Multi-Dimension Monitoring System for Regional Economy: Exploration and Practice in Xinjiang Autonomous Region

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Abstract

Based on the concept of “economic cycle cube”, this research constructs the multi-dimension monitoring system for Xinjiang Autonomous Region. The system is able to monitor the main subjects of Xinjiang regional economy including economic growth, investment, consumption, trade, prices, industrial enterprises, coal industry and services, with the tools like diffusion index, composite index, signal lamp, comprehensive monitoring index and business cycle tracer. Then, this research tries to combine the different signals into a comprehensive views of economic trends presented in a unified platform. A decision support system is developed to connect the dynamic coming data, methods for generating index, interpretation of results, and insightful interface. The multi-dimension monitoring system has been used in the decision making and policy support by the Economic Research Academy of Xinjiang Uygur Autonomous Region Development and Reform Commission.

1. Introduction

Economic monitoring and early warning system based on business cycle technology have been successfully applied in many countries and regions, such as UN, IMF, OECD, the European Central Bank and CEPR (Centre for Economic Policy Research euro zone). A growing number of international conferences are focusing on the economic early warning. However, these applications are mainly based on sovereign countries, of which...
The economy is much more independent, and current researches rarely target for regional economy. Hence, this research is to establish an economic monitoring system to analyze and forecast the Xinjiang autonomous region’s economy.

There are some differences between regional economy and state economy. Firstly, a region can not have much independent economic policy, which would affect the selection of indicators. Regional economy tend to be less diversity, higher degree of specialization, and larger amplitude of economic fluctuations than state economy. Besides, the leading-lagging relationship for regional economy is much more instable, which makes it more difficult to screen the leading indicators. Therefore, the construction of monitoring and early warning system for regional economy is more challenging compared to state economy. Secondly, the economy monitoring requirements between the local government and central government is different. The central government mainly concerns about economic growth and price level. But as the executive of local government, many dimensions of the economy are concerned, especially the local industries. Hence, it is significant to build the monitoring and early warning system for regional economy.

Economic Cycle Cube is a new concept developed by the Economic Cycle Research Institute of the United States. It is a tool used by policy makers to establish monitoring and early warning systems to support the decision making. By establishing early warning indicators for the various themes of economy, Economic Cycle Cube makes it possible to explore the interaction and relationship among various economic dimensions. According to the perspective of systematic monitoring of endogenous economic fluctuations, it can achieve multi-dimensional monitoring and early warning.

Xinjiang is located in the northwest of China. The great-leap-forward economic development of Xinjiang can promote the social development and maintains stability in border areas. Besides, Xinjiang is a vast province with regional characteristics such as resource industry-oriented, multi-national border and so on. The regional economy of Xinjiang is affected greatly by the international and domestic market because of its large state investment and favorable policy. Therefore, the establishment of early warning system for Xinjiang economy, which could be in comprehensive and dynamic perspective to monitor and early warning the economy, is useful to make the central and regional government economic policies more timely and scientifically.

The rest of this paper is organized as follows. In Section 2 we introduce the related literature about the methods and application of early warning system. We also discuss the application of multi-dimension monitoring system. In Section 3 we analyze the user demand of early warning system and give the framework of multi-dimension monitoring system. In Section 4 we introduce the methods to construct monitoring system for Xinjiang province system including diffusion index, composite index, signal lamp, comprehensive monitoring index and business cycle tracer. In Section 5 we show the practice in decision supporting for Xinjiang Uygur Autonomous Region Development and Reform Commission.

2. Literature Review

Based on the relationship between economic indicators, it has a long history to build the monitoring and early-warning system for economy. Until now, the methods of monitoring the economy are constantly evolving and improving. In recent years, with the economic globalization, many developed countries and emerging market countries have strengthened the construction about the economic booming and early warning. Hence, we will review the literature about early-warning method and its application separately.

First of all, we review the development of theoretical methods. In practice, the study of economic leading indicators system began in the late 19th century. With the development of the capitalist economic and the increasing economic statistics, the statistics of the Western scholars carry out the research on economic leading indicators. Harvard index, which was calculated by Harvard University, predicted the economic volatility in the U.S. successfully during the 1920s. However, the judgment about the capitalist economic crisis led to the
failure of Harvard index. NBER (National Bureau of Economic Research) studied the time series of nearly 500 economic indicators to predict the economic turning points. From the early 1960s, the governments have joint the study of the leading indicators. With the development of the theory of economic cycles, Growth Cycle Theory replaced Classical Cycle Theory. Afterwards, some developing countries have begun to enter the field of research. Brazil, Japan, Singapore, China Taiwan, India, South Korea and many other countries and regions have established their own economic boom monitoring and warning system.

After the global financial crisis, the Western countries and international organizations, such as The UN, IMF, OECD[1], the European Central Bank, CEPR (Centre for Economic Policy Research Eurozone) dedicated to the research of the Economic warning and frequently explored the economic warning in the international economic conference. Moreover, more and more methods are applied to the study of economic monitoring and early warning. Dynamic factor model, which is introduced by Sargent and Sims [2] in 1977, have been used to analysis the economic structure of the system based on deep, invariant or structural factors. Mixed data sampling regressions (MIDAS) are introduced by Ghysels, et al.[3] in 2002 to forecast the volatility, which played an important role on the research of micro-finance. Multi-Dimension Monitoring System is the combination of a variety of methods including composite Index, diffusion index, signal lamp, comprehensive monitoring index and business cycle. However, these studies of economic leading indicators system are based on the country level. Now, the study of economic leading indicators system is expanded to regional economy and the development of companies. In China, the research on leading indicators began in 1988 and there are some research institutions and experts explored the theoretical and practical aspects of early-warning system, including the Institute of Systems Engineering in Jilin University, Custer economic evaluation centers and Dong Wenquan [4], Gu Haibing. National Bureau of Statistics and the state information center and other government departments introduced the leading indicators and try to build Chinese leading indicator system.

The corresponding theory constantly improved, which give a good foundation for practical application. Early-warning methods have played an important role in the field of economy analysis. Both developed and developing countries construct different system of leading indicators according to their economic characteristics. Regularly, countries will change their leading indicator system according to the changes in economic structure and the improvement of statistical system. However, the adaptability of the theories needs further discussion in China. Because of the incomplete statistics, many indicators used by the western countries are difficult to use in China. At present, China has established the leading indicators system, which can give theoretical support to the macroeconomic monitoring and early warning.

In China, the National Development and Reform Commission, the National Bureau of Statistics, China People's Bank, the State Information Center forecasts, local NBS / People's Bank branches, commercial banks, financial institutions have developed the economic monitoring and early warning system currently. Center for Forecasting Science of Chinese Academy [5-6] has established economic leading indicators system for Jilin, Zhejiang and Ningxia province. However, previous research only focuses on works on the economic growth and inflation. In this study, based on the economic characteristic of Xinjiang Autonomous Region, multiple subjects of economy are monitored including economic growth, investment, consumption, trade, prices, industrial enterprises, coal industry and services industry. Besides, we use multiple methods to monitoring the economy.

3. Framework of the Multi-Dimension Monitoring System

As the most important border region in China, Xinjiang is one of the main producers of natural gas, crude oil and coal and consequently has significant impact on China’s economy. With the deepening of Western Development Strategy and the corresponding support project of 19 provinces in China, Xinjiang’s economy grows rapidly and shows many different cyclacity characteristics over business cycle. Hence, it is of vital
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importance for policy-makers to set up the monitoring and early-warning system for regional economy. In this study, we build the multi-dimension monitoring system for Xinjiang province based on the following requirements. First, it is the requirement of macro-control and decision-making support for the local government. The multi-dimension monitoring system makes it possible for government to grasp the trend of economy more timely, deeply and comprehensively. Second, the increased uncertainty of international economic environment and the demand for reform in China propose higher requirement for regional monitoring and early-warning.

Therefore, according to the concept of “economic cycle cube”, this study constructs a multi-subjects and multi-methods monitoring system for Xinjiang. Multi-subjects indicate that the important dimension of economy will be monitored, including economic growth, investment, consumption, trade and prices. Besides, we also monitor the important industries in Xinjiang, including industrial enterprises, coal industry and services. Among them, the economic growth and prices are two most important subjects for regional economy monitoring. As the main drivers of economic growth, investment, consumption and trade can reflect the different characters of Xinjiang economy, compared with China’s economy as a whole. Based on the industrial feature of Xinjiang province, we select industrial enterprises, coal industry and services as the main subjects to monitor. The reasons are as follows. Firstly, the development of industry and service is the main driving force for sustained development and economic modernization in Xinjiang. Secondly, Xinjiang is rich in energy. It is forecast that Xinjiang’s coal reserve is 2.9 trillion tons, accounting for approximately 40% of China. Hence, it is of significance to construct monitoring system for Coal industry, which makes it easier to grasp the prospect of energy industry.

Multi-methods indicate that many different methods are used to monitor different subjects, including diffusion index, composite index, signal lamp, comprehensive monitoring index and business cycle tracer. We construct the multi-methods monitoring system based on the following reasons. Firstly, robustness, which means the outcome of different methods can check with each other and improve the reliability of results. For the different results of each method, the system users can analyze the outcome discreetly and avoid dogmatism errors. Secondly, comprehensiveness, which indicates that many methods constitute as a whole and display the result completely. For example, leading/coincident/lagging diffusion index focus on the qualitative judgment of reference series while composite index concern more about the quantitative change. Signal lamp and comprehensive monitoring index describe the changes of reference series during long time period. While business cycle tracer illustrates the phase of reference series over business cycle on each time spot. More importantly, these methods interrelate with each other and constitute as a whole to monitor the economy comprehensively.

Hence, this research develops a computer support system, which is "monitoring and early warning system for Xinjiang province”. It is a platform for integrated monitoring and comprehensive early warning. The system consists of four modules, system management, data management, scenario analysis and display layer. System management module is designed for system administrators to manage the entire system, including user access control, process configuration, display configuration and so on. Data management module is the foundation of the system. Its main function is to initialize and manage all types of data in the database, including external data and internal data. Scenario analysis module is responsible to analyze the data and configure the model for each topic or subject, so as to enable the comprehensive monitoring. Analysis tools, theme analysis, correlation analysis and comprehensive analysis are included in this module. Apparently, it is the most important part to achieve qualitative and quantitative analysis for all subjects. Display layer module provides a display platform for all the monitoring and early-warning models and results. It directly shows the assumption, outcome, risks of the forecast without complex model and calculations. The purpose of display layer is to display the results of monitoring to experts and governors for decision making support.
The framework of “monitoring and early warning system for Xinjiang province” is shown in Fig 1. In this study, we construct the multi-dimension monitoring system for Xinjiang and develop the computer support system.

![Framework of “Monitoring and Early Warning System for Xinjiang”](image_url)

Fig. 1. Framework of “Monitoring and Early Warning System for Xinjiang”

### 4. Construction of Monitoring Instruments

Based on the framework we illustrated before, we construct different monitoring instruments for multi-dimension in Xinjiang province in this section, including diffusion index, composite index, signal lamp, comprehensive monitoring index and business cycle tracer. Besides, the regional features of indicator-screening for Xinjiang economy are shown in the first part of this section.

#### 4.1. Leading-lagging relationship in Xinjiang’s economy

The completeness of database plays a decisive role in indicator screening process. Hence, in this study we build a large database consists of 942 indicators from 14 fields, including industry performance, energy production, financial and monetary, animal husbandry and fishery, price index, foreign trade, income and expenditure of residents, investments, employment and wages, real estate, consumption and fiscal income and expenses. The indicators cover the condition of China economy as a whole and Xinjiang’s regional economy.
and characterize all aspects of economy, which provides a good foundation for data analysis. In order to screen the indicators more precisely, we divide the screening process into two steps. In step 1, we select the indicators by time difference analysis, KL analysis and BB algorithm analysis. If the results of the three methods consistent with each other, we will further to step 2. Based on step 1, we carry on peak-trough graphical analysis in step 2. If the peaks and troughs of the indicator stably precede the benchmark, we select it as a leading indicator in our monitoring system.

Due to the different development stage and culture backgrounds, the early-warning indicator system varies among countries and regions. Hence, it is of vital importance to take regional economic features into consideration when screening indicators. As one of the most important frontier provinces and one of the main producers of energy in China, Xinjiang economy has its own cyclicality feature compared with China economy as a whole. Therefore, we screen indicators for Xinjiang base on its regional features as well as its association with national economic situation.

4.2. Diffusion Index and Composite Index based on Leading Indicators

In this section, we build early warning indicator system for each subject based on the leading/lagging indicators we screened. We describe the regional economic development mainly by diffusion index and composite index in this part. Diffusion index is calculated as the number of expanding indicators as a percentage of all indicators in the system. It can make it possible for users to do qualitative judgment of reference series. However, composite index can not only predict the turning point of fluctuations but also reflect the quantitative changes of business cycle. The two indices can interact with each other to describe the fluctuation of economy.

The diffusion indices and composite index for 8 subjects are shown in Fig 2 and the series are end in December 2012. The leading periods of diffusion index changes among different subjects. For economic growth, trade, industrial enterprise, coal industry and services, the leading diffusion index precedes the reference series 5 to 8 months. The leading periods for consumption is much longer, which is 9 to 14 months. However, the leading diffusion index for investment is only 3 to 4 months in advance. As an expansion rate, the diffusion index has a threshold at 50%. If it is greater than 50%, the economy may in the upswings stage while in the downswings stage if it is lower than 50%.

Different with diffusion index, composite index is an average index of selected indicators, weighted by the change magnitude of each indicator. Hence, it can not only predict the turning point of reference series, but also reflect the quantitative of business cycle. Similarly to diffusion index, the leading and lagging periods for composite index are also different among subject Leading composite index for most subjects are 5 to 8 months ahead of the reference series. Consumption has the longest leading periods and it can predict the fluctuations 9 to 12 months in advance. However, investment has the shortest leading periods for 3 to 4 months. Actually, different leading periods illustrate the different characteristics of the eight aspects of economy. Investment is most easily to influence and drive by its leading indicators. The real economy, which mainly includes economic growth, trade, industrial enterprises, coal industry and services, is affected much slowly by the leading indicators. Consumption is the slowest subject to be affected. The extended explanation is meaningful. On one hand, it is a long process to cultivating consumption and it requires stable policy to maintain the trend. On the other hand, investment, which is the main measures for Chinese government, can stimulate the economic growth more efficiently. Therefore, the adjustment of economic structure is difficult because of the different characteristics of consumption and investment.
4.3. Signal Lamp and Comprehensive Monitoring Index

In order to describe the changes of reference series during long time period, we construct signal lamp and comprehensive monitoring index in this section. Signal lamp is a kind of warning lights for the economy base on some important macroeconomic indicators selected. It can present the state of each macroeconomic indicator and combines them together to judge the state of current economic situation. The colors of the lights indicate the state of the indicators. For instance, dark blue, light blue, green, yellow and red lights represent cold, turning cold, normal, turning hot, and hot respectively. If the signal lamp becomes blue, the policy makers should take some measures to stimulate the economy. And if the signal appears to be red, it is wisdom to slow down the economy to stabilize the business cycle. Because of the simplicity and visualization of signal lamp, it provides useful information for policy makers to get knowledge of the economic situation directly and rapidly.

Fig 3 shows the signal lamps and comprehensive monitoring indices for 8 subjects separately. We select the explanatory indicators from leading indicators and consistent indicators screened in section 4.2. For example, the indicators of signal lamp for economic growth include CPI of Xinjiang, import and export, electricity production, crude oil production, industrial added value and investment in fixed assets. These variables cover the main sectors in economy including price, trade, industry, energy industry and investment, and reflect the condition of economy comprehensively.

Based on the construction of signal lamp, comprehensive monitoring index is calculated by weighted sum of the indicators in signal lamp. As supplements of diffusion index and composite index, signal lamp and comprehensive monitoring index not only portray the situation of economy overall, but also make it possible to distinguish which aspect of economy causes the current problem. Besides, by establishing different signal lights for different subjects, we can make cascade analysis between subjects and investigate the economic problem deeply.
4.4. Business cycle tracer

Signal lamp and comprehensive monitoring index describe the changes of economy during long time period. While in order to illustrate the phase of reference series over business cycle on each time spot, we should come to business cycle tracer for help. Business cycle tracer is a popular monitoring method used by some international monitoring organizations. It can trace the main changes of key indicators in the economy. The object of business cycle tracer is the cyclical component of economic indicators after seasonally adjustment. The horizontal axis indicates the how far the current month level of indicators above or below the historical average and the vertical axis indicates the increase or decrease amplitude of current month compared with the last month. Hence, the four quadrants stand for four stages of business cycle, in which the first quadrant (in the upper right) indicate prosperity stage, the second quadrant (in the upper left) indicate recession stage, the third quadrant (in the bottom left) indicate depression stage and the forth quadrant (in the bottom right) indicate recovery stage. The principle of the quadrants is easy to understand. For example, indicators in the first quadrant are above the average and still increase compared with last month. It is in the prosperity stage.

Fig. 3. Signal Lamps and Comprehensive Monitoring Indices for the Eight Subjects

Note: The sequence of the first column is economic growth, investment, consumption and trade. The sequence of the second column is prices, industrial enterprise, coal industry and services.
According to the principle, the indicators will do counter-clockwise movement repeatedly. Therefore, we can judge the state of each indicator based on their position in the business cycle tracer and make corresponding policy based on the changes of key indicators.

Fig 4 illustrates the business cycle tracer for 8 subjects. Most of the reference series of the subjects for Xinjiang economy will do counter-clockwise in the cycle tracer, which indicates that they have a cyclicality feature. The line in the graph traces the change of 8 subjects from June 2012 to December 2012. Specifically, economic growth goes from the forth quadrant to the first quadrant during this period, which indicates that economy experiences gradually recovery from the trough few months before. Investment and consumption are both in the downside period. The difference is that investment is still above the historical average while consumption shifting from the recession stage to the depression stage. The prices in Xinjiang move to the recovery stage and begin to rise. The outcome of business cycle tracer shows the same trend as the diffusion index, composite index and comprehensive monitoring index.

![Business Cycle Trace for Eight Subjects](image)

**5. Practice in Decision Supporting**

Multi-dimension monitoring system provides not only the operating layer, but also the presentation layer. The operating layer includes system management, data management, basic analysis tools, model configuration, theme analysis, boom predicted and presentation layer configuration. The analysis of the results can be obtained in the presentation layer. The final analysis and comprehensive conclusions will be presented for the system user. Multi-dimension monitoring System has played an important role in the decision making support in Xinjiang province.

Economic Research Academy of Xinjiang Uygur Autonomous Region Development and Reform Commission has undertook macroeconomic monitoring and early warning based on the system we construct in this study. Seven policy reports have been completed based on the analysis of the system and have submitted to the relevant government departments. Besides, the multi-dimension monitoring system also makes contribution in annual reports of Xinjiang economy, which are publicly issued to support the decision making of central government, Xinjiang local government and even companies and the ordinary people.
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