Analysis on the Method of Coordination Evaluation of Regional Statistical Indicators—An Empirical Study Based on Business Cycle Theory and State Space Model

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Abstract. Based on the preliminary judgment of the business cycle theory, there is a certain degree of disharmony among the statistical indicators in Sichuan Province. The elastic coefficient is used to construct the coordination degree measurement method, and the variable parameter state space model is constructed to compare the GDP and social commodity retail total in various regions of Sichuan. The coordination of the empirical test shows that the coordination degree between the statistical indicators of most cities and states in Sichuan is rising, the coordination degree of a few cities and states is low; the overall coordination degree is slightly left-biased. In addition, there is no necessary link between the degree of coordination between statistical indicators in various regions and the level of regional economic development.

1. Introduction

With the transparency of the government's economic information, the quality of statistical data, especially the coordination of regional statistical data, has aroused widespread concern in all sectors of society. However, due to the interests of all parties in the real game, people have a certain degree of doubt about the quality of statistical data. The regional statistical data is the basis of national statistical data, and the quality of statistical data directly affects the judgment of government personnel and scholars from all walks of life on the national economic operation situation. The coordination of statistical data is the premise for data analysis. Therefore, before the regional economic situation is judged, it is necessary to judge the coordination between regional statistical data.

At present, the domestic research on the coordination of statistical data is mainly based on the macro level; Relevant research mainly adopts single indicators such as GDP for evaluation, while the use of multiple indicators is less studied, such as GDP and industrial producers purchase prices, total retail sales of social goods, fixed asset investment, etc.\cite{1,2,3}; The static method is mainly used in the method of use, and the dynamic change of the system is considered less; in the research perspective, considering more of the evaluated indicators themselves, less consideration of relevance and matching between other indicators\cite{4,5,6}. This paper adopts multiple indicators to simulate the intrinsic relationship between the main statistical indicators from the time dimension, conducts empirical research based on business cycle theory and state space model, and then explores the method of local statistical data coordination judgment.
2. The initial judgment of regional statistical data coordination

2.1 Business cycle theory
Western economists believe that there are cyclical phenomena of expansion and contraction overlapping and circulation in economic operation, that is, there is a business cycle, also known as the economic cycle. Burns and Mitchell believe that overall economic growth will experience four stages of prosperity, recession, depression and recovery. According to the length of the economic cycle, the economic cycle is divided into the Keqin cycle, the Kuznets cycle and Kondratieff cycle. Dividing the business cycle by cycle length is only a direct response to the cycle performance form, and more important in the business cycle theory is the business cycle formation mechanism. The reasons for the formation of the business cycle are generally considered to be cyclical factors, seasonal factors, accidental factors, and long-term trends. Among them, the cyclical factors and long-term trends reflect the basic trends and essential characteristics of economic operations, while seasonal factors and contingency factors will cause economic data to change, often masking the essence of economic activities, causing people to misjudge the economic situation.

The indicators causing economic fluctuations include leading indicators, synchronization indicators and lagging indicators, and they change in order of economic operation. The leading indicators can predict future economic conditions and possible cyclical changes in business, including money supply, stock price index, orders for machinery and equipment, industrial raw material prices and construction contracts, and leading indicators change ahead of economic activity. The synchronization indicators mainly describe the trajectory of the overall economy, and determine the peak or valley position of the overall economic operation, including the gross national product, the total industrial output value, and the total retail sales of social consumer goods. The time of change of the synchronization indicators is basically consistent with the general economic situation. The lagging indicators lag behind the changes in the national economy and are used to verify whether the economic trend indicated by the leading indicator is true and to judge the change of the leading indicator.

2.2 Indicator selection and data source
According to the previous analysis, one or two indicators are selected from the above three series of indicators to judge the coordination between economic data. First of all, as the leading industry in China, the industrial producer purchase price index can reflect the business status of the enterprise, and thus predict the overall development trend of the social economy. The direct manifestation of economic performance is the gross domestic product and the people's living standards. Therefore, the GDP growth rate, the industrial production index and the retail price index of commodities are selected among the synchronization indicators. Fixed assets investment is the main means of social fixed assets reproduction, which directly reflects the status of economic activities and operational trends. Specific indicators are shown in Table 1.

The data mainly comes from the China Statistical Yearbook, the Sichuan Statistical Yearbook and the statistical bulletins of various cities (states). In addition, the author also carried out the expansion treatment of relevant data, using the consumer price index and the commodity retail price index to convert the gross domestic product and the total retail sales of social consumer goods into comparable prices.

Table 1. List of Different Categories of Indicators

| category               | name                        | brief description            |
|------------------------|-----------------------------|-----------------------------|
| Leading Indicator      | Industrial producer purchase price | Industrial Producer Purchase Price Index |
| Synchronization Indicator | GDP                       | GDP Growth Rate             |
|                        | Gross Industrial Production | Industrial Value Added Index |

2
The Total Retail Sales of Social Consumer Goods

| Lagging Indicator | Fixed Asset Investment | Fixed Asset Investment Price Index |
|-------------------|------------------------|------------------------------------|
| The Total Retail Sales of Social Consumer Goods | Commodity Retail Price Index |

2.3 Initial judgment of data coordination

This paper selects the data of Sichuan Province from 2000 to 2016, based on the GDP growth rate, fits various indicators and their charts, and judges whether the indicators are coordinated and matched through the fitting degree between the trends.

Figure 1. GDP Growth Rate and Industrial Producers Purchase Price Index Growth Rate Fit Map

It can be seen from Figure 1 that the volatility of the industrial producer's purchase price index is significantly larger than the GDP growth rate, and the year in which the volatility turns around lags behind the GDP growth rate. In 2008, the GDP growth rate reached the lowest point, while the industrial producer purchase price index was at a high level, and reached its lowest point in 2009. As a leading indicator, the industrial producer purchase price index did not show its response to sensitive features of the economic situation. Based on this, it can be initially judged that there is an inconsistency between the GDP growth data of Sichuan Province and the purchase price index of industrial producers.

Figure 2. GDP Growth Rate and Commodity Retail Price Index Growth Rate, Industrial Value Added Index Growth Rate Fit Map

It can be seen from Figure 2 that the GDP growth rate and the industrial added value index have strong convergence at the fluctuation amplitude and fluctuation time point, and it is preliminarily judged that the coordination between the two indicators is better. The retail price index of goods has a significant difference in the fluctuation range and frequency from the GDP growth rate. At the turning point of the fluctuation, the turning point of the commodity retail price index lags behind the GDP growth rate, especially at some big turning points. Therefore, it can be judged that the coordination between the GDP growth rate of Sichuan Province and the retail price index of goods is poor.
Figure 3. GDP Growth Rate and Fixed Asset Investment Price Index Growth Rate Fit Map

It can be seen from Figure 3 that the fixed asset investment price index is higher than the GDP growth rate in terms of fluctuation amplitude and frequency, but it lags behind the GDP growth rate at the time of the volatility transition, and is consistent with the GDP growth rate in the volatility trend. This reflects the characteristics of the lagging indicator. Therefore, it is considered that the GDP growth rate of Sichuan Province and the fixed asset investment price index are relatively coordinated.

In summary, according to the business cycle theory, using the time difference comparison of indicator changes, it can be preliminarily judged that there is a certain degree of inconsistency in the statistical data of Sichuan Province, mainly reflected in poor coordination and matching between the synchronization indicator GDP growth rate reflecting the economic fluctuations, the leading indicator industrial producer purchase price index and the synchronization indicator commodity retail price index.

3. The empirical study of data coordination measurement

The coordination of regional statistical data needs to be studied from the dynamic changes of time and space. The above content mainly studies the coordination between statistical data from the variation of regional time difference, and the spatial change needs to quantitatively analyze the coordination degree of statistical data in different regions. Therefore, based on the variable parameter state space model, the coordination between GDP and total retail sales of social goods in various regions of Sichuan is measured.

3.1 Model description and measurement method

Affected by factors such as policy changes and technological advances, economic operations are subject to cyclical fluctuations. If the fixed parameter model and the ordinary least squares method (OLS) are usually not able to express this change well, we consider a time varying parameter model. The state space representation of the variable parameter model is:

$$ y_t = x_t \beta + \sigma_t \gamma + u_t, \quad t = 1, 2, ..., T $$(1)

In the formula, \( \beta \) changes with time, which reflects the change of the explanatory variable to the influence of the dependent variable, assuming the variable parameter \( \beta \) is described by \( AR(1) \):

$$ \beta_t = \psi \beta_{t-1} + \epsilon_t $$ (2)

We can also be extended to a \( AR(p) \) model and assumed:

$$ (u_t, \epsilon_t) \sim N\left( \begin{bmatrix} 0 \\ \sigma^2 \end{bmatrix}, \begin{bmatrix} g & Q \\ Q' & g \end{bmatrix} \right), \quad t = 1, 2, ..., T $$ (3)

In equation (1), \( \beta \) is unobservable variable and must be estimated using the observable \( y_t \) and \( x_t \). According to equation (3), \( u_t \) and \( \epsilon_t \) are not necessarily independent of each other, and obey the normal distribution which mean is 0, variance is \( \sigma^2 \), covariance matrix is \( Q \) and \( \text{cov}(u_t, \epsilon_t) = g \).

On the other hand, the elastic coefficient has strong stability. Therefore, this paper uses the stability of the elastic coefficient to study the coordination between indicators. Suppose there are two time
series indicators $X$ and $Y$ that require measure coordination, the rate of change of $t$ period relative to the previous period is $x_t$ and $y_t$ respectively, Then the elastic coefficient of $X$ to $Y$ in period $t$ is:

$$e_{XY} = \frac{x_t}{y_t}$$

(4)

In a certain period of time, the mean value of $e_{XY}$ can be used as a reference for judging whether or not $e_{XY}$ is coordinated and stable during the period, that is, it can be used as a basis for judging if $x_t$ and $y_t$ are coordinating and stability. Therefore, define the coordination measure function as:

$$c(X, Y) = g(x_t, y_t) = z(x_t - \bar{x}_t)$$

(5)

Among them, $z(\bullet)$ is a monotonically decreasing function, that is, the higher coordination is, then the smaller $|e_{XY} - \bar{e}_{XY}|$ is, the larger $z|e_{XY} - \bar{e}_{XY}|$ is, and the larger $c(X, Y)$ is. The expression of $z(\bullet)$ is pushed down below.

According to the central limit theorem, $e_{XY}$ approximates a normal distribution, namely:

$$f(e_{XY}) = \frac{1}{\sqrt{2\pi\sigma_{XY}}} \exp\left[-\frac{(e_{XY} - \bar{e}_{XY})^2}{2\sigma_{XY}^2}\right]$$

Among them, $f(e_{XY}) \in (0, 1/\sqrt{2\pi\sigma_{XY}})$, then $\sqrt{2\pi\sigma_{XY}} f(e_{XY}) \in (0, 1)$.

By formula (5), it can make:

$$c(X, Y) = g(x_t, y_t) = z(x_t - \bar{x}_{XY}) = \sqrt{2\pi\sigma_{XY}} f(e_{XY})$$

then

$$c(X, Y) = \sqrt{2\pi\sigma_{XY}} f(e_{XY}) \exp\left[-\frac{(e_{XY} - \bar{e}_{XY})^2}{2\sigma_{XY}^2}\right]$$

(6)

As shown in equation (6), $c(X, Y)$ is a monotonically decreasing function, and $c(X, Y) \in (0, 1)$, therefore it can be used as a formula for the coordination between the measurement indicators, and the coordination measure coefficient is a positive indicator, the larger the better.

3.2 Data description and empirical research

GDP is the core indicator of national economic accounting, and is an important indicator to measure a country's overall economic status; the total retail sales of social goods directly reflects regional consumption demand, reflecting the degree of economic prosperity. This paper establishes a variable parameter state space model through the total retail sales of social goods and GDP, and empirically tests the coordination between indicators and the stability of the system. The total retail sales of social goods below is expressed by SALE. This paper selects sample data of Sichuan Province and 21 cities (states) of Sichuan Province in 17 years from 2000 to 2016. The data comes from China Statistical Yearbook, Sichuan Statistical Yearbook and statistical publications of various cities (states). In order to make the data comparable, this section also performs the expansion processing of the data.

Based on the state space model, the elasticity of the GDP of each city (state) in Sichuan Province to the total retail sales of social consumer goods can be measured. The state space model combines the unobservable variables with the observable variables to obtain the estimation results, and uses the Kalman filter iterative algorithm for estimation. This paper uses Eviews10.0 to estimate and obtain the estimated value of state space variables, and uses equation (6) to measure the coordination degree of each city (state) GDP to the total retail sales of social goods. The calculation results are shown in Table 2.
Table 2. Coordination between GDP and SALE In Various Cities (States) In 2000 and 2016

| Area   | 2000   | 2016   | Variety | 2000   | 2016   | Variety |
|--------|--------|--------|---------|--------|--------|---------|
| Chengdu | 0.8989 | 0.9476 | 0.0688  | 0.6233 | 0.8839 | 0.2605  |
| Zigong  | 0.6583 | 0.9312 | 0.2736  | 0.4487 | 0.8271 | 0.3774  |
| Panzhihua | 0.6622 | 0.8862 | 0.2240  | 0.8464 | 0.9341 | 0.0877  |
| Luzhou  | 0.9650 | 0.9439 | -0.0221 | 0.4530 | 0.7778 | 0.3365  |
| Deyang  | 0.6518 | 0.8904 | 0.2386  | 0.4231 | 0.8240 | 0.3721  |
| Mianyang | 0.7141 | 0.8972 | 0.1831  | 0.7358 | 0.8977 | 0.1399  |
| Guanyuan | 0.8926 | 0.9407 | 0.0481  | 0.8884 | 0.9882 | -0.0012 |
| Suining | 0.9048 | 0.9366 | 0.0141  | 0.5772 | 0.8609 | 0.3156  |
| Neijiang | 0.8238 | 0.9223 | 0.0995  | 0.8323 | 0.9434 | 0.0120  |
| Leshan  | 0.7117 | 0.8839 | 0.1722  | 0.6975 | 0.8791 | 0.1034  |
| Nanchong | 0.8425 | 0.9132 | 0.0727  |        |        |         |

Table 3. Mean of GDP and SALE For Each City (State) From 2000 To 2016 and Correlation

| Area  | 2016 Mean coordination | 2016 GDP per capita ranking | 2016 Mean coordination | 2016 GDP per capita ranking |
|-------|------------------------|----------------------------|------------------------|----------------------------|
| Ziyang| 0.9839                 | 1                          | 0.8179                 | 12                         |
| Chengdu | 0.8973                  | 2                          | 0.8632                 | 13                         |
| Luzhou | 0.9540                  | 3                          | 0.8776                 | 14                         |
| Suining | 0.9507                  | 4                          | 0.8715                 | 15                         |
| Guangzhou | 0.9384                 | 5                          | 0.9805                 | 16                         |
| Guangxi | 0.9375                  | 6                          | 0.8029                 | 17                         |
| Tian  | 0.9542                  | 7                          | 0.8324                 | 18                         |
| Neijiang | 0.9272                  | 8                          | 0.8419                 | 19                         |
| Guizhi | 0.9202                  | 9                          | 0.8654                 | 20                         |
| Zigong | 0.9172                  | 10                         | 0.7624                 | 21                         |
| Nanchong | 0.9199                 | 11                         | 0.7839                 | 18                         |

It can be seen from Table 2. that in 2000-2016, the coordination degree of GDP and total retail sales of social goods in 19 regions showed an upward trend, and the coordination degree of two regions was declining. Among them, Yibin's coordination degree increased the most. Compared with 2000, in 2016, it increased by 0.3774 units; followed by Dazhou, an increase of 0.3266 units. From the comparison of the coordination degree between 2000 and 2016, the coordination degree of Ziyang and Luzhou decreased more obviously, with a decrease of 0.0012 units and 0.0221 units respectively.

In order to more clearly judge the degree of coordination between the GDP and the total retail sales of social goods in Sichuan Province, the following will average the coordination degree calculated by each region in 2010-2016. The coordination mean and its ranking are listed in Table 3. It can be seen from Table 3. that the overall level of coordination of the two indicators of Sichuan cities (states) from 2000 to 2016 is relatively high and is left-biased. On the whole, the average of the coordination degree of 21 cities (states) in Sichuan Province is 0.8977, indicating that the coordination degree between the GDP of 21 cities (states) and the total retail sales of social goods in Sichuan is generally good. From the structural point of view, there are 11 regions with a degree of coordination exceeding 0.9, accounting for more than half of the total, among which Ziyang, Chengdu, Luzhou and Suining are in the forefront; 9 between 0.8 and 0.9, 42.86% of the total; only one between 0.7 and 0.8 is
Dazhou. Most of the regions are above 0.8, indicating that the overall level of coordination between the two indicators in Sichuan Province is relatively high. At the same time, due to the low degree of coordination of indicators in some areas such as Yibin and Dazhou, the overall mean value decreased, and the coordination degree was slightly left-biased.

According to calculation, under the 95% confidence level, the coordination degrees of Ziyan, Chengdu, Luzhou, Suining, Panzhihua, Yibin and Dazhou are outside the confidence interval, and the coordination degree of all other regions is in the confidence interval. Among them, the coordination degree of Ziyan, Chengdu and Luzhou is higher than the 95% confidence upper limit, and Ziyan is the highest (0.9809); the coordination degree of Panzhihua, Yibin and Dazhou is lower than the 95% confidence lower limit, and Dazhou is the lowest (0.7624); The areas with high degree of coordination within the confidence interval are Guangyuan and Guang'an, reaching 0.9384 and 0.9375 respectively. As can be seen from the foregoing, the average value of coordination in each region is 0.8977, and the median degree of coordination in each region is 0.9139, which is higher than the mean. It can be seen that the coordination degree of the two indicators of 21 cities (states) in Sichuan Province is not a normal distribution, but a left-biased distribution.

In addition, from the per capita GDP rankings of the cities (states) in Table 3, there is no inevitable connection between the coordination degree of GDP and the total retail sales of social goods and the level of regional economic development between cities. The coordination areas of Ziyan, Chengdu, Luzhou and Suining ranked in the top four, while their per capita GDP rankings were 7, 2, 12 and 14; the coordination of Yibin and Dazhou ranked in the last two, and their per capita GDP rankings are 9 and 17 respectively. It can be seen that there is no significant correlation between the coordination degree of indicators and the level of regional economic development.

4. Research Conclusions

Based on the business cycle theory, this paper makes a preliminary judgment on the coordination between the economic data of 21 cities (states) in Sichuan Province by using the time difference of index changes. On this basis, constructs the coordination degree measurement method based on the elasticity coefficient, and then Constructs a variable parameter state space model to empirically study the coordination of statistical data in 21 cities (states) of Sichuan Province, and draws the following conclusions:

Based on the analysis of business cycle theory, there is a certain degree of inconsistency and mismatch between the GDP growth rate of Sichuan Province, the industrial producer purchase price index and commodity retail price index.

Based on the analysis of variable parameter state space model, the coordination degree of 19 cities (states) in Sichuan Province showed an upward trend from 2000 to 2016, and the coordination degree of Yibin was the largest; only the coordination degree of Ziyan and Luzhou was decline.

The overall coordination degree of Ziyan, Chengdu, Luzhou and Suining is relatively high, and the overall coordination degree of Yibin and Dazhou ranks at the bottom. Judging from the overall situation of each region, the overall coordination degree of 21 cities (states) in Sichuan Province is slightly left-biased. According to the ranking calculation, there is no necessary connection between the coordination degree between the 21 cities (states) and the regional economic development level.

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