Spatial Measurement of Regional Capacity in China Based on Static and Dynamic Spatial Panel Econometric Model

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Abstract. Spatial econometrics came into being in the 1970s. The reputation of spatial econometrics has become more and more popular after that. It attracted many scholars at home and abroad. After years of research, space metrology has gradually matured. Compared with traditional econometrics, spatial econometrics uses spatial correlation to combine some seemingly independent individuals to build a spatial model to help researchers carry out detailed data analysis through a certain relationship. In this paper, it summarizes the theory of spatial econometrics and the differences between spatial econometrics and traditional econometrics. Then, an economic model is established by using spatial econometrics to study the regional production capacity of China based on the static and dynamic spatial panel.

Keywords: Capacity, Spatial Measurement, Economic Model

1. Introduction

We find that in the study of regional issues, the spatial relevance between regions is not allowed to be ignored after doing a lot of investigation[1]. I remember that someone said that as for all the data problems about spatial regions, we can find that all of them have spatial dependence and spatial autocorrelation after sorting out these data[2]. So I think that the same is true for the study of China's regional production capacity. However, production capacity is an abstract concept, which can not be directly measured by human or computer software[3]. Therefore, we need to use the estimation of TFP to measure regional production capacity. Then we can use the static spatial panel to build models for data analysis. But, because the data of static model analysis may have some errors, we will use the dynamic spatial panel to build the same model again to carry out the general deviation correction, and analyze and study the regional productivity in China.

2. Theoretical generalization of spatial econometrics
2.1. Origin and development

The concept of spatial econometrics was firstly put forward by paelinck in 1979. However, the measurement system was not completed at that time, only the basic framework was constructed. The burgeoning spatial econometrics was appeared. It mainly used Moran index test methods, including spatial correlation test, the establishment of spatial econometric model and spatial model estimation and so on[4]. After anselin and others' research and development of space metrology, a relatively complete framework system of space metrology was gradually formed in 1997[5]. It’s said that the 1990s was the era of rapid development of space metrology. Compared with the embryonic period, the metrology in this era was formal and strict, and various methods of model building gradually appeared. With the rapid development of computer technology, it provides an effective research tool for space metrology, and the model setting system is gradually improved. During this period, a variety of measurement software was formed, and the existing statistical measurement software also increased the software package of spatial correlation statistics.

Spatial econometrics has been widely recognized after entering the 21st century. It has achieved great development because of many people's research[6]. In recent years, it began to enter the mainstream of Econometrics from the edge, and also involved in regional economics, urban and real estate fields. Foreign scholars call it the standard data analysis tool of international economics, international politics and resource environment. Generally speaking, modern spatial metrology has developed rapidly, and its position in the world has been gradually recognized. Some mainstream economic magazines and newspapers have successively appeared articles about spatial metrology. Some countries' economics textbooks also contain many special courses and chapters of space measurement, which guide students to discover and explore the mystery of space measurement.

2.2. Key research fields of spatial econometrics

①Regional economic development and trade circulation

Many studies have shown that in the field of economic research, the impact of spatial factors on economic and trade development cannot be ignored. Therefore, the research in this field of metrology is in a state of accelerated development, the research shows that it has a lot of gains. Most scholars use the method of dynamic and static panel to analyze data. The results show that this method plays an important role in the analysis of trade development.

②Technological innovation and development

In the development of spatial metrology, many scholars have found the spatial correlation in innovation activities. Many experiments show that there is a positive correlation between the growth of scientific and technological innovation and spatial data distribution in a region. It is called aggregation phenomenon in the field of economics. In the later research, scholars found that spatial econometric method can be used to establish a model for data analysis and research, relying on this way can easily explore the development and innovation of science and technology in a region.

③Development of regional environment and agriculture

With the increasing application of space metrology, scholars have opened up new space for the development of space metrology in the field of environment and agriculture. Due to the spatial dependence between geographical proximity and climate change, it is obvious that agricultural development can be estimated by using the method of establishing models. In addition, it can also
study and measure the lease rate of farmland, which can make a great contribution to the comprehensive development of farmers' economy and agriculture.

As for space measurement, the above regional nature of the research area is relatively developed. In addition, we can also study some closely related issues, such as employment, medical care, personal income, housing price statistics and so on. In a word, the research scope of spatial econometrics is becoming more and more extensive.

3. Spatial measurement of regional production capacity in China based on static and dynamic panel

3.1. Comprehensive “Moranl” index and scatter plot method
Our aim is to study the total factor productivity of a region, and to deduce the regional capacity situation. The first thing we need to do is to understand the spatial correlation of regional productivity and the degree of data correlation about the survey. It can be seen from the literature that we can use the correlation index of “Moranl” spatial statistics to make the theoretical spatial correlation clear. Spatial statistical correlation index can be defined as:

\[
\text{Mordanl} = \frac{n \sum_{i=1}^{n} \sum_{j=1}^{n} \omega_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n} \sum_{j=1}^{n} \omega_{ij} \sum_{i=1}^{n} (x_i - \bar{x})^2}
\]

where \( \omega_{ij} \) is the spatial weight between the \( i \)-th and \( j \)-th space units, \( n \) is the total number of space units. When the value of Mordanl index exceeds 0, it means that the calculated data is the positive correlation of space, and when it is less than 0, it means that it is the negative correlation of space. The size of its absolute value indicates the degree of spatial correlation. In general, though the spatial measurement correlation index, we can see the aggregation type and characteristics of the local space of the data.

3.2. Spatial panel economic model
After checking the spatial correlation of the data, what we have to do is to establish a preliminary economic model for data analysis. Spatial panel measurement model is usually divided into static model and dynamic model. Researchers usually use cross-section data, that is the mean of many years' data to build the model, or through the combination of data and time series, to build a static panel spatial measurement model. People used this method because the section space model is relatively simple and the data measurement is also very time-saving at that time. However, it was found that the data measured by the static panel was not accurate, so the dynamic panel model was used to correct the data. Therefore, many people often use the combination of dynamic and static models for experimental research. The common formulas of spatial econometric model are:

\[
\begin{align*}
\text{SAR - PANAL} \quad Y_t &= \pi Y_{t-1} + \rho W Y_t + X_t \beta + \psi_t \\
\text{SEM - PANAL} \quad \psi_t &= \delta W \psi_t + \epsilon_t
\end{align*}
\]

“\( Y (i) \)” represents the “\( N \times 1 \)” vector group composed of the observation values of the explanatory
variables of each spatial unit in t period, and X (t) represents the matrix group of “n×k”. When τ = 0, 𝜉 (it) = 0, it is suitable to establish non spatial static spatial data economic model. When τ = 0, 𝜉 (it) ≠ 0, it is suitable to establish a static spatial data economic model. When τ ≠ 0, 𝜉 (it) ≠ 0, it is suitable to establish a dynamic spatial economic model. This study establishes a dynamic and static economic model for data research.

3.3. Estimation of spatial panel model

Researchers generally believe that the least square method should be used to estimate the model in any research. However, as for regional productivity measurement, the least square method is not suitable, and the maximum likelihood method can effectively solve this problem. Nerove's viewpoint formula is used to perform the first-order difference regression equation, and then the log likelihood function equation is obtained again:

$$
\log L = -\frac{NT}{2} \log (2\pi \sigma^2) + \frac{T}{2} \sum_{i=1}^{N} \log (1 - \delta \omega_i) - \frac{1}{2} \sum_{i=1}^{N} \log \left[ 1 - T + \frac{2}{1 + \tau} (1 + \tau^{2m-1}) + T \left( \frac{1 - \tau^m}{1 - \tau} \right) \beta \sum \delta \omega \right] (1 - \delta \omega_i)^2 - \frac{1}{2\sigma^2} \Delta e^* \psi H^{-1} \psi^* \Delta e^*
$$

$$\Delta e^* = \begin{pmatrix}
B \left( \Delta Y_1 - \pi Y_1 \right) \\
\Delta Y_2 - \tau \Delta Y_1 - \Delta X \beta \\
\vdots \\
\end{pmatrix}
\quad E \left( \Delta e^* \Delta e^*^T \right) = \sigma^2 H_{n\ell}
$$

After the formula is calculated, we also need to determine the variable data appearing in the study.

4. Variable data analysis

4.1. The basic establishment of weight matrix

As for regional TFP, we can divide the provincial regions into many regions, and then consult the literature and data to find out the growth of TFP in recent years. After that, we can draw the chart according to the data situation, which helps us to find the basic situation of the data conveniently. It paves the way for the establishment of spatial weight matrix and represents the interdependence between spatial elements.

4.2. Data source analysis

First of all, we should know that TFP refers to the productivity of all factors of production, so this kind of information can be found on the Internet. Therefore, we plan to divide 31 provinces (autonomous regions, municipalities directly under the central government) into four regions: central, northeast, west and north. Then through the reading of online data, the regional productivity data in recent years are collated.

5. Conclusion

First of all, we have carried out the regional autocorrelation test. After the calculation of “Moranl” index, we have mastered its specific changes, as shown in the fig1.
Figure 1. Regional TFP survey data

According to the fluctuation of data, we draw the scatter diagram of “Moranl” index, as shown in the fig2.

Figure 2. M-index scatter plot

"E" represents the eastern region, "C" represents the central region, "W" represents the western region, "NE" represents the northeast region. After drawing the scatter diagram, we build the non spatial static economic model, the static economic model and the dynamic economic model. The data generated by these three models is shown in Fig 3, Fig 4 and Fig 5.
Figure 3. Non spatial static economic model

Figure 4. Spatial static economic model

Figure 5. Spatial dynamic economic model

From the analysis of the above data, we can know that the economic structure of the western region is well adjusted with the support of national policies, while the eastern region has not changed much. However, in recent years, in addition to the northeast, the productivity of the other three regions has increased significantly. The change of regional productivity is the same as that of regional productivity, so we can also analyze the change trend of regional productivity.

We have also learned that the difference between the production capacity of the central and western regions and that of the northeast is too large, which leads to overcapacity in the central and western regions. We cannot ignore that if we do not manage overcapacity, it may affect the capitalist market. It
may seriously lead to the disorder of China's financial system structure and unstable balance between finance and industry, which is not conducive to China's future development. Therefore, I suggest that regional production capacity can be reduced slightly and the relationship between regional production capacity and human society can be balanced as soon as possible. In addition, the state can make use of policies to vigorously develop the northeast areas with backward production capacity and economy, which can vigorously promote the development of national economy.

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