and calculates θ degree of each period (in table 1).

The provincial gross domestic product *(Y)* is adjusted by the gross domestic product index as an index to measure the economic growth of Guizhou Province, and the employment personnel *(L)* as an index to measure the employment. In order to avoid the non-monolithic variable sequence as much as possible and not change the original co-integration relationship, the stationary sequence can be easily obtained. Natural logarithm is adopted to process the data. *LY*, LX_1, LX_2 and *LL* are used to represent the natural logarithm of the total GDP, output structure, employment structure and the number of employees of the province. ΔLY, ΔLX_1, ΔLX_2 and ΔLL are used to represent the first-order difference.

From Figure 1, since the reform and opening up, Guizhou's economy has shown a relatively stable growth trend, but the change trend of total employment is not obvious. From the evolution process of output structure and employment structure of the three industries, we can find that in 1978, the industrial structure and employment structure of Guizhou Province were "primary, secondary, tertiary"; in 1989, the industrial structure of Guizhou Province was "primary, secondary, tertiary", and the employment structure began to change into "primary, tertiary, secondary"; in 1992, the industrial structure began to change into "secondary, primary, tertiary", while the employment structure was still "primary, tertiary, secondary" in 1995 and 1996. In 2006, the industrial structure became "tertiary, secondary, primary" and the employment structure remained "primary, tertiary, secondary". Excluding the special situation in 1995 and 1996, we can see that the employment structure of Guizhou Province has been "primary, tertiary, secondary", while the industrial structure has gradually changed from "primary, secondary, tertiary" to "tertiary, secondary, primary". It can be seen that the employment structure changes faster than the industrial structure at first, and then slower than the industrial structure. It is easy to see that in recent years, the output structure and employment structure of the three industries have changed asynchroniously, that is, the employment structure has lagged behind and the output structure has changed ahead of time.

Results

The test of stationary time series

The premise of Granger causality test is that the time series variables are stationary or there is cointegration relationship between them. The ADF test in unit root test is usually used to test the variables. In this paper, SC criterion is used to judge the dynamic adjustment lag order of test type and McKinnon critical value is used to judge whether there is unit root. Table 2 indicates that the ADF values of LY, LX_2 and LL are all greater than the critical values of 5% significant level, so we accept the original assumption that there is a non-stationary unit root, while the ADF values of LX_1 are less than the critical values of 5% significant level, so we reject the original assumption that there is a stationary unit root. Continuing to test their first-order difference, the results show that the ADF values of the first-order difference of four variables are less than the critical value of 5% restrictive level, this is to say, rejecting the original assumption, the first-order difference of each sequence is stationary, so the four variables are first-order single-integer sequences.

Establishment of VAR Model

Based on the above tests, it can be determined that time series LY, LX1, LX2 and LL are first-order monolithic sequences.

Although LY, LX1, LX2 and LL are not stationary in themselves, some linear combination may be stationary. This linear combination reflects the long-term stable equilibrium relationship between variables, i. e. the co-integration relationship. In this paper, Johansen (1995) Likelihood Ratio (LR) based on complete information maximum likelihood estimation is used to test the co-integration relationship of these four variables. Since Johansen cointegration test is a test method based on vector autoregressive model, the structure of VAR model must be determined before cointegration test. After many experiments, logarithmic likelihood value, AIC and SC information are used to determine the lag order, and finally the optimal lag order is determined to be 3. By using EViews 610 software, the estimated values of VAR (3) model parameters, the test results of various equations and the overall test results are obtained. Table 3 shows that the adjusted goodness of fit R2 of the four regression functions are 0.998527, 0.952001, 0.809895 and 0.953064 respectively, which shows that the four regression functions fit well.

When the AR root diagram is used to test the stability of the lagging structure of VAR (3) model, if the reciprocal of all root modules of the estimated VAR model is less than 1, i.e. within the unit circle, it is stable; if the module root is not within the unit circle, it shows that the model is unstable and the model results are not effective. Figure 2 draws that all units are rooted in the unit circle, indicating that the established VAR (3) model is stable.

Johansen cointegration test

Johansen test is used to test the co-integration relationship between multivariates by using maximum likelihood estimation proposed by Johansen and Juselius in 1990. Based on the results in Table 3, Johansen cointegration test was performed. The VAR model and cointegration equation (CE) have only intercept terms and no linear trend. In addition, the VAR model of cointegration test is based on error correction VAR settings, that is, the interpreted vector is a first-order difference form. Because the optimal lag time of unconstrained VAR model is 3, the lag time of cointegration test VAR model is 2.

According to the test results in Table 4, both the likelihood trace test and the maximum eigenvalue test of likelihood ratio show that the assumption that there is no co-integration equation is rejected at the 5% significant level, that is, there is a long-term equilibrium relationship among variables *LY*, LX_1, *LX2* and *LL*.

Granger causality tests

The results of co-integration test show that there is a long-term stable equilibrium relationship among economic growth, industrial structure, employment structure and labor employment in Guizhou Province. Whether this equilibrium relationship constitutes a causal relationship needs further verification. Granger causality test is used to analyze this. According to the results of integration test and the lag order of unconstrained VAR, Granger causality test was carried out for *LY*, LX_1, LX_2 and *LL*, and the lag order of the set form was 2.

Discussion

According to Granger's theory, some opinions can be concluded from Table 5.

First of all, there is no causal relationship between economic growth and industrial structure change in Guizhou Province. The possible explanation is that Guizhou's economic growth is due to the improvement of labor productivity within the three industries, rather than the overall improvement of labor productivity. There is no causal relationship between economic growth and the change of employment structure, which shows that economic growth has little effect on the transfer of labor force among the three industries. It also proves that Guizhou's economic growth originates from the improvement of labor productivity within each industry. The economic growth of Guizhou Province has no obvious effect on the transfer of labor force among the three industries. The possible explanation is that the excessive labor force, the lack of household registration system and human capital restrict the flow of labor force in Guizhou Province, which makes the transfer speed quite slow.

Secondly, the change of labor employment has not caused the economic growth of Guizhou Province, and the economic growth has not caused the change of labor employment. On the one hand, the sustained and rapid economic growth is not necessarily the sufficient condition for employment growth; on the other hand, it also shows that labor employment has not significantly improved production efficiency and output has not significantly increased.

Thirdly, the change of employment structure has caused the change of industrial structure, but the change of industrial structure has not caused the change of employment structure. This shows that the employment structure and industrial structure of Guizhou Province are asymmetrical, the output structure and employment structure of industry are asynchronized, the transformation of employment structure is advanced, and the transformation of industrial structure lags behind. The possible explanation for this phenomenon is that after the gradual improvement of infrastructure, Guizhou Province vigorously develops tourism, logistics and other tertiary industries. The labor force in Guizhou Province shifts more to the tertiary industry, thus promoting the development of the tertiary industry, and the absorptive capacity of the tertiary industry to labor force is far greater than that of the secondary industry.

Lastly, The change of the scale of labor employment plays a very limited role in promoting the change of industrial structure. The adjustment of industrial structure cannot expand the total amount of labor employment. This also proves to a certain extent that the productivity of Guizhou's three industries has been rising, and the absorptive capacity of labor force is limited. The change of employment structure is only the movement of minority migrants between the secondary industry and the tertiary industry. There are still a large number of surplus labor in the primary industry. Labor employment does not affect the change of employment structure, but also supports this judgment to a certain extent.

Conclusion

Through the analysis of the characteristics of Guizhou's economic growth, industrial structure and employment structure change, we can find that the employment structure of Guizhou Province was earlier than the industrial structure change, and then lagged behind the industrial structure change. The contradiction between employment structure and industrial structure is very prominent. It is urgent to solve the contradiction between the industrial structure and employment structure. From the perspective of co-integration analysis, this paper studies the changes of industrial structure and employment structure in Guizhou Province, and the

conclusions are consistent with the qualitative analysis of statistical data, which shows that co-integration analysis method is suitable for the study of the relationship between industrial structure and employment structure.

Through the analysis of the causal relationship between economic growth, output structure change, employment structure change and employment in Guizhou Province, if we want to solve the contradiction between high growth, low employment and unbalanced development of industrial structure and employment structure in Guizhou Province, we should start from the following three aspects: First, to promote the transfer of rural surplus labor force. From the data point of view, agriculture has always been the industry with the largest employment population in Guizhou, but the proportion of output value is the lowest. This shows that there is still a lot of surplus labor in the countryside. At the policy level, we should break down the institutional factors that hinder the transfer of labor and effectively promote the transfer of rural labor force. Second, vigorously develop the secondary industry. Guizhou Province has a low degree of industrialization. Under the background of "strong industrial province", and on the premise of protecting ecology and intensive resources, it should develop labor-intensive industries in an appropriate way to increase the absorptive capacity of labor force. Third, we should continue to increase investment in education and raise the level of human capital.

Table 1: The Various Value of Moore Structure in Output Structure and Employment Structure of Three Industries in Guizhou Province

Year	Output Structure (X_1)	Employment Structure (X_2)	Year	Output Structure (X_1)	Employment Structure (X_2)
1979	3.6060	0.5791	1996	23.1921	9.1664
1980	4.9004	1.0274	1997	24.3616	9.1938
1981	3.4569	1.3523	1998	25.9442	9.4045
1982	1.9697	1.6442	1999	23.1921	9.5734
1983	4.0348	1.6886	2000	24.3616	9.9837
1984	4.9830	2.1647	2001	25.9442	4.2328
1985	8.7732	4.1024	2002	27.1222	6.2371
1986	8.6056	4.2255	2003	27.9592	7.7614
1987	11.4937	3.1591	2004	29.2972	8.7985
1988	14.9121	2.8898	2005	30.4458	5.9846
1989	14.3078	3.5395	2006	31.2904	6.3197
1990	15.1690	3.6163	2007	32.1387	7.8738
1991	13.8741	3.5652	2008	32.9952	9.1633
1992	17.0167	3.8707	2009	33.8891	10.1167
1993	19.0851	4.8796	2010	35.0393	11.8041
1994	20.4678	6.8553	2011	35.5483	13.1531
1995	21.9002	6.7409	2012	36.1784	14.1124

Data source: Guizhou Statistical Yearbook 2013, obtained by sorting out and calculating

Table 2: ADF Test Results of LY、LX_1、LX_2 and LL

1	ADF statistics	Inspection form (C, T, K)	Critical Value (5%)	P	conclusion
LY	0.259278	(C,T,0)	-3.548490	0.9975	instability
LX_1	-3.656405	(C,T,3)	-3.603202	0.0450	stability
LX_2	-3.407365	(C,T,0)	-3.552973	0.0676	instability
LL	-0.426796	(C,T,0)	-3.548490	0.9823	instability
ΔLY	-4.115284	(C,T,0)	-3.552973	0.0142	stability
ΔLX_1	-4.745786	(C,T,1)	-3.612199	0.0047	stability
ΔLX_2	-5.745564	(C,T,0)	-3.557759	0.0002	stability
ΔLL	-5.512324	(C,T,0)	-3.552973	0.0004	stability

Table 3: Estimated Results of VAR (3) Model

	LY	LX1	LX2	LL
LY(-1)	1.325725	1.099269	0.384220	-0.049378
	[6.18528]	[1.61582]	[0.35121]	[-0.33661]
LY(-2)	-0.647977	-0.401483	0.540927	-0.189881
	[-1.85337]	[-0.36179]	[0.30313]	[-0.79355]
LY(-3)	0.329787	-0.635985	-0.667672	0.216013
	[1.48368]	[-0.90144]	[-0.58851]	[1.41996]
LX1(-1)	0.124875	0.244259	0.124805	0.048712
	[1.97703]	[1.21835]	[0.38713]	[1.12684]
LX1(-2)	-0.114220	-0.051196	0.000341	0.013976
	[-1.90759]	[-0.26938]	[0.00112]	[0.34104]
LX1(-3)	0.052884	-0.196879	-0.370968	0.010498
	[0.96651]	[-1.13362]	[-1.32832]	[0.28034]
LX2(-1)	-0.022530	0.092328	0.570125	-0.006543
	[-0.51243]	[0.66160]	[2.54055]	[-0.21743]
LX2(-2)	-0.014270	0.105189	-0.119935	-0.006097
	[-0.27964]	[0.64944]	[-0.46048]	[-0.17457]
LX2(-3)	-0.051334	0.371404	0.096772	0.019771
	[-1.22322]	[2.78825]	[0.45178]	[0.68837]
LL(-1)	-0.235803	1.278526	0.587114	0.712004
	[-0.72318]	[1.23535]	[0.35278]	[3.19058]
LL(-2)	-0.015742	0.254990	0.331189	0.094777
	[-0.03867]	[0.19734]	[0.15939]	[0.34017]
LL(-3)	0.205918	0.016748	-0.355507	-0.103712
	[0.61877]	[0.01586]	[-0.20930]	[-0.45536]
C	0.400153	-10.10178	-4.460881	2.187420
	[0.32229]	[-2.56332]	[-0.70392]	[2.57421]
Adj. R-squared	0.998527	0.952001	0.809895	0.953064

The value in [] is *t* statistical value

Table 4: Johansen Cointegration Test Results

Trace Test				Maximum Eigenvalue Test			
Original hypothesis: Cointegration relation number	Trace statistics	5% critical value	P-value	Original hypothesis: Cointegration relation umber	Maximal Eigenvalue Statistic	5% critical value	P- value
No cointegratin relationship*	64.74987	47.85613	0.0006	No cointegratin relationship*	36.97830	27.58434	0.0023
At most 1	27.77157	29.79707	0.0841	At most 1	14.17386	21.13162	0.3509
At most 2	13.59770	15.49471	0.0947	At most 2	13.28696	14.26460	0.0709
At most 3	0.310737	3.841466	0.5772	At most 3	0.310737	3.841468	0.5772

* Represents rejection of the original hypothesis at a significant level of 5%

Table 5: Granger Causality Test Results

Variable	Original hypothesis	Number of observations	F-test statistics	P-value
LY,LX_1	LX_1 is not LY's Granger cause	32	1.28436	0.2932
	LY is not LX_1's Granger cause		0.98753	0.3856
LY,LX_2	LY is not LX_2's Granger cause	32	0.59741	0.5573
	LX_2 is not LY's Granger cause		3.30594	0.0520
LY,LL	LY is not LL's Granger cause	32	0.26953	0.7658
	LL is not LY's Granger cause		0.53394	0.5924
LX_1,LX_2	LX_1 is not LX_2's Granger cause	32	5.42359	0.0105
	LX_2 is not LX_1's Granger cause		1.57375	0.2257
LX_1,LL	LX_1 is not LL's Granger cause	32	2.72035	0.0839
	LL is not LX_1's Granger cause		0.42977	0.6550
LX_2,LL	LX_2 is not LL's Granger cause	32	0.90670	0.4158
	LLis not LX_2's Granger cause		0.63492	0.5377

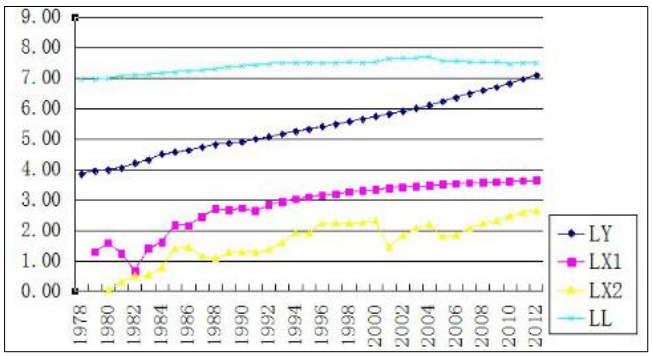

Fig 1: Time-series Graph

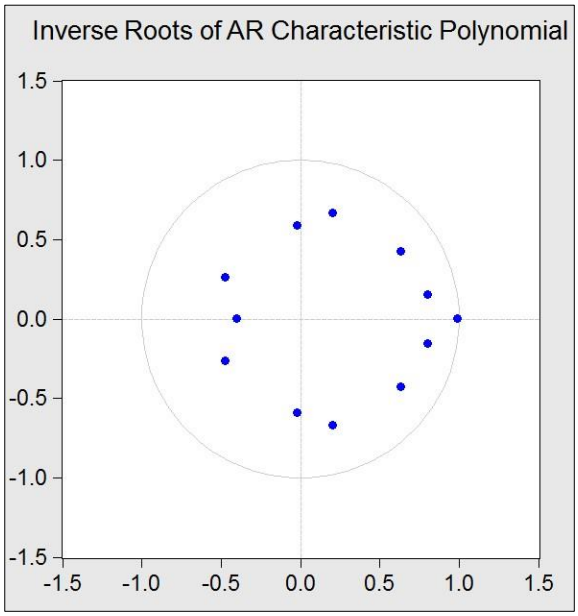

Fig 2: AR root graph

Declarations

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Data from Guizhou Statistical Yearbook 2013

Author's contributions
LZ conceived of the study, drafted and revised the manuscript. ST helped to performed the statistical analysis and provided a variety of comments.

Competing interests
The authors declare that they have no competing interests.

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