Comprehensive Evaluation of Mainland of China’s Openness Since China Joined the WTO

Qi-Yun HUANG\textsuperscript{1,2,a} and Jing-Yuan JIANG\textsuperscript{3,b}

\textsuperscript{1}Institute of Economics, Chinese Academy of Social Sciences, Beijing 100836

\textsuperscript{2}Innovation Center for Technology, Beijing Tsinghua Tongheng Urban Planning & Design Institute, Beijing 100085

\textsuperscript{3}Institute of Management, Capital Normal University, Beijing 100048

\textsuperscript{a}2483637514@qq.com, \textsuperscript{b}jiangjingyuan@sina.com

Keywords: Openness; Comprehensive indicators system; Entropy method; Cluster analysis; Spatio-temporal analysis.

Abstract. Economic globalization has become the trend of the 21st century. Since China joined the World Trade Organization in 2001, it has entered a stage of rapid integration into the globalization of the world economy. This paper constructs comprehensive indicators system about Chinese Mainland regional openness to the oversea market since China joined the WTO. We use the entropy method to calculate the score of the relevant evaluation index system, and then give empirical analysis by clustering method and space-time analysis to compare the characteristics and relationships of the opening up between different regions. We also analyzed the characteristics of the evolution and the interaction of economic opening up between adjacent regions. The results of the analysis show that the accession to the WTO has promoted the improvement of the economic opening up level in various regions of the Chinese mainland and upgraded the open type; those areas with good industrial base and open tradition have improved rapidly; but the 2008 financial crisis has had a huge impact on the openness of the Chinese Mainland regions. It also proved that the interactive effects between the coastal areas and its nearby inland regions existed. However, the differences between China's various regions are large, and the economic openness changes in the central and western regions are relatively small.

Introduction

The degree of openness is a comprehensive indicator to measure the opening up of a country or region's economy, and is also an important criterion to judge the integration of the country or region into economic globalization. China began to promote the market economy and open to the outside world since 1980s, and introduced a large number of foreign-invested enterprises in 1990s. In particular, since China joined the World Trade Organization (hereinafter referred to as WTO) in 2001, the degree of economic openness has been rapidly improved, and China has entered a new stage of rapid integration into the globalization of the world economy. Through constructing the openness indicators system with relevant indicator data reflecting China's integration into economic globalization, this paper scientifically evaluates the state and analyzes the characteristics, types of economic openness of the provinces and municipalities in mainland China by using the entropy method. This paper also use the spatio-temporal model to analyze the evolution of different types of openness and the economic openness interaction between adjacent regions in various regions in Chinese mainland (excluding Hong Kong, Macao and Taiwan).

At present, there are many literatures on economic openness. However, there is still no relatively well-established conclusion, and there are even different definitions that differ greatly, which are divided into broad definition and narrow definition. The definition in narrow sense mainly measures the economic openness from three aspects including trade openness, financial openness and investment openness. The definition in broad sense includes, in addition to the above narrow definition, broader scopes and metrics such as production openness, technology openness, and staff...
mobility. In the empirical research, we can choose different indicator systems of openness according to the research purpose. This paper selects the narrow definition of economic openness to construct the evaluation indicator system, because it has been widely recognized, and it is easier to find relevant indicator data.

**Openness Indicator System**

**Measurement of Openness**

In the empirical research, the indicator system of openness can be selected according to the research purpose among different indicator systems. This paper chooses the narrow definition of economic openness to construct the evaluation indicator system.

**The Openness Indicator System**

This paper constructs an openness indicator system from three aspects including trade openness, financial openness and investment openness based on the indicator system construction principles of systematization, effectiveness, scientificity and operability. In order to eliminate the influence of different economic size of various regions on evaluation system, this paper selects relative indicators such as proportion and per capita value to avoid this problem.

**Data Source**

The data in this paper are all quoted from the 2001-2017 China Statistical Yearbook. The relevant statistical data on the yearbook are calculated to obtain relevant indicator data according to the constructed indicator system.

**Measurement Model and Analysis Method**

**Measurement Model**

In the empirical analysis of the comprehensive evaluation indicator system, the weight determination of the indicator system is one of the key links in addition to the reliability of the data. In the measurement of the comprehensive indicator system, the weight determination of each indicator is also one of the key points in addition to the correlation between the various variables in the indicator system. The methods for determining the weight of indicators mainly include subjective weighting method and objective weighting method. The subjective weighting method generally assigns weight to each variable of the indicator system based on experience. The objective weighting method usually assigns weight to the indicator variable according to the difference of distribution of the indicator variables, which can eliminate the subjective factors of artificially determining the weight and make the weight of the indicator system more scientific.

One of the most commonly used methods of objective weighting is the entropy method. The principle of entropy method is as follows. The less the difference of distribution of the indicator data is, the higher the information entropy value is, so the internal difference of the system is smaller, or we could say that, the system changes slower, the influence of the internal variables of the system on the system is less, then the smaller weight value is assigned to the corresponding indicator variable. On the contrary, The bigger the difference of distribution of the indicator data is, the lower the information entropy value is, that means the system structure is more unbalanced, the internal difference is larger, or we could say that, the system changes faster, the system is unstable, the influence of the internal variables of the system on the system is larger, then a greater weight value is assigned to the corresponding indicator variable.

**Analytical Method**

This paper mainly conducts an empirical analysis of the economic openness of the Chinese mainland (excluding Hong Kong, Macao and Taiwan) from the perspectives of the regional ranking, openness types, characteristics and the evolution of openness types by analyzing the indicator score values. Specifically, the main focus of the analysis is on the following three aspects.
Firstly, comparison of indicator scores (ranking analysis), which mainly analyzes the comprehensive scores of the openness indicator and regional rankings in various regions, then judges the regional differences in openness.

Secondly, openness type analysis (cluster method), which mainly analyzes different types of openness and their characteristics in different regions.

Thirdly, Regional interaction analysis (Spatio-temporal analysis), which mainly analyzes the evolution of the openness types of various regions, so as to observe whether there is an economic opening linkage effect between regions and the economic openness radiation effect of the regions with high openness to the surrounding areas.

An Empirical Analysis of the Opening of the Economy of Mainland China after Entry into the WTO

On December 11, 2001, China formally joined the World Trade Organization (WTO) and became its 143rd member. 2001 is also the key time node for this paper.

Data Selection

This paper selects the relevant openness indicator data one year before China's accession to the WTO (2000) as the base period of comparison, and examines the economic opening indicators of the provinces and municipalities in mainland China (excluding Hong Kong, Macao and Taiwan) from 2001 to 2016 for an empirical analysis. The data comes from China Statistical Yearbook from 2001 to 2017.

Indicator Screening

In the early stage of formal empirical analysis, the correlation test of the indicator data should first be carried out to eliminate the indicators with high correlation value with other indicators so as to solve the related correlation problems. Due to the limitations of data acquisition and the relevance of macroeconomic data, the screening criteria for correlation test values are temporarily raised from the general 0.50 to 0.70. Although the proportion of exports to GDP is highly correlated with the proportion of foreign-invested enterprises' total liabilities to GDP and the proportion of the total amount of fixed-asset investment of foreign-invested enterprises to fixed-asset investment, it is not highly correlated with other indicators, and export is an important judgment indicator for some economic extroversion in China, so this indicator is temporarily retained and other indicators of investment openness that are highly correlated with it are excluded.

According to the preliminary autocorrelation test (Pearson correlation text) results, the above indicators are screened by excluding four indicators with high correlation with most indicators.

Related Model Indicator Measurement and Calculation Results

This paper has processed 454 raw data of 10 statistical indicators related to 6 indicator variables of the 3 types of indicators from 2000 to 2016 according to the calculation method of entropy method and obtained the comentropy, redundancy and weight value of the 6 indicator variables, which are shown in the following table.

From the weight ranking of indicators, the order from large to the small are successively the import value as a share of GDP (0.3008), the export value as a share of GDP (0.2008), the proportion of actual use of foreign capital in the amount of capital formation (0.2004), the proportion of total fixed assets investment of foreign-invested enterprises to fixed assets investment of the whole society (0.1477) and the proportion of total liabilities of foreign-invested industrial enterprises to GDP(0.1468). This shows that the proportion of imports and the proportion of exports are the main factors to evaluate the economies of China and other regions after China's accession to the WTO. Especially in the context of China's implementation of "export-oriented" economic policies, the proportion of imports reflects the confidence of China’s economic openness.
Table 1. Weighted Results of Relevant Indicators for the Openness Indicator System under Entropy Method.

<table>
<thead>
<tr>
<th>Indicator categories</th>
<th>Indicators</th>
<th>Comentropy</th>
<th>Redundancy</th>
<th>Indicator weight value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade openness</td>
<td>Export value as a share of GDP</td>
<td>0.923132066</td>
<td>0.076867934</td>
<td>0.200793482</td>
</tr>
<tr>
<td></td>
<td>Import value as a share of GDP</td>
<td>0.884838203</td>
<td>0.115161797</td>
<td>0.300824245</td>
</tr>
<tr>
<td>Financial openness</td>
<td>The proportion of total liabilities of foreign-invested industrial enterprises to GDP</td>
<td>0.943820027</td>
<td>0.056179973</td>
<td>0.146752641</td>
</tr>
<tr>
<td>Investment openness</td>
<td>The proportion of total foreign investment in fixed assets to total investment in fixed assets of the whole society</td>
<td>0.943462691</td>
<td>0.056537309</td>
<td>0.147686071</td>
</tr>
<tr>
<td></td>
<td>The proportion of actual use of foreign capital in the amount of capital formation</td>
<td>0.9232943</td>
<td>0.0767057</td>
<td>0.200369697</td>
</tr>
<tr>
<td></td>
<td>The proportion of foreign registered capital of foreign-invested enterprises to the total registered capital of foreign-invested enterprises</td>
<td>0.99863185</td>
<td>0.00136815</td>
<td>0.003573864</td>
</tr>
</tbody>
</table>

Data Source: China Statistical Yearbook, 2001~2017

The Evolution of China's Economy's Opening from 2000 to 2016

Through the above entropy method, the individual indicator scores and comprehensive scores of the economic openness of various regions in mainland China in 2000-2016 can be obtained, and relevant overall analysis and structural analysis can be carried out.

Figure 1. China's Mainland Economic Opening before and after China's Accession to the WTO in 2000-2016.

Data Source: China Statistical Yearbook, 2001~2017

From the national average level of China's economic openness under the entropy method, both the comprehensive level and the individual trade openness, financial openness, and investment openness have experienced a process of sharp increase in 2002-2006 after China joined the WTO, peaked in 2005-2007, and then entered the decline phase after the 2008 financial crisis. With the global financial downturn caused by the financial tsunami in 2008, countries began a trade war, China's export trade decreased, some foreign-invested enterprises withdrew from China, some manufacturing industries in China’s coastal areas moved to Southeast Asia. Both trade openness and investment openness of China have declined rapidly and entered the downward channel. The comprehensive level of the indicator system has even appeared to be less than the pre-WTO level.
This shows that the 2008 financial crisis has severely affected the opening up of the Chinese economy. The year 2008 has become a watershed in the trend of China’s economic opening up.

Judging from the economic openness of various regions in China under the entropy method, the trends of the openness indicator in most regions are similar to the national average, which first rose in 2002-2007 and showed a downward trend after the global economic downturn in 2008. A rebound phenomenon occurs in Shanghai, Beijing, Fujian, Chongqing, Zhejiang, Liaoning, and Tibet Autonomous Regions, but most of them are in a depressed slumping downtrend and have not recovered to the level before the 2008 financial crisis, and even lower than the 2000 level before China joined the WTO.

![The comprehensive level of economic opening-up of various regions of China's Mainland before and after accession to the WTO in 2000-2016](image)

Figure 2. The Comprehensive Level of Economic Opening-up of Various Regions of China's Mainland before and after China's Accession to the WTO in 2000-2016.

Data Source: China Statistical Yearbook, 2001~2017

Fig. 2 shows that the national average and the economic opening-up of various regions in mainland China have been greatly improved in 2002-2007 after China's accession to the WTO, but has entered a long-term decline channel subject to the impact of the financial crisis in 2008, and even appears to be less than the level before China joined the WTO. This shows that the level of economic opening up of a country or region is deeply affected by the world economic situation. When the world economy is prosperous and world economic activity is dynamic, the economic openness degree of a country or region will increase rapidly and remain at a higher level. On the contrary, if the world economy is sluggish and world economic activity shrinks, the economic openness degree of a country or region will drop rapidly and may stay in the downward channel for a long time, making it difficult to get out of the trough.

The above-mentioned economic opening-up trend analysis shows that joining the WTO has greatly enhanced the level of economic opening up in Chinese mainland. The 2008 financial crisis has brought a significant shock on the opening up of the Chinese mainland economy.
The Economic Openness Level Rankings of Various Regions

Here, the author selects several key time nodes of economic openness comparative analysis to analyze the rankings of economic opening-up in various regions. These key time nodes are the year 2000 which is the year before China's accession to the WTO (the base period for comparative analysis), the peak year 2007 after joining in the WTO, the bottom level year 2009 after the 2008 economic crisis and the year 2016 which can reflect the latest situation.

From the comprehensive rankings of the four key annual economic opening degrees before and after China's accession to the WTO, the rankings in the coastal areas have changed greatly. We could see that, Shanghai's ranking in the coastal areas has rapidly increased to rank first, and soon surpassed Beijing and Guangdong province, which has always ranked first. Instead, the rankings of provinces of Guangdong, Fujian and Hainan, which were previously in the forefront, have declined. The rankings of provinces and municipalities of Jiangsu, Zhejiang and Chongqing, which are non-coastal areas but have more developed water transportation and better industrial economic base, are constantly improving and their status is becoming more and more prominent. Among them, the ranking of Jiangsu Province has declined due to its outstanding export to the EU and the fact that it has been also deeply affected by the 2008 financial crisis. The ranking of Zhejiang Province has increased steadily and has risen from the ninth place in 2000 before the financial crisis to the fifth in 2016 due to its open strategy of relatively balanced development and the fact that it has been less affected by the 2008 financial crisis. The rankings of the Tibet Autonomous Region and Guizhou province, which are economically backward in the northwest, have been in the doldrums and have not changed much.

Judging from the reasons for ranking changes, the coastal areas of Chinese mainland and the regions with better industrial bases and more comprehensive development have higher economic openness and have gained rapid growth after China's accession to the WTO. The rankings of Beijing and Tianjin have declined after the WTO accession. The ranking of Beijing has risen in the following years, but that for Tianjin has not changed and still in a lower level. The economic openness of Shanghai has quickly surpassed Beijing and Guangdong Province to rank the first in the country with its consistent open tradition, solid industrial foundation and good talent accumulation. The economic openness indicator of Guangdong Province has declined due to foreign capital withdrawal, economic transformation and industrial transfer after the financial crisis. Due to the trade-oriented open economy, Jiangsu Province was deeply affected by the 2008 financial crisis and its ranking declined. Zhejiang Province was less affected by the 2008 financial crisis due to balanced development and its ranking has improved. The economic openness of the regions with good industrial bases, which include Henan Province in the central region, Shaanxi Province and Chongqing Municipality in the west and Liaoning Province in the northeast, have improved significantly after China's WTO accession due to its foreign investment absorption and opening up to the outside world, especially in the process of undertaking industrial transfer and industrial upgrading after the 2008 financial crisis. The economic openness of the provinces such as Shandong and Hunan, which have certain industrial bases but small changes in open policies and slow industrial upgrading, have not changed much in the country. Xinjiang Uygur Autonomous Region ranks middle and lower in the country in terms of economic openness due to its increasingly active border trade and oil and gas trade with Central Asia for more than a decade, far ahead of the neighboring western regions.
Open Type Evolution Analysis (Cluster Analysis)

The more scientific method for the classification of the results of the comprehensive indicator system is to use the clustering method. Based on the distribution characteristics of various indicators of the indicator system, the clustering method classifies the matrix of related indicator data according to their similarities. By classifying each classification object and giving relevant indicator values for each category, it is possible to extract the characteristics of each category more scientifically and reasonably. Here, the author still selects several key time nodes of the economic opening-up analysis to carry out cluster analysis of the types and characteristics of openness. The higher the type is, the higher the level of the type is, and the higher the openness degree is. For example, the first type in a certain year is the highest level in the year, its economic openness comprehensive index system has the highest score and its openness degree is the highest.

The results of cluster analysis reveal the evolution of the type of opening up of the Chinese mainland economy.

The cluster analysis reveals the evolution of the type of opening up in mainland China. The author got all the types through the cluster analysis.

The types of economic openness during 2000~2016 were as follows.

Type One (Highly open): Shanghai. Features: The highest level of trade openness and the highest comprehensive level of economic openness which belongs to the first level.

Type Two (Fully open): Beijing, Guangdong province. Feature: the levels of trade openness, financial openness and investment openness are higher, the comprehensive level is higher which belong to the second level.

Type Three (Steadily open): Tianjin, Liaoning province, Jiangsu province, Zhejiang province, Fujian province. Features: the levels of trade openness, investment openness and financial openness
are at the upper middle level, the comprehensive level is high ranking in third level which is above the national average.

Type Four (Balanced open): Zhejiang province, Shandong province, Hainan province, Chongqing municipality. Features: the levels of Investment openness, financial openness and trade openness are low, the comprehensive level is at the fourth level.

Type Five (Trade-led): Guangdong province. Features: The highest level of trade openness, the highest comprehensive level which belongs to the first level.

Type Six (Financial-led): Shanghai in the early years, Tianjin. Features: The highest level of financial openness, higher trade openness level, and a higher comprehensiveness level which belongs to the second level.

Type Seven (Investment-led): Jiangsu province, Hainan province. Features: The highest level of investment openness, low financial openness level and trade openness level, the comprehensive level is at the fourth level.

Type Eight (Low open): Hebei province, Shanxi province, Inner Mongolia autonomous region, Jilin province, Heilongjiang province, Anhui province, Jiangxi province, Henan province, Hubei province, Hunan province, Guangxi Zhuang autonomous region, Sichuan province, Guizhou province, Yunnan province, Tibet autonomous region, Shaanxi province, Gansu province, Qinghai province, Ningxia Hui autonomous region, Xinjiang Uygur autonomous region. Features: The openness levels of all indicators are the lowest, the lowest comprehensive level of the all the types.

Radar charts showing the final cluster center of each indicator in the cluster analysis results reveal the characteristics of each open type in each year. It can be seen from the changes in the radar charts that the evolution of the Chinese mainland's economic openness is as follows:

![Radiation Maps of the Final Clustering Center of Individual Indicators of Each Economic Openness Types in the Chinese Mainland during 2000~2016.](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAAgAAAAAQCAYAAAAf8/9hAAAAGXRFWHRTb2Z0d2FyZQBBZG9iZSBJbWFnZVJlYWR5ccllPAAAAA1JREFUeNrsyGwMBAAQAwjzAAAAAElFTkSuQmCC)

Data Source: China Statistical Yearbook, 2001~2017

We could see that the types of openness in various regions before and after joining in the WTO have changed greatly, of which the changes of the open types for the coastal areas with open traditions are the largest. Guangdong Province, a coastal region which has always been at the forefront of openness in China, is a typical case. Overall, Shanghai and Guangdong are the pioneers
of opening up to the outside world. The coastal provinces of Fujian and Hainan are at the forefront due to the geographical and popularity advantages of foreign economic exchanges. Tianjin municipality, Jiangsu, Zhejiang, Liaoning, Shandong and Chongqing are higher in openness level with a good industrial economic base. The economically undeveloped western areas like Tibet autonomous region have always been low-open areas.

Judging from the evolution path of the types of economic opening up in various regions, the economic opening-up of each region has gradually evolved into a balanced open path with balanced development from single trade-oriented open path. Shanghai has gradually developed from a financially-oriented open area into an all-round high-level open area in which all openness indicators are outstanding. Beijing and Guangdong Province have developed from a trade-oriented to a fully open type. Tianjin Municipality and Liaoning, Jiangsu, Zhejiang, Fujian Provinces have developed into a steady improvement type. Shandong, Hainan Provinces and Chongqing Municipality have developed from a low-level openness to a balanced open-up area in overall improvement. It is particularly noteworthy that Guangdong Province, which has been at the forefront of opening up, has benefited the most since the accession to the WTO due to its outstanding foreign trade and became the first-level open area.

Regional Interaction Analysis (Spatio-temporal Analysis)

The Spatio-temporal analysis are the most commonly used methods to observe the changes of the indicator monitoring values of different regions in different periods, look into the data variation trend of these different regions at different time points on the map, and then judge whether there is an interactive development trend between different regions, especially adjacent regions, so as to judge whether there exists the inter-regional radiation effect in the neighborhood areas. Here, the author still selects the previous key time nodes of economic openness to analyze the spatial evolution of the openness levels in different regions at different times, and observe the correlation between the indicator data of different regions.

![Figure 5. The Evolution of Economy's Open Degree in Various Regions of China's Mainland before and after Accession to the WTO. (Temporal and Spatial Analysis)](image)

Data Source: China Statistical Yearbook, 2001~2017
From the above-mentioned evolution of the degree of economic openness in the Mainland before and after China's accession to the WTO, we can see that the level of economic openness in the Mainland has changed in time and space. Shanghai and Guangdong have obvious radiation-driven effects on the economic openness levels of the surrounding areas. Especially, Shanghai has effectively promoted the level of economic openness of Jiangsu Province around the city, showing the same characteristics as the rise and fall of economic openness and the same trend. Guangdong Province was deeply affected by the financial crisis in 2008. After that, the level of economic openness has not been restored to its pre-WTO level. Moreover, the differences between China's regions are large, and the differences of economic openness levels in the central and western regions are small and the changes are also small.

Specifically, Jiangsu Province has taken a balanced open path before joining the WTO, which is different from Shanghai's financially dominant open road. However, Jiangsu Province gradually began to follow the pace of Shanghai's economic opening up. In 2007, Jiangsu Province changed into an investment-led open path and undertaken a large number of manufacturing operations in Shanghai's epitaxial processing areas. In 2008, when the financial crisis broke out, it generated a large number of trade exports relying on previous investment companies to become a trade-led economic open area. After the 2008 financial crisis, Jiangsu Province once again followed Shanghai's financial open policy, promoted an investment-led openness path, and undertook a large number of high-tech enterprises investment, and then moved on to the balanced open path like Shanghai. During the evolution process of the entire open path, Jiangsu Province gradually integrated into the Shanghai economic circle after China joined the WTO. As the economic hinterland of Shanghai, Jiangsu Province has taken over the spillover effect of Shanghai's economic openness, and has increasingly developed into an economic openness linkage area of joint opening and development of the adjacent areas with Shanghai.

Conclusion

From the above analysis of the economic openness indicator system in various regions of mainland China, the following conclusions are drawn.

Firstly, Joining in the WTO has greatly enhanced the level of economic openness in various regions of China.

Secondly, the 2008 financial crisis has had a great impact on the economic openness levels of the Chinese mainland. So far, it has not completely escaped the decline channel after the financial crisis. This proved that the level of China's economic openness is deeply depended on the openness environment of the world economy.

Thirdly, judging from the ranking changes in various regions, the rankings in coastal areas have changed greatly. The rankings of trade-led regions have risen rapidly after China's accession to the WTO, and have declined after the 2008 financial crisis. The rankings of the regions with good economic foundations, open traditions and more comprehensive development have risen.

Fourthly, the open type of coastal areas that adhere to the open tradition has changed the most. From the perspective of the evolution of the types of economic openness in various regions, all regions have gradually evolved from a single-oriented open path to a balanced open path with balanced development, especially in coastal areas with open traditions, which have benefited from China's accession to the WTO and transformed gradually into the leading highly open type of comprehensive and balanced development from trade-led economic open type. The laws of enhancement advantages of diversified and balanced development and risk dispersion rules still apply in the field of economic openness.

Fifthly, judging from the spatio-temporal analysis of the economic openness levels of various regions, China's accession to the WTO has also brought about the radiation effects of regional economic openness joint development in the Chinese mainland. Shanghai and Guangdong Province have shown signs of radiation effects on economic openness levels in the surrounding areas, especially the obvious radiation effects of Shanghai on Jiangsu Province. The radiation effects of
cooperation in adjacent regions still exist in the economic open field (open type, open path and open level). However, the differences between China's regions are large, and the level of economic opening-up in the central and western regions is low and the changes are small.

Acknowledgement
This paper is funded by the Beijing Municipal Commission of Education: the Talent Training Base Project for Silk and Belt Countries (2017-2019)

References