
An Empirical Analysis of the Relationship between Tax Capacity and Economic Growth in China

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Abstract – Taxation is an important source of regional revenue growth and economic operation quality improvement, and taxation and economic and social development are interacting and influencing each other. In the process of regional economic growth, the only way to maintain the balance of tax policies in various fields and adjust the regional tax system is to continuously increase the economic growth rate, so as to achieve a balanced growth of tax revenue and regional economy. Therefore, this paper will focus on the coordinated development management of tax revenue and economic growth in China. Based on the economic and tax data of 31 Chinese provinces and cities in the past 10 years from 2009 to 2018, we construct a stochastic frontier surface model to conduct a stochastic frontier analysis on the mutual influence relationship between tax revenue and GDP, and we find that GDP has a positive pulling effect on the tax revenue capacity of 31 Chinese provinces and cities. Economic growth will promote the increase of tax revenue, and the increase of tax revenue will also drive economic growth. Based on the results of the analysis, suggestions were made to improve the economic development of remote areas and to increase inter-regional cooperation between provinces and cities.

Keywords – Tax Revenue Capacity, GDP, Stochastic Frontier Analysis, Panel Data.

I. INTRODUCTION

The construction of a modern fiscal system is the primary goal of all government departments at present. Local governments clearly divide their powers and responsibilities and coordinate their financial resources in order to allow a coordinated development between themselves and the central government. To this end, local governments need to establish a scientific and effective budget management mechanism and deepen the reform of the taxation system to regulate the structure of local economic development by means of a sound tax system.

Since the reform of the tax sharing system in 1994, the growth rate of China's tax revenue has been significantly higher than the growth rate of GDP, and the proportion of national tax revenue to GDP has been increasing. According to the data of China's Bureau of Statistics, in 1994, the total amount of China's tax revenue was 512.688 billion yuan; while in 2019, the total amount of China's tax revenue grew to 157,992.21 billion yuan, with an average annual growth rate of 14.70%. Overall, China's tax revenue is in a better situation, and it has gained significant growth along with the development of the economy.

Economy is the basis of taxation, and taxation is the reflection of economic operation. Tax data comprehensively covers all fields of social economy, which can truly show the economic essence, accurately record the economic achievements and reflect the economic changes centrally. In practice, the differences in indicators such as the change of total regional tax revenue, the level of tax burden and the structure of tax sources among regions are all objective reflections of the economic operation. However, for China nowadays, with the deepening of opening up to the outside world and the development of socialist market economy, the status and role of taxation in the national economy becomes increasingly important, so the role of taxation in the

economic development of the whole country is pivotal.

This paper focuses on the relationship between tax revenue and economic growth, from a practical point of view to talk about can be conducive to a more thorough understanding of China's economy, after clarifying the impact of China's tax revenue on economic growth, both to promote the sustainable development of taxation and the economy, the coordinated development of tax revenue and economic growth proposals; but also to effectively improve China's tax capacity, so as to promote the development of China's economy. At the same time, regarding the relationship between the two, the government can promptly identify problems and formulate management policies that are more in line with the actual situation of China's economic development from the government's perspective, so as to enhance our taxation capacity and promote regional economic development.

II. RELATED WORK

Back in 2014, Yao made an aggregate and structural analysis of China's macro tax burden by establishing a mathematical model of the changes in China's macro tax burden and the changes in related economic indicators to answer the above questions at some level and to suggest changes in the overall tax burden level and tax burden structure in China [1].

In 2016, Wang introduced the economic characteristics of Tai'an City, followed by Tai'an City 1994-2004 macro tax burden and the status quo analysis, by comparison with other cities in the province, summed up the overall characteristics of Tai'an City macro tax burden: First, the overall tax burden level is low; second, the macro tax burden is relatively stable vertically, and the fluctuation range is small. Third, the overall tax burden is low but the industry and enterprise tax burden is high; fourth, the macro tax burden of counties and districts in the city is quite different [2]. Gao used regression analysis method to empirically analyze the relationship between tax growth and economic growth in China. The results show that China's tax growth is in a reasonable growth range; the relationship between tax growth and economic growth is basically coordinated; it is no problem to maintain the strong momentum of tax revenue growth for a period of time; tax revenue will enter the track of coordinated development with GDP growth [3].

In the same year, Zhang used regression model, autoregressive distribution lag model and dynamic distribution lag model to empirically analyze the relationship between tax growth and economic growth in Guangxi. The results show that the elasticity of tax revenue to GDP in Guangxi is too low, mainly due to the unreasonable structure of tax system and the problems of tax collection and management. Tax revenue growth has a large inertia in the short term, but in the long term it still depends on the continuous and stable economic growth, and there is a long-term coordinated growth relationship between tax revenue growth and economic growth [4].

In 2017, Wang conducted an empirical study on the relationship between tax revenue and GDP in Hubei Province from 1952 to 2004 based on co-integration theory and error correction model, determined the long-term equilibrium relationship and short-term fluctuation effects between the two, and established a stable tax forecasting model, which provides a scientific theoretical basis for improving the current tax system and promoting stable economic growth [5]. The empirical study on the elasticity of tax revenue of Shandong Province in terms of aggregate and structure, and analyzed the factors leading to the high growth of tax revenue in Shandong, which is important for understanding the role that tax revenue can play in the current situation of

Shandong and how to play it [6].

In the same year, Guan used econometric analysis to study the relationship between fiscal revenue and economic aggregate, macro tax burden and economic growth in Tianjin from 1978 to 2005. Based on the actual situation of Tianjin's economic development, tax growth and industrial structure change, this paper attempts to verify and explore the relationship between Tianjin's macro tax burden and regional economic development by revealing the quantitative relationship between variables. It is found that since the reform and opening up, the overall tax burden in Tianjin has been moderate, and the macro tax burden has shown a downward trend. However, the development of Binhai New Area will provide sufficient tax sources for Tianjin, so the macro tax burden will rebound [7]. Li used unit root test, cointegration analysis and Grange causality analysis to empirically study the relationship between tax revenue and GDP in Sichuan Province. The cointegration analysis results show that there is no long-term stable cointegration relationship between them. Grange causality analysis shows that there is a one-way causal relationship between tax revenue and GDP. Finally, the VAR method that does not require strict theoretical support is used to establish a tax revenue forecasting model for Sichuan Province and has achieved good results [8].

In 2019, Qi used unit root test, Granger causality test, and co-integration theory to empirically analyze the relationship between tax revenue and GDP in China from 1978 to 2007 and established an error correction model. Grange causality test showed that there was a unidirectional causal relationship between tax revenue and GDP, and co-integration analysis showed that there was a long-term stable co-integration relationship between them [9]. Li's quantitative analysis of fiscal revenue and its accurate prediction can provide reliable theoretical forecasting reference for relevant departments or enterprises to make development plans and implement relevant measures. Using the time series method to empirically analyze the change process of China's fiscal revenue and the two factors that affect China's fiscal revenue: GDP and taxation [10].

In 2021, based on China's fiscal revenues from 1999 to 2018, seven explanatory variables, including the number of domestic consumption taxes, were selected and a theoretical model was constructed. The parameters of the model were estimated and tested using E Views software, and the goodness-of-fit and statistical significance analyses were carried out. Finally, the model is analyzed in the economic sense, and policy recommendations are made for the change of fiscal revenue and economic development of China [11].

In 2022, Wang combined with the tax and economic situation of 18 provincial-level cities in Henan Province, and then used the principal component analysis method and factor analysis method under the objective weighting method to analyze the data, and obtained the principal component factor score formula and the comprehensive score formula, and then obtained the three factors that affect the sustainable growth ability of Henan tax revenue, namely, the quality of economic development, tax structure and tax growth, and obtained the ranking of the sustainable growth ability of tax revenue in 18 provincial-level cities in Henan Province, which is not conducive to the sustainable growth of tax revenue in Henan Province. According to the empirical results, the sustainable growth ability of tax revenue in Henan Province is mainly reflected in the quality of economic development, tax structure and tax growth [12].

III. EMPIRICAL ANALYSIS

A. Variable Selection

In order to better measure the impact of GDP on tax revenue, this paper selects tax revenue as the dependent variable, takes GDP as the independent variable, and adds other control variables. The control variables are mainly divided into economic variables, tax variables, and collection variables:

1. *Economic Control Variables*

Since the amount of the economy plays a decisive role in determining the size of tax revenue, economic variables usually play a decisive role in measuring the tax revenue capacity of a country or a region. In addition, since there are more variables to measure the economic development of a country or a region, such as: the degree of economic development, industrial layout, the level of openness to the outside world, price and consumption levels, etc. Therefore, in this paper, we will select additional economic-type control variables in addition to GDP that are consistent with the content of this paper, and four main ones are selected, which are shown below:

Industrial Structure:

This variable mainly measures the development among various economic agents, and in general, the role of the tax revenue capacity varies from industry to industry. Taking the role capacity as an example, in general, the secondary industry is higher than the tertiary industry, while the tertiary industry is higher than the primary industry, i.e. secondary industry > tertiary industry > primary industry. The industrial structure is by affecting the tax revenue of a country or a region, which in turn affects the tax revenue capacity of this country or this region. Therefore, this paper will select the absolute value of the secondary industry as a share of GDP and the absolute value of the tertiary industry as a share of GDP for 31 Chinese provinces and cities in the last 10 years from 2009-2018 as measurement variables to measure the relationship between them and tax revenue capacity.

Price Level:

This variable is primarily a measure of economic life. Although this variable is closely related to people's lives, its changes play a role in the tax revenue capacity of a country or a region. Therefore, this paper will choose the CPI of 31 Chinese provinces and cities in the last 10 years from 2009-2018 as a measurement variable to measure the relationship between it and tax revenue capacity.

Openness to the Outside World:

This variable has an effect on the tax revenue capacity of a country or a region, and this effect is usually positive, i.e., the higher the degree of openness to the outside world, the greater the tax revenue capacity. In addition, there is a positive relationship between this variable and economic development, i.e., the higher the degree of openness to the outside world, the better the level of economic development. Therefore, this paper will choose the total import and export of 31 Chinese provinces and cities in the last 10 years from 2009-2018 as a share of GDP as a measurement variable to measure the relationship between it and tax revenue capacity.

Investment Level:

Investment is one of the main variables that drive economic development, and the level of investment plays a role in the tax revenue capacity of a country or a region. Therefore, this paper will select the per capita investment in fixed assets of 31 Chinese provinces and cities in the last 10 years from 2009-2018 as a measure-

-ment variable to measure the relationship between it and tax revenue capacity.

2. Tax-Based Explanatory Variables:

To address the issue of tax rate setting, since China's tax system does not vary much and is basically consistent for different taxes, this makes the tax revenue less affected by the role of tax rate between different regions. Therefore, this paper will choose the share of local taxes in tax revenue of 31 Chinese provinces and cities in the last 10 years from 2009-2018 as a measurement variable to measure the relationship between it and tax revenue capacity. This variable, to a certain extent, more fully reflects the degree of dependence of tax revenues on local taxes in 31 Chinese provinces and cities, and if the measured degree of dependence is greater, then this indicates that the greater the degree of self-sufficiency of 31 Chinese provinces and cities to meet their fiscal revenues, which can promote local economic development and improve local tax revenue capacity, and vice versa.

3. Explanatory Variables for the Expropriation Category:

The level of tax administration and the level of taxpayers' tax payment have an impact on the tax revenue capacity of a country or a region. Therefore, this paper will choose the number of tax personnel and population density of 31 Chinese provinces and cities in the last 10 years from 2009-2018 as the measurement variables to measure the relationship between them and tax revenue capacity. In general, if the number of tax collectors is higher, it indicates that the level of tax administration will be higher, which will lead to richer tax revenue capacity; if the population density is higher, it indicates that the cost of tax collection will be lower, and the tax collection capacity will be higher, which will lead to richer tax revenue capacity.

In addition, since the heteroskedasticity of the time series will play a role in the model to some extent, the variables of tax revenue, GDP, fixed asset investment per capita, number of tax collectors, and population density in the selection of variables are measured in logarithmic form for all of them in this paper.

In summary, this paper selects the panel data of 31 Chinese provinces and cities in the last 10 years from 2009-2018 and analyzes them by using the stochastic frontier surface model. In addition, all the data used in this paper have authenticity, they source, all the data used in this paper have authenticity, they source from the National Bureau of Statistics and the China Taxation Yearbook, and the data sources are shown in the following table.

Table 1. Data sources.

Region	TAX (Billions of Dollars)	GDP (Billions of Dollars)	Region	TAX (Billions of dollars)	GDP (Billions of dollars)
Beijing	4988.83	33105.97	Hubei	2463.52	42021.95
Tianjin	1624.89	13362.92	Hunan	1959.67	36329.68
Hebei	2555.82	32494.61	Guangdong	9737.51	99945.22
Shanxi	1645.67	15958.13	Guangxi	1122.09	19627.81
Inner Mongolia	1399.86	16140.76	Hainan	628.68	4910.69
Liaoning	1976.13	23510.54	Chongqing	1603.03	21588.80

Region	TAX (Billions of Dollars)	GDP (Billions of Dollars)	Region	TAX (Billions of dollars)	GDP (Billions of dollars)
Jilin	891.75	11253.81	Sichuan	2819.77	42902.10
Heilongjiang	980.8	12846.48	Guizhou	1266.02	15353.21
Shanghai	6285.04	36011.82	Yunnan	1423.25	20880.63
Jiangsu	7263.65	93207.55	Tibet	155.93	1548.39
Zhejiang	5586.63	58002.84	Shaanxi	1774.29	23941.88
Anhui	2180.74	34010.91	Gansu	610.47	8104.07
Fujian	2237.42	38687.77	Qinghai	205.49	2748.00
Jiangxi	1663.15	22716.51	Ningxia	298.3	3510.21
Shandong	4897.92	66648.87	Xinjiang	1051.80	12809.39
Henan	2656.65	49935.90			

B. Model Setting

The general linear panel data model is usually set in the following form:

$$y_{it} = \alpha_{it} + \beta_{it}x' + \mu_{it}, i = 1,2,3,\dots, N, t = 1,2,3,\dots, T$$

Where y_{it} is the explanatory variable, x_{it} is a $k \times 1$ -dimensional explanatory vector, and $x_{it} = (x_{1, it}, x_{2, it}, \dots, x_{k, it})'$. Thus, the above model can be used to measure the dynamic relationship between $k+1$ variables; i is the cross-sectional scale with N cross-sectional data, t is the temporal scale with T time-point data; α_{it} represents the constant term of the model (also called the intercept term), β_{it} represents the coefficients of model explanatory vector (also called the coefficient vector), and μ_{it} is the residual, which is consistent with white noise.

Panel data models can be classified into three types according to the intercept term α_{it} and the coefficient vector β_{it} : when the intercept term and the coefficient vector are different, they are called variable coefficient models; when the intercept term is different and the coefficient vector is the same, they are called variable intercept models; when the intercept term and the coefficient vector are the same, they are called mixed models (also called constant coefficient models without individual effects). Depending on the data characteristics and estimation methods, they are further divided into fixed-effects estimation and random-effects estimation.

This paper draws on the Cobb-Douglas production function to construct the production function of tax revenue and economic growth. The Cobb-Douglas production function is one of the most widely used basic production functions in Western economics. Its basic form is: $Y = A(t)L^\alpha K^\beta$

Taking the logarithm of the left and right sides of the equation above, we get: $\ln Y = \ln A(t) + \alpha \ln L + \beta \ln K$ where $A(t)$ denotes the integrated technology, which is a variable of time and therefore can be considered constant in the short run; in the explanatory variables, L denotes labor input and K denotes capital input; in the coefficients, α denotes the output elasticity of labor and β denotes the output elasticity of capital input.

Based on the above-mentioned ideological basis of production function, the degree of contribution of econo-

-mic growth to tax revenue can be well realized in this paper. Therefore, the effect of economic growth in measuring tax revenue in this paper can be represented by the above model. The specific model takes the following form:

$$\ln y = \beta_0 + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3 + \beta_4 \ln x_4 + \beta_5 \ln x_5 + \beta_6 \ln x_6 + \beta_7 \ln x_7 + \beta_8 \ln x_8 + \beta_9 \ln x_9 + \nu - \mu$$

Where y is tax revenue, x_1 is GDP per capita, x_2 is the share of the secondary sector in absolute terms in GDP, x_3 is the share of the tertiary sector in absolute terms in GDP, x_4 is the consumer price index, x_5 is the share of total imports and exports in GDP, x_6 is the amount of fixed asset investment per capita, x_7 is the share of local taxes in tax revenue, x_8 is the tax staff number, x_9 is population density, β is the constant term and the parameter to be estimated for each explanatory variable, ν is the random effect, and μ is the inefficiency effect.

B. Model Construction

Data exploration was first conducted to explore the relationship between tax revenue and GDP. The scatter plot of tax revenue TAX (billion dollars) and GDP (billion dollars) is shown below.

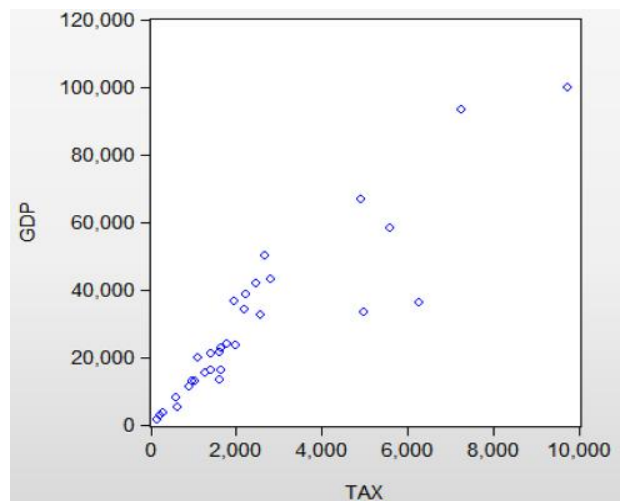


Fig. 1. Scatterplot of tax revenue TAX (billion dollars) and GDP (billion dollars).

We can see from the above graph that our GDP and tax revenue show an overall positive correlation.

Subsequently, the tax revenue of each province in the country for the last 10 years from 2009-2018 is used as the dependent variable, GDP as the independent variable, and variables such as per capita fixed asset investment, number of tax personnel, and population density as control variables, and 31 mainland provinces including Beijing, Shanghai, Tianjin, and Henan Province are used to focus on analyzing the impact of GDP on tax revenue. In this paper, a stochastic frontier surface model is applied to measure each variable as a way to obtain their parameter estimates. The results of parameter estimation are shown as follows:

Table 2. Parameter estimation results.

Variables	Coefficient	p> t
Constants	8.507333	0
GDP	0.3686805	0
Absolute value of secondary industry to GDP	0.860671	0

Variables	Coefficient	p> t
Share of tertiary sector in GDP in absolute terms	0.5444082	0.016
CPI	0.0194196	0.03
Total imports and exports as a share of GDP	0.387704	0
Fixed asset investment per capita	0.3545857	0
Share of local taxes in tax revenue	0.1274185	0.189
Number of tax staff	0.9131745	0
Population density	0.629293	0.003

According to the parameter estimation results, $wald\ chi2(9) = 7230.13$, $prob > \chi^2 = 0.0000$, which shows that the model of this paper is significant. σ^2 's parameter estimation result is 0.0352021, and it is significant at 5% confidence level, which shows that the composite effect of the residual term measured by using the stochastic frontier surface model is significant. The log likelihood = 113.12976, LR = 2.49, and the parameter estimation result of γ is 0.8015394, which shows that 80.15% of the difference between the actual value and the estimated value of this paper comes from the inefficiency effect, that is, there is an inefficiency effect, and the model can choose the stochastic frontier surface model. It is also significant at 5% confidence level, which shows that this paper is effective in studying the tax revenue capacity of 31 provinces and cities in China by using the stochastic frontier surface model.

The specific results measured by the model are shown below:

1. Economic Category Explanatory Variables:

The parameter estimate of GDP is 0.3686805 and it is also significant at 5% confidence level with the value of 0.000, which shows that there is a positive relationship between GDP and tax revenue capacity of 31 provinces and cities in China. It means that when GDP grows by one unit, the tax revenue capacity of 31 provinces and cities in China will grow by 0.3686805 units. In addition, the results measured by the model illustrate that the larger the GDP is, the larger the size of the tax base follows in the nearly 10-year period from 2009-2018, thus it is easy to find that GDP has a positive pulling effect on the tax revenue capacity of Chinese provinces and cities.

The parameter estimate of the absolute value of the secondary sector as a share of GDP is 0.860671 and it is significant at 5% confidence level with a value of 0.000, which indicates that there is a positive relationship between the absolute value of the secondary sector as a share of GDP and the tax revenue capacity of 31 provinces and cities in China. It means that when the absolute value of the secondary sector as a percentage of GDP increases by one unit, the tax revenue capacity of 31 provinces and cities in China will increase by 0.860671 units. The parameter estimate of the absolute value of the tertiary sector as a percentage of GDP is 0.5444082 and it is significant at 5% confidence level with a value of 0.016, which indicates that there is a positive relationship between the absolute value of the tertiary sector as a percentage of GDP and the tax revenue capacity of 31 provinces and cities in China. It means that when the absolute value of tertiary sector as a percentage of GDP increases by one unit, the tax revenue capacity of 31 provinces and cities in China will incre-

-ase by 0.5444082 units.

The parameter estimate of CPI is 0.0194196 and it is significant at 5% confidence level with a value of 0.030, which shows that there is a positive relationship between CPI and the tax revenue capacity of 31 provinces and cities in China. It means that when CPI increases by one unit, the tax revenue capacity of 31 provinces and cities in China will increase by 0.0194196 units. The parameter estimation of the share of total import and export to GDP is 0.387704 and it is significant at 5% confidence level with a value of 0.000, which shows that there is a positive relationship between the share of total import and export to GDP and the tax revenue capacity of 31 provinces and cities in China. It means that when the share of total import and export to GDP increases by one unit, the tax revenue capacity of 31 provinces and cities in China will increase by 0.387704 units.

The parameter estimation result of per capita fixed asset investment is 0.3545857 and it is significant at 5% confidence level with the value of 0.000, which indicates that there is a positive relationship between per capita fixed asset investment and tax revenue capacity of 31 provinces and cities in China. It means that when the per capita investment in fixed assets increases by one unit, the tax revenue capacity of 31 provinces and cities in China will increase by 0.3545857 units.

2. Tax-Based Explanatory Variables:

The parameter estimate of the share of local taxes in tax revenue is 0.1274185, while it is insignificant at 5% confidence level with a value of 0.189, which indicates that there is little relationship between the share of local taxes in tax revenue and the tax revenue capacity of China. It implies that when the share of local taxes in tax revenue increases by one unit, the tax revenue capacity of 31 provinces and cities in China does not necessarily increase by 0.1274185 units. This may happen because these prefectures are more dependent on other revenues such as shared taxes and transfer payments, and have a lower degree of fiscal self-sufficiency.

3. Explanatory Variables for the Expropriation Category:

The parameter estimation of the number of tax personnel is 0.9131745 and it is also significant at 5% confidence level with the value of 0.000, which shows that there is a positive relationship between the number of tax personnel and the tax revenue capacity of 31 provinces and cities in China. It means that when the number of tax personnel increases by one unit, the tax revenue capacity of 31 provinces and cities in China will increase by 0.9131745 units. The parameter estimate of population density is 0.629293 and it is significant at 5% confidence level with a value of 0.003, which indicates that there is a positive relationship between population density and tax revenue capacity of 31 provinces and cities in China. It means that when the population density increases by one unit, the tax revenue capacity of 31 provinces and cities in China will increase by 0.629293 units.

IV. CONCLUSION

The good or bad economy of a country or a region plays a decisive role in the amount of tax revenue of that country or region. On the whole, the tax revenue capacity of 31 provinces and cities in China cannot be generated without the support of local economic development level, and the difference of economic development level among prefecture-level cities is also the reason for the difference of tax revenue capacity among prefecture-level cities. For China as a whole, the economic development level of Zhejiang Province is

high, while the economic development level of some other provinces and cities is lower than that of Zhejiang Province, and it is because of the low economic development level of these prefecture-level cities that their tax revenue capacity is lower. It is easy to find that if we want to solve the problem of the difference of tax revenue capacity among prefecture-level cities, it is urgent to change the economic growth mode and promote the coordinated development of the region.

In order to transform the economic growth mode and promote the coordinated development of the region, this paper proposes the following two main points:

First, it can be solved by adopting the way of improving the economic development level of remote areas as a way to promote local economic growth. As China's economy has entered a new normal, at the same time, the economic growth mode brought by the development concept of innovation, coordination, green, openness and sharing has become a general trend. Therefore, for remote provinces and cities, they can use the above-mentioned economic growth methods to improve local economic efficiency and optimize local resource allocation, so as to reduce the difference in economic development level and tax revenue capacity between themselves and other prefecture-level cities.

Second, each province and city should increase inter-regional cooperation and promote coordinated regional development by taking the best and removing the worst and using them for our own benefit. Since there are many differences between provinces and cities with higher and lower levels of economic development, such as the sufficiency of natural resources, the openness of investment environment, the richness of labor force and the advanced degree of science and technology, all these factors provide conditions for inter-regional cooperation to a certain extent. Therefore, for the provinces and cities with higher level of economic development, they can provide sufficient capital, advanced technology, and perfect system to the provinces and cities with lower level of economic development by using their own advantages, such as: they can provide sufficient capital, advanced technology, and perfect system to the provinces and cities with lower level of economic development. For the provinces and cities with lower economic development, they can also use their advantages, such as the natural resources and abundant labor, which are unique to the provinces and cities with higher economic development. The two can optimize their respective economic benefits through cooperation, thus promoting the sustainable, healthy and stable development of the local economy.

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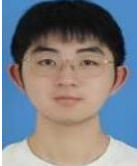
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