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Is the World Being Flattened?

-- Empirical Research Based on China's Innovation Drive and Regional Economic Convergence

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Abstract

The issue of uncoordinated regional development and unequal income distribution is an important content in the field of regional economic research, and it is also an influential factor in formulating a suitable regional development strategy. Based on the economic convergence hypothesis theory, this paper expands the inspection analysis by period, region, and industry by establishing an absolute convergence model and an extended conditional convergence model. At the same time, a contiguous space weight matrix, a distance space weight matrix, and an economic space weight matrix were introduced in order to build a spatial convergence model. Using panel data from 30 provinces and cities in China from 2004 to 2016, we explored whether China ’s economy is being “flattened” and whether The impact of innovation on China's economic convergence. The research results show that: from the perspective of time, China's regional economy has significant convergence characteristics during the study period, especially from 2005 to 2010. According to this convergence trend, it will take at least more than 100 for the backward regions to catch up with the developed regions. From the perspective of space, China ’s regional economic convergence pattern is roughly represented by Northeast> Eastern> West and Central, that is, the more backward the Northeast region, the faster the convergence, it is difficult to catch up with other more developed regions; from the perspective of the industrial dimension Although innovation can accelerate the rate of economic convergence as a whole, the impact on industries one, two, and three is different. Innovation mainly promotes economic convergence by acting on the secondary industry. The research conclusions in this article can provide some theoretical guidance for China to better formulate regional development policies and achieve coordination between innovation-driven and industrial policies.

Keywords

Regional innovation, economic convergence, conditional convergence, spatial effect.

1. INTRODUCTION

For a long time, uncoordinated regional development and unequal income distribution have been important directions in regional economic research, and the rate of economic growth has always been a hot topic that has attracted much attention from society. The neoclassical growth theory and traditional economic geography theory believe that with economic development, regional economic disparities and income differences will tend to narrow, so-called economic "convergence." Corresponding to this, the "world is being flattened" proposed by American economist Thomas Friedman in "The World is Flat" in 2006 not only reveals the profound changes in the world, but also affects future economic development trends. It made a strong prediction that with the rapid advancement of science and technology, the world's flattening

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trend will intensify and gradually penetrate into economic, social, political and other aspects, making globalization an irresistible trend. On the other hand, the new growth theory believes that the regional economy will develop in a divergent direction. The "world city theory" proposed by Peter Hall, the British master of urban and regional planning, is more inclined to this divergent Viewpoint, which divides new-type cities into three levels, and derives the development concept of "the world is sharp" from this urban cascade relationship, and has been recognized and supported by many scholars of urban economics. The report of the Nineteenth National Congress of the Communist Party of China mentioned that "the country's economic innovation and competitiveness should be continuously enhanced", "realize innovation to lead the eastern development, actively promote the rise of central China, and establish a new pattern of western development". These regional development strategies and The formulation and implementation of innovation-driven strategies are based on "placing" regional economic disparities and achieving a flat economic development pattern. However, due to the high threshold, high agglomeration and high leadership of innovation, while innovation has become a new engine of economic growth, it has also brought about the debate whether it will further strengthen the core-edge polarization development trend, making the innovation-driven strategy coordinate regional coordination. The impact of development is questionable.

Since the beginning of the 21st century, economic globalization has continued to deepen, world politics and culture have become more and more diverse, geographical isolation has been gradually broken by cyberspace, and knowledge flows have become more frequent. Is the world evolving toward homogeneity as we have seen? Throughout the 40-year development history of China's reform and opening up, in 2010 the total economic volume surpassed Japan to become the second largest economy. In 2015, it replaced the United States as the largest exporting country. The economic volume continued to expand. It is still difficult to get a fundamental change in a short time. Grossman & Helpman's (1994) endogenous growth theory shows that technological progress and innovation are the source of disparities in economic development in different countries and regions[1]. Zhou Wenyong and Xiang Yang (2015) 's empirical research also reached similar conclusions: China's provinces and cities have huge disparities in regional innovation capabilities, and this gap keeps pace with the gap in economic strength[2]. Archibugi & Pianta (1994) believes that there is convergence in national innovation capabilities, which may cause convergence in output or productivity per capita in different countries.[3] This has led to thinking about China's regional economic growth profile: Is there a convergence trend in China's regional economic growth? Will innovation continue to exacerbate regional differences, causing economic development to fall into a Matthew effect where the stronger is stronger and the weaker is weaker? Or will it show up as a catch-up effect, so that backward areas will gradually catch up with areas with more developed economies and realize the flat development of China's regional economy? To this end, this article conducts research and inspection at the inter-provincial level to reveal the overall convergence or divergence trend of inter-provincial economic growth during the inspection period, to a certain extent, to test the effectiveness of policies such as regional coordinated development strategies and innovation-driven strategies. It is further divided into four major regions: eastern, central, western, and northeast. It examines whether there is a phenomenon of club convergence in the region and analyzes the economic development trends in different regions to provide a reference for further improvement of related policies.

2. LITERATURE REVIEW

The economic convergence hypothesis (also known as economic convergence) originated from the "Solow-Swan model" proposed by Solow and Swan (1956) of the neoclassical economics school. There should be a stable state of the economy. At the same time, technological progress is introduced as an exogenous factor. It is believed that if there is no technological

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progress, the economy represented by per capita output will eventually stagnate. In fact, most economic indicators have convergence characteristics, so in addition to studying GDP growth, the "convergence theory" has also been widely used in recent years in wage income (Yildirim et al., 2009), and interest rate levels (Kisswani & Nusair, 2014)[4], innovation ability (Huang Desen and Yang Chaofeng, 2017)[5], total factor productivity (Li Jian and Pan Yuzhang, 2018)[6], etc.

Many previous studies have been based on economic convergence models, which are aimed at revealing the objective trends of economic convergence and the regional economic convergence. Due to the choice of indicators and the scope of investigation, the conclusions drawn by the research are not consistent. The first is that there is an absolute convergence characteristic of per capita output or per capita income, which is mainly supported by empirical evidence in highly qualitative samples from OECD countries. For example, Dall'Erba & Gallo (2010) [7]used spatial measurement to evaluate the impact of structural funds on the economic convergence process between 145 European regions, and found that there was significant convergence between European regions, but structural funds did not play a role. The results suggest that current regional policy tools should be reconsidered. Carlino & Mills (1993) [8]used data from 1929-1990 to study the convergence of regional economic growth in the United States; Qin Chenglin and Zhang Weili (2009) [9]found that China's regional economic growth has seen significant club convergence since the reform and opening up and thought that The important factors in this phenomenon are the level of marketization and regional policies.

The second opinion states that there is no absolute convergence in per capita output, but conditional convergence may exist. For example, Fleisher & Chen (2004)[10] studied the convergence of per capita GDP in China's provinces from 1978 to 1993, and found that although there was no absolute convergence, there was conditional convergence. However, in the research by sub-sector, the convergence between different industries will be different. The research found that the labor productivity or GDP per capita of the manufacturing industry supports the absolute convergence hypothesis, while the non-manufacturing sector does not support it (Rodrik, 2013[11]; Dai Mi and Mao Rui (2015)[12]; Zheng Jianghuai and Shen Chunmiao (2016)[13], through numerical simulation analysis and empirical analysis of panel data from 31 provinces in China from 1997 to 2013, also concluded that the convergence of China's sectoral productivity showed a different industry experience from the "industrial sector labor Productivity does not converge and service sector labor productivity passively converges. "Increasing the productivity of the industrial sector will still be the key conclusion that determines whether China's future economic growth can continue to converge to advanced economies.

The third view is that the economy is in a state of absolute divergence, which is reflected in the different development trends of regional economies due to differences in regional endowments and local development policies, and local economies in a state of divergence. For example, Zhu Guozhong et al. (2014)[14] added spatial factors to the model and used dynamic spatial panel data model tests to conclude that the spatial correlation in the eastern region is strong and there is no convergence feature, and the spatial correlation in the central and western regions is weak and a significant economy Convergence, meanwhile, China's overall economy is in a state of divergence. Chen et al. (2016)[15] discussed the actual wage convergence in China during the market-oriented reform process and found that wage levels in the eastern and western provinces converged, while the northeast and central provinces showed non-convergence. The research conclusions are different. Sofi & Durai (2016)[16] used second-order Gaussian kernel density function research to verify the convergence hypothesis of 22 states in India from 1980-1981 to 2010-2011. The results show that there is an absolute divergence in per capita income of Indian states.

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In recent years, domestic scholars have continued to introduce new ideas, which has enriched and expanded the theory of economic convergence and reflected the actual economic situation more deeply. This is reflected in the fact that more empirical studies have begun to examine various factors affecting economic convergence, that is, focus on conditional convergence. For example, Yang Fan and Teng Jianzhou (2013)[17] studied the relationship between trade liberalization and economic convergence between major East Asian economies from 1978 to 2011 and found that East Asian economic growth showed obvious characteristics of club convergence, and trade liberalization played a positive role in it. Mao Rui (2017)[18] examines the role of easing financing constraints in industrial agglomeration to promote corporate innovation, enhance corporate productivity, and then accelerate balanced development among regions, examining the relationship between industrial agglomeration and regional productivity convergence; Li Siwei et al. (2017) [19]Believes that social financing structure, as an important indicator of China's financial reform and development, is one of the main factors for economic convergence.

To sum up, on the one hand, whether the trend of regional economic disparity in China has converged or diverged needs further investigation; on the other hand, under the general background of "mass entrepreneurship, innovation by all people", does the innovation drive have an impact on the regional economic convergence in China? What kind of influence is also a major subject worthy of study at the moment, which has inspired the research ideas of this article. Compared with previous research, the innovation of this paper lies in: First, there are more literatures on economic convergence, mainly from the relationship between productivity, industrial structure and economic convergence. There is more research on innovation, involving innovation ability, innovation Efficiency, innovation influencing factors, and other dimensions, and few literatures put innovation and economic convergence within the same model framework to study the relationship between the two. This article separately studies the absolute convergence without any control conditions and the conditional convergence with the addition of innovation variables, and explores whether there is a trend of "flattening" our economy and the impact of innovation on China's economic convergence. Second, most previous studies were based on traditional panel or time series model analysis, and did not consider spatial effects. Although spatial models in this area have been slightly supplemented in recent years, most of their spatial effects are based on the space between adjacent regions. The actual situation does not exactly match. Because the economic development of various provinces and cities will not only produce spatial diffusion or spatial spillover effects, but also the spatial effect is related to the geographical distance and close economic relationship between the provinces and cities, this article will fully consider the spatial correlation and construct adjacencies based on adjacent relationships. Spatial weight matrix, distance-based spatial weight matrix based on geographical factors, and economic-space weighted matrix based on economic factors, to conduct in-depth research at the spatial level, aiming to more deeply verify whether China's regional economy is being "flattened" as a miniature of the world economy To reflect the historical results and future direction of coordinated development of the regional economy. In addition, the introduction of the index of the number of invention patent applications to analyze the significance of innovation in "mopping up" China's regional economy and reducing regional disparities can provide a way for innovation-driven strategies and regional coordinated development strategies to better integrate and complement each other to promote regional economic development. Suggested reference.

3. THEORETICAL MODELS AND RESEARCH METHODS

Economic convergence is based on the hypothesis that countries with lower initial per capita levels tend to grow faster than countries with higher initial per capita levels, that is, the economic growth rate of a country or region is negative to its initial per capita economic level

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Related relations, so the economic gap between the two countries or places will gradually narrow. Economic convergence can be divided into two categories: one is convergence, which shows that the gap between per capita economic levels between countries or regions is continuously decreasing, commonly used indexes, Theil index, coefficient of variation, Gini coefficient, etc. The other type is convergence. The internationally accepted model of economic growth convergence is introduced. This form of convergence mainly manifests in the growth rate of backward areas higher than developed areas.

3.1. Traditional Convergence Model and Spatial Convergence Model

More attention in macroeconomics is convergence. It is further subdivided. Convergence without the influence of other factors is called absolute convergence. Conversely, convergence with control conditions (such as factor flow, policy factors, infrastructure, etc.) is conditional convergence. It is worth noting that the main concern for the study of economic convergence is not the total economic volume, but the per capita economic level. Generally, per capita GDP or labor productivity is the research object.

This paper draws on the general convergence model of Barro (1992) and defines the test equation for absolute convergence of regional economy as:

$$\frac{1}{T}\ln(\frac{y_{i,t+T}}{y_{i,t}}) = \alpha + \beta \ln(y_{i,t}) + \varepsilon_{i,t} \tag{1}$$

Among them, T is the time span, i represents the region, $y_{i,t}$ represents the per capita output level of the i region in the t year, $\ln(\frac{y_{i,t+T}}{y_{i,t}})$ is the growth rate of per capita output in each region during the study period, α is a constant term, β is a convergence coefficient, and $\varepsilon_{i,t}$ is a random disturbance term.

After adding the control variable innovation ability P on the basis of the absolute convergence model, the test equation for conditional convergence is obtained:

$$\frac{1}{T}\ln(\frac{y_{i,t+T}}{y_{i,t}}) = \alpha + \beta \ln(y_{i,t}) + \delta \ln(P_{i,t}) + \varepsilon_{i,t} \tag{2}$$

The convergence test of traditional economic growth usually presupposes that the variables in each region are independent of each other, and fails to take into account the spatial effect. The first law of geography proposed by Tobler (1979) states that the development between regions is not completely independent. There is a wide range of interactions between them, and generally there are objective laws that are closer and closer. Spatial effects include spatial dependence and spatial heterogeneity. The former refers to the observations of samples in one area affected by the observations in other areas, and the latter refers to the spatial effects caused by the heterogeneity of spatial units (Anselin, 2003). It is mainly reflected in the random error term, which corresponds to the spatial lag model (SAR) and the spatial error model (SEM). In addition to the above two models, there is a more general model that is a spatial Dubin model proposed by LeSage and Pace. This model contains both the spatial lag of the dependent variable and the spatial lag of the independent variable. Considering the possible two The spatial effects are all present. The models (3) and (4) respectively represent the absolute and conditional convergence of regional economic growth:

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$$\frac{1}{T}\ln(\frac{y_{i,t+T}}{y_{i,t}}) = \alpha + \lambda\frac{1}{T}W\ln(\frac{y_{i,t+T}}{y_{i,t}}) + \beta\ln(y_{i,t}) + \theta W\ln(y_{i,t}) + \mu_i + \varphi_t + \varepsilon_{i,t} \quad (3)$$

$$\frac{1}{T}\ln(\frac{y_{i,t+T}}{y_{i,t}}) = \alpha + \lambda\frac{1}{T}W\ln(\frac{y_{i,t+T}}{y_{i,t}}) + \beta\ln(y_{i,t}) + \theta W\ln(y_{i,t}) + \delta\ln(p_{i,t}) + \rho W\ln(p_{i,t}) + \mu_i + \varphi_t + \varepsilon_{i,t} \quad (4)$$

In the above formula, W is the spatial weight matrix, $\lambda \backslash \theta \backslash \rho$ and respectively represent the spatial spillover effects of per capita output growth rate, per capita output, and regional innovation capacity, and μ_i represent the individual effects of the province, φ_t representing the time effect, and $\varepsilon_{i,t}$ are random disturbance terms, $\mu \sim N(0, \sigma^2 I)$. When $\theta = 0$, the model degenerates into a spatial lag model. When $\lambda = 0$ and $\theta = 0$, the model degenerates into a spatial error model.

In the models (1)-(4), if the estimated value (β) of the convergence coefficient is significantly negative, it indicates that the growth rate of per capita output is negatively correlated with the level of per capita output in the initial period. Regions that are faster indicate that there is convergence in the regional economy, and the smaller they are, the more it converges; otherwise, it indicates that the economy is diverging. In addition, according to the estimated value β, we can calculate the convergence speed s and the half-life cycle of convergence τ, that is, the time required for the economically backward regions to catch up with the developed regions. The calculation formula is:

$$s = -\ln(1+\beta)/T \quad (5)$$

$$\tau = \ln(2)/s \quad (6)$$

From this, the relationship between speed s and convergence coefficient β can be deduced: if $s > 0$, equivalent to $\beta < 0$, there is convergence; $s < 0$, equivalent to $\beta > 0$, that is, economic divergence.

3.2. Variable Selection and Data Description

This article mainly examines the convergence of innovation capacity and economic growth in 30 provinces (municipalities, autonomous regions) in China from 2004 to 2016. Among them, Tibet is not included in the scope of investigation due to the serious lack of data. The reason for taking 2004 as the time point for sample inspection is that following the strategic decision of the western development at the Central Economic Work Conference in 1999, the government work reports in 2003 and 2004 also proposed the Northeast Revitalization Strategy and the Central Rise Strategy. So far, China's three major regional coordinated development strategies have been proposed and started deployment. Although China's innovation-driven development strategy was only explicitly put forward in 2012, in fact, since the central government proposed to build an innovative country in 2005, the innovation environment has gradually formed, and innovation-driven economic development has been gradually implemented. The variables involved are mainly per capita output levels and innovation capabilities. The data used in this article are derived from the China Statistical Yearbook and the China Science and Technology Statistics Yearbook.

The explanatory variable in this article is the growth rate of output per capita, and the core explanatory variable is the level of output per capita. The selection of per capita output level

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indicators, part of the literature uses labor averages to better represent labor productivity, while this article selects more general and representative per capita GDP indicators, which reflect the level of regional economic development and production capacity. For the base period.

Conditional convergence adds the ability to innovate as a condition variable. There are currently different selection criteria for evaluating the innovation capacity of a region in academia. It is mainly measured by various levels of innovation output. Common examples are patent applications (or grants), new product sales revenue, and technology market turnover. Patents, especially invention patents, are the result of research and development activities, and also the source of industrialized technology. They are closely related to innovation and can to some extent characterize regional innovation capabilities (Pan Xiongfeng and Zhang Weiwei, 2013). Patent standards have been relatively objective for a long time The data is also easily available. Although the use of patent data to analyze innovation has its natural limitations, it is still the most commonly used important measure of innovation capacity (Acs et al., 2002). Since not all patent applications can be authorized, judging from the current progress of innovation research, the latter may be more inclined between the number of patent applications and the number of patent grants. The reason why this article selects the number of invention patent applications to measure innovation capacity The reasons are: first, compared with the number of patent applications, the amount of patent grants has a certain lag in time, which easily leads to information distortion (Liu Fengchao and Pan Xiongfeng, 2005); second, from the perspective of three patent types, the same Compared with utility model patents and design patents, invention patents have a higher level of technological novelty and potential commercial value.

3.3. Setting of Spatial Weight Matrix

The setting of the spatial weight matrix is a key step in spatial measurement. However, in many research literatures, only the adjacent spatial weight matrix based on geographical adjacency is selected. It is assumed that there is no connection between non-adjacent regions and it cannot fully reflect the inter-regional The objective fact that the interaction weakens with increasing distance. In addition to the adjoining spatial weight matrix, this paper also selects the distance spatial weight matrix that represents geographical factors, that is, the straight-line distance between the regional capital i and the provincial capital city of regional j. In addition, considering the fact that economically backward regions are often more significantly affected by economically developed regions, for example, Hebei Province is adjacent to Shandong, Tianjin, Beijing, Henan and other provinces, but is significantly affected by Beijing to a greater extent. In order to better fit the regional economic development in China, this paper introduces an economic space weight matrix that is calculated from the difference in per capita GDP between regions. The adjacent space weight matrix (W_{ij}), distance space weight matrix (W_{ij}^{d}), and economic space weight matrix (W_{ij}^{e}) are set as follows:

$$w_{ij}^{d} = \begin{cases} \frac{1}{d_{ij}}, & i = j \\ 0, & i \neq j \end{cases} \tag{7}$$

$$w_{ij}^{e} = \begin{cases} w_{ij} \frac{1}{\left|\bar{Y}_i - \bar{Y}_j\right|}, & i = j \\ 0, & i \neq j \end{cases} \tag{8}$$

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W_{ij}^{d} is obtained from the spherical straight distance between the area i and the area j, $\overline{Y_i}$ and $\overline{Y_j}$ respectively represent the average GDP per capita of i and j in the sample period. This article will examine the results obtained under the three kinds of matrices, and make a comparative analysis.

4. THE EMPIRICAL ANALYSIS OF TRADITIONAL PANEL CONVERGENCE MODEL

4.1. Traditional Convergence Test

Without considering the spatial effect, this paper makes OLS estimation for the model (1) and model (2) separately (not considering the individual effect and time effect). The results are shown in Table 1. It can be seen that during the entire sample period from 2004 to 2016, the convergence coefficient is significantly negative. The conditional convergence coefficient obtained after adding the ability to innovate as a control variable is still significantly negative, indicating that China's regional economic growth has established absolute convergence during the sample period. Its absolute convergence rate is 0.32%, and its half-life period is 216.61 years. It also shows conditional convergence as the innovation capacity increases. The conditional convergence rate is 0.394%, and its half-life period is 175.93 years. Under the innovation-driven strategy, the economic gap between regions has gradually narrowed, and the economy is moving toward a dynamic and balanced development that is "flattened." In addition, taking 2010 as the dividing point, dividing 2004-2016 into two time periods. The reason for this division is based on the following two considerations: First, 2009 was the year when the global financial crisis broke out, and China's economy was greatly affected. Secondly, although the concept of the "new normal" was only proposed in 2014, some scholars believe that the Chinese economy has shown many new normal features as of 2010, and the growth momentum has been gradually transformed. It can be said that the year 2010 was the transition of China's economy Key period (Liu Ming and Wang Siwen, 2018). The final empirical results are basically consistent with the whole, especially the economic convergence shown in the period of 2004-2009 has a strong explanatory power for the convergence phenomenon of the entire inspection period, and the 2010-2016 test results show that although this There are characteristics of economic convergence during the period, but only the conditional convergence coefficient is significant, and the absolute convergence coefficient is not significant, which may be related to the national economic structural adjustment and economic growth slowdown during this

Table 1. Panel regression results of the convergence test by period

Variables	2004-2016		2004-2009		2010-2016	
	Absolute Converg-ence	Conditional Convergence	Absolute Convergen-ce	Conditional Convergence	Absolute Convergen-ce	Conditional Convergence
C	0.477***	0.5294***	0.4478***	0.4532***	0.3072**	0.4112**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.050)	(0.013)
Lny	-0.0379***	-0.0462***	-0.0299***	-0.0308***	-0.0225	-0.0380**
(β)	(0.000)	(0.000)	(0.001)	(0.002)	(0.129)	(0.023)
Lnp	-	0.0047***	-	0.0006	-	0.0078***
(δ)		(0.005)		(0.805)		(0.004)
R2	0.3850	0.4062	0.255	0.256	0.058	0.108

Note: ***, **, and * indicate that they passed the significance test of 1%, 5%, and 10%, respectively.

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period. It reflects that with the changes in the environment from 2004 to 2016, the uncertain factors of economic growth are increasing, the phenomenon of absolute convergence is gradually disappearing, and the speed of condition convergence is also showing a downward trend. China's overall economic gap is undergoing a dynamic process from "continuously shrinking" to "slowly shrinking".

In addition, this article draws on the practice of Chunsheng Hu and Xiurong Mo (2016), further divides the per capita GDP index according to the industrial structure, and calculates the first, second, and third industries based on the proportion of the added value of the primary, secondary, and tertiary industries to the total added value. The per capita GDP of the secondary and tertiary industries is also used for regression estimation using the above convergence model. The results in Table 2 show that the convergence coefficients of the primary industry are all positive and there is no convergence phenomenon; the convergence coefficient of the secondary industry is significantly less than 0, the convergence trend is significant, and the absolute value of the conditional convergence coefficient is significantly greater than the absolute value of the absolute convergence coefficient, that is, the conditional convergence The speed of 0.57% is greater than the absolute convergence rate of 0.47%, which indicates that innovation has promoted the convergence of the secondary industry; the tertiary industry also has significant characteristics of absolute convergence and conditional convergence. The contribution of innovation in China mainly comes from the secondary and tertiary industries. At the same time, notice that the convergence rate of the secondary industry is significantly faster than that of the tertiary industry, indicating that the secondary industry is the main force for economic convergence. Therefore, the path for China's economy to be "flattened" is to vigorously promote the development of innovative activities to reduce the gap in the per capita output level of the secondary industry in each region, thereby achieving the overall economic convergence.

Table 2. Panel regression results of convergence test by industry

Variables	The First Industry		The Second Industry		The Third Industry	
	Absolute Convergence	Conditional Convergence	Absolute Convergence	Conditional Convergence	Absolute Convergence	Conditional Convergence
Cons	0.0390	0.0931	-0.5814***	0.6412***	0.3268***	0.3507***
	(0.772)	(0.342)	(0.000)	(0.000)	(0.000)	(0.000)
Lny(β)	0.0030	0.0063	-0.0550***	-0.0664***	-0.0220***	-0.0271***
	(0.856)	(0.644)	(0.000)	(0.000)	(0.000)	(0.000)
Lnp(δ)	-	-0.0114***	-	0.0069**	-	0.0034**
		(0.001)		(0.035)		(0.019)
R2	0.00	0.196	0.366	0.385	0.328	0.350

For the country as a whole, due to differences in regional systems and cultures, regional economic growth may not have significant convergence as a whole, but for geographically adjacent areas, there may be significant club convergence. In this paper, China's 30 provinces (municipalities, autonomous regions) are classified into four major regions: eastern, central, western, and northeast China, to examine whether there is a regional economic growth space convergence in local areas.

The results are shown in Table 3. The absolute and conditional convergence coefficients of the eastern, central, western, and northeastern regions of China are negative and have a certain significance, indicating that the economic growth of the four regions of east, middle, west, and northeast China has significant convergence characteristics in economic growth, that is, club

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convergence. In addition, the absolute value of the conditional convergence coefficient is greater than the absolute value of the absolute convergence coefficient in all regions except the Northeast region. That is to say, the rate of economic convergence accelerates with the improvement of the ability to innovate, reflecting that innovation has significantly contributed to economic convergence. Promotion effect. At the same time, it can be found by comparing the regions. According to the convergence coefficients, they are ranked from small to large. The fastest absolute convergence rate is in the order of 0.82% in the northeast, 0.41% in the west, 0.40% in the middle, and 0.19% in the east, which is exactly the opposite of the regional development level. Convergence showed that the central part converged fastest at 0.63%, followed by the western part (0.44%), followed by the northeast (0.40%), and the eastern part (0.20%), the slowest convergence. According to this result, regions with lower levels of economic development will converge at a faster rate due to the relatively rapid convergence rate. Economically developed regions such as the east will converge to higher levels due to the slower convergence rate. The economic level, and thus the divergence rather than convergence among the clubs, will lead to the development of China's overall economy as a polarized development without the tendency to be "smoothed." Contrary to this result, theoretically speaking, the eastern region has basically reached a relatively high level of development, and the atmosphere of innovation is active, and it should converge at the fastest speed; while there is still a lot of room for development in the western and northeast regions, and the economy is more It is likely to develop in the direction of divergence. Therefore, in order to avoid the contingency of this result, this paper will establish a spatial econometric model to carry out the same subregional convergence empirical test, and conduct in-depth analysis and discussion based on the results.

Table 3. Traditional panel regression results for the convergence test by region

Variables	Eastern Area		Middle Area		Western Area		East-northern Area	
	Absolute Convergence	Conditional Convergence	Absolute Convergence	Conditional Convergence	Absolute Convergence	Conditional Convergence	Absolute Convergence	Conditional Convergence
Cons	0.3255*** (0.000)	0.3391*** (0.001)	0.5655*** (0.000)	0.7273*** (0.008)	0.5719*** (0.000)	0.5918*** (0.000)	1.0224** (0.040)	0.7482** (0.023)
Lny(β)	-0.0223*** (0.002)	-0.0242*** (0.006)	-0.0470*** (0.002)	-0.0732** (0.029)	-0.0477*** (0.000)	-0.0517*** (0.000)	-0.0934* (0.052)	-0.0467* (0.052)
Lnp(δ)	-	0.0008 (0.564)	-	0.0136 (0.204)	-	0.0033 (0.163)	-	-0.0323*** (0.008)
R2	0.36	0.36	0.52	0.63	0.61	0.62	0.53	0.65

4.2. Spatial Correlation Test

From the test results of the traditional convergence model above, it can be seen that the R2 obtained by various tests is low, indicating that the model setting form may have defects. The results of the residual test show that there is a significant autocorrelation in the residual term, presumably due to the result of not considering the spatial correlation. Many empirical evidence also show that regional economies are growing at different rates, and these rates will tend to converge over time and are convergent with spatial correlation (Ivanova, 2018), so it is necessary to establish a spatial econometric model for correction.

Before using a spatial econometric model to analyze the relationship between innovation capacity and economic growth convergence, we first test whether the innovation capacity and economic convergence have a spatial correlation through an index. That is

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$$Moran's\ I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}}$$

$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$, $S^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}$, n is the number of regions, w_{ij} is elements of the spatial weight matrix. $\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}$ is the sum of all spatial weights. The value range of $Moran's\ I$ is [-1,1]. Greater than 0 indicates positive correlation, less than 0 indicates negative correlation, and equal to 0 indicates that there is no spatial correlation.

Figure 1 shows the index of China's provincial per capita GDP (taken as logarithm) from 2005 to 2016. I (1), I (2), and I (3) correspond to the adjacent space weight matrix, distance space weight matrix, and economy respectively. Index of the spatial weight matrix. The results show that during the sample period, the values all passed the 5% significance test. And the values over the years are positive and fluctuate slightly within the range of 0.2-0.4, which means that China's regional economic growth shows a positive spatial correlation, that is, the more developed provinces tend to be adjacent to the more developed provinces; the economy Relatively backward provinces are adjacent to relatively backward provinces. Different from the existing research, the values calculated in this paper showed a slowly rising trend before 2010, but gradually declined after 2010, indicating that although China's regional economic activities are not in a random state and tend to cluster, this kind of Agglomeration has been slowly declining in recent years. The reason may be that before 2010, the economy began to move towards agglomeration, and the economic agglomeration effect increased significantly to the maximum level; after 2010, the agglomeration economy basically formed, the economic radiation effect increased and the agglomeration effect was relatively small, so inter-provincial economic growth The spatial correlation gradually decreases. This result also supports the rationality of the phased division of the sample period above.

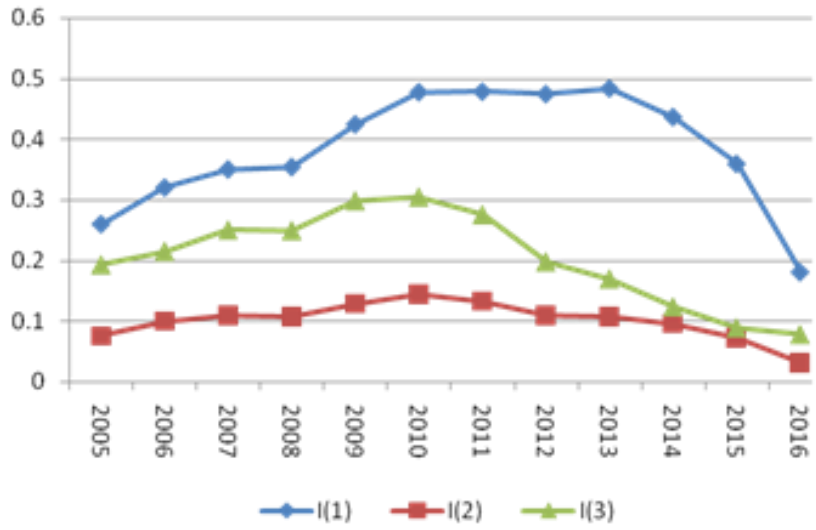

Figure 1. Moran 's I index of China 's per capita GDP from 2005 to 2016

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5. EMPIRICAL ANALYSIS OF CONVERGENCE MODEL CONSIDERING SPATIAL EFFECTS

5.1. Convergence Test Based on Spatial Econometric Model

In this paper, the Hausman test is first performed on the spatial Dubin model, the spatial lag model, and the spatial error model to determine whether it is more appropriate to use a fixed effect model or a random effect model for regression. The results show that the test statistic values of the absolute convergence model are 23.93, 106.64, 25.13, and p values are 0.0000 respectively; the test statistic value of the conditional convergence model is 18.31, 87.25, 42.01, and p values are 0.001, 0.000, 0.000. Both passed the 1% significance test and rejected the null hypothesis of random effects. Therefore, a fixed effect model should be selected for all three models. For the estimation of the spatial econometric model, the results estimated by the traditional OLS may be biased and invalid. The commonly used estimation methods include the two-stage least squares method (2GLS), the maximum likelihood method (ML), and the generalized moment method (GMM). For the dynamic space panel model, the ML estimation is more accurate than the GMM estimation. This paper follows previous experience and uses the ML estimation method to reveal the absolute and relative convergence characteristics of China's regional economic growth.

Table 4. ML estimation results of convergence test based on spatial econometric model

	Models	SDM Model		SAR Model		SEM Model	
	variables	Absolute Converge-nce	Conditio-nal Converge-nce	Absolute Converge -nce	Conditional Convergenc-e	Absolute Converge-nce	Conditional Convergen-ce
Adjacency space weight matrix	Lny(β)	-.0595***(0.000) (0.000)	-.0610***(0.000)	-.0322***(0.000)	-.0349***(0.000)	-.0533***(0.000)	-.0545***(0.000)
	Lnp(δ)	-	.00045(0.767)	-	0.00149(0.143)	-	0.00066(0.559)
	W*lny	0.03303***(0.000)	0.02840***(0.001)	-	-	-	-
	W*lnp	-	0.002845(0.235)	-	-	-	-
	λ or π	0.4924***(0.000)	0.4869***(0.000)	0.4006***(0.000)	0.4001***(0.000)	0.4927***(0.000)	0.4913***(0.000)
	σ_e^2	0.00028***(0.000)	0.00028*** (0.000)	0.0003(0.144)	0.0003(0.146)	0.003(0.173)	0.0003(0.174)
	R2	0.6417	0.6436	0.6302	0.6321	0.6408	0.6414
Distance space weight matrix	lny	-.08907***(0.000)	-.08955***(0.000)	-.03609***(0.001)	-.03931***(0.001)	-.06249***(0.000)	-.06485***(0.000)
	lnp	-	0.00103(0.549)	-	0.0021*(0.060)	-	0.00178*(0.088)
	W*lny	0.06634***(0.000)	0.06694***(0.000)	-	-	-	-
	W*lnp	-	-0.0011(0.726)	-	-	-	-
	λ or π	0.5835***(0.000)	0.5824***(0.000)	0.3442*(0.061)	0.3552**(0.048)	0.6436***(0.002)	0.6354***(0.001)
	σ_e^2	0.0003***(0.000)	0.0003***(0.000)	0.0003(0.123)	0.0003(0.126)	0.0003(0.168)	0.0003=(0.169)
	R2	0.6489	0.6496	0.6293	0.6298	0.6408	0.6418
Economic space weight matrix	lny	-.06638***(0.000)	-.07071***(0.000)	-.04272***(0.000)	-.04580***(0.000)	-.05696***(0.000)	-.06227***(0.000)
	lnp	-	0.00302*(0.082)	-	0.00201**(0.048)	-	0.00295**(0.033)
	W*lny	0.03803***(0.000)	0.04464***(0.000)	-	-	-	-
	W*lnp	-	-.00387(0.166)	-	-	-	-
	λ or π	0.48208***(0.000)	0.48914***(0.000)	0.1996(0.152)	0.2110(0.110)	0.50204***(0.000)	0.52325***(0.000)
	σ_e^2	0.00033***(0.000)	0.00033***(0.000)	0.00035(0.104)	0.00035(0.106)	0.0003(0.123)	0.0003(0.128)
	R2	0.6438	0.6466	0.6347	0.6349	0.6408	0.6414

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Note: λ is the space lag coefficient in the space lag model, and π is the space error coefficient in the space error model.

The results in Table 4 show that under the adjacent space weight matrix, distance space weight matrix, and economic space weight matrix, the coefficients are significantly negative at a significance level of 1%, indicating that China's economic growth has significant absolute and conditional convergence characteristics. Similarly, the absolute value of the conditional convergence coefficient is greater than the absolute value of the absolute convergence coefficient, which means that innovation accelerates economic convergence. Based on the estimated convergence coefficients, using equations (5) and (6), we can further calculate the absolute convergence and conditional convergence rate of China ’s overall economy and the half-life cycle from 2004 to 2016. The values in the table and the spatial weighting coefficients are both significantly positive in the spatial Dubin model, indicating the existence of spatial effects.

Due to space limitations, the following does not estimate each model one by one, but selects an appropriate model for analysis through model diagnosis. Whether the spatial lag model or the spatial error model is used, the commonly used discriminant criteria are the Lagrangian multiplier test and the likelihood ratio test. If LLMAG is statistically more significant than LMERR in the estimation of the spatial measurement model, LRERR is also more significant, then choose the spatial lag model; otherwise, choose the spatial error model (J. Paul Elhorst, 2010). From the above regression results, it can be seen that the parameter estimates of the three types of spatial weight matrices are not much different, so this paper only selects the distance spatial weight matrices for model diagnosis. The test results are shown in Table 5. The LR and LM of the spatial lag model are more significant than the spatial error model. Therefore, the spatial lag model is selected for the subsequent regression analysis.

Table 5. Model verification based on distance space weight matrix

Test statistics	SAR Model	SEM Model
LR	4.782**(0.029)	3.267*(0.071)
LM	4.267**(0.039)	0.175(0.676)

Based on the empirical results of the spatial lag model in Table 4, specific analysis is performed. Under the adjacent space weight matrix, the absolute convergence coefficient is -0.0322, the absolute convergence speed is 0.27%, and the half-life period is 256.7 years. The conditional convergence coefficient is -0.0349, and the conditional convergence speed. It is 0.29% with a half-life period of 239 years. Under the distance weight matrix, the absolute convergence coefficient is -0.03609, the absolute convergence rate is 0.31%, and the half-life period is 223.60 years. The conditional convergence coefficient is -0.03931, and the conditional convergence speed is 0.33%. The half-life period is 210.04 years; under the economic space weight matrix, the absolute convergence coefficient is -0.04272, the absolute convergence rate is 0.36%, and the half-life period is 192.54 years; the conditional convergence coefficient is -0.04580, the conditional convergence rate is 0.39%, and the half-life period is 177.73 year.

The above results verify that coordinated regional development is a arduous and long process. Although China ’s regional economic development gap has gradually been “flattened” by its own and innovative factors in recent years, backward regions have caught up with developed regions and realized their economies. The development of planarization takes at least a hundred years. The author believes that, on the one hand, the mechanism by which innovation promotes regional economic convergence is the learning effect of underdeveloped areas through

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technological imitation and catch-up; and the radiated and spillover effects of developed areas on the surrounding areas. On the other hand, regions with strong innovation capabilities usually have high-level talents and high capital density, which has a crowding effect on talents and capital inflows in other regions; and with the emergence of new technologies and emerging industries, low-tech industries And traditional manufacturing industries, such as innovation-led regions, continue to make gradient transfers, which is not conducive to economic convergence. Therefore, whether innovation can promote economic convergence depends on the competition between technology learning effects and spillover effects and factor crowding effects. Based on the current development of China, despite the significant effects of technology learning effects and spillover effects, China is still in the initial stage of innovation-driven implementation. Talents at different levels are still lacking, and the limited capital stock in some regions leads to insufficient innovation investment, so the factor crowding effect cannot be ignored.

5.2. Convergence Test of Economic Club Based on Spatial Lag Model

Similarly, in order to verify the spatial convergence of different regional economic clubs in China, three types of spatial weight matrices are introduced for regression estimation. Based on the spatial lag model, the regional economic club convergence test results (see Table 6) show that the convergence trends under the three types of spatial weight matrices are generally the same, but slightly different. The fitted spatial lag model is more effective than the traditional convergence model. Based on the spatial lag model, the convergence coefficient of each region, β is significantly negative at a significance level of 1%. The regional economic growth has significant characteristics of absolute club convergence and conditional club convergence, that is, the economic gap between the provinces and cities in the region was gradually "smoothed." σ_e^2 are significantly positive, indicating that there is a positive spatial effect, while the spatial lag coefficient is significantly positive only in the central and western regions, and less significant in the eastern and northeastern regions, indicating that the central and western regions have stronger positive per capita GDP growth rates Spatial autocorrelation. This article speculates that the spatial effects of the eastern and northeastern regions may exist more in the form of spatial errors, leading to this result. In addition, the regression coefficients of the innovation capacity measured by the three types of spatial weight matrices also showed a high degree of consistency. The estimated regression coefficients of the innovation capacity in the east and west are positive, the east is more significant and the west is not significant, which means that the The growth rate of per capita GDP increases with the improvement of innovation capacity; the estimated regression coefficients of innovation capacity in the central and northeast regions are both negative, but not significant.

Considering the rationality of the selection of the spatial weight matrix, this paper tends to the test results of the distance spatial weight matrix, and believes that a simple adjacent spatial matrix cannot well fit the spatial relationship between regions. For example, Hainan Province is not adjacent to any of the other 29 provinces and cities, and is considered as an island in the adjacent space matrix. Obviously, in practice, Hainan Province is more closely related to its neighboring provinces Guangdong and Guangxi; and economic space Because the weight matrix uses the per capita GDP to measure the economic distance, the weight matrix overlaps with the variables in the model or causes estimation errors. In addition, although the method of setting the spatial weight matrix of the model is different, it basically does not change the direction of convergence, and there are certain commonalities with the test results under the traditional model. The reflected innovation has basically the same effect on the convergence of regional economic clubs. , Illustrates the robustness of the results of this study.

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Table 6. Economic club convergence test results for three types of spatial weight matrices

	Regions	Eastern area		Middle Area		Western area		East-northern Area	
	Variables	Absolute Convergence	Conditional Convergence	Absolute Convergence	Conditional Convergence	Absolute Convergence	Conditional Convergence	Absolute Convergence	Conditional Convergence
Adjacency space weight matrix	Lny(β)	-0.033*** (0.000)	-0.038*** (0.000)	-0.028*** (0.000)	-0.022*** (0.003)	-0.176*** (0.000)	-0.185*** (0.000)	-0.088*** (0.000)	-0.075*** (0.002)
	Lnp(δ)	-	0.00244* (0.095)	-	-0.0026 (0.297)	-	0.0008 (0.418)	-	-0.0087 (0.387)
	λ	0.0398 (0.617)	0.0511 (0.519)	0.4368*** (0.000)	0.4536*** (0.000)	0.6573*** (0.000)	0.6628*** (0.000)	0.0855 (0.624)	0.086 (0.621)
	σ_e^2	0.0001*** (0.000)	0.0001*** (0.000)	0.00007*** (0.000)	0.00007*** (0.000)	0.00005*** (0.000)	0.00005*** (0.000)	0.0013*** (0.000)	0.0013*** (0.000)
	R2	0.64	0.65	0.86	0.86	0.85	0.85	0.63	0.64
	obs	120	120	72	72	120	120	48	48
Distance space weight matrix	Lny(β)	-0.032*** (0.000)	-0.037*** (0.000)	-0.019*** (0.000)	-0.013*** (0.046)	-0.015*** (0.000)	-0.016*** (0.000)	-0.094*** (0.000)	-0.081*** (0.001)
	Lnp(δ)	-	0.00254* (0.083)	-	-0.0026 (0.223)	-	0.0002 (0.854)	-	-0.0087 (0.388)
	λ	0.08 (0.617)	0.1019 (0.312)	0.6104*** (0.000)	0.624*** (0.000)	0.724*** (0.000)	0.725*** (0.000)	0.015 (0.923)	0.014 (0.929)
	σ_e^2	0.0001*** (0.000)	0.00009*** (0.000)	0.00005*** (0.000)	0.00005*** (0.000)	0.00006*** (0.000)	0.00006*** (0.000)	0.0013*** (0.000)	0.0013*** (0.000)
	R2	0.64	0.64	0.87	0.86	0.85	0.86	0.63	0.64
	obs	120	120	72	72	120	120	48	48
Economic space weight matrix	Lny(β)	-0.031*** (0.000)	-0.037*** (0.000)	-0.015*** (0.001)	-0.012*** (0.053)	-0.021*** (0.000)	-0.021*** (0.000)	-0.098*** (0.000)	-0.085*** (0.000)
	Lnp(δ)	-	0.00264* (0.078)	-	-0.0015 (0.474)	-	0.0002 (0.838)	-	-0.0089 (0.378)
	λ	0.088 (0.368)	0.110 (0.255)	0.622*** (0.000)	0.625*** (0.000)	0.580*** (0.000)	0.581 (0.929)	0.024 (0.853)	-0.0334 (0.796)
	σ_e^2	0.0001*** (0.000)	0.0001*** (0.000)	0.00005*** (0.000)	0.00005*** (0.000)	0.00009*** (0.000)	0.00008*** (0.000)	0.0013*** (0.000)	0.0013*** (0.000)
	R2	0.63	0.64	0.88	0.87	0.86	0.86	0.63	0.64
	obs	120	120	72	72	120	120	48	48

Under the distance space weight matrix, the regions are ranked in order of northeast, east, middle, and west according to the absolute convergence speed. The results are significantly different from the results under the adjacent space matrix, which are 0.82%, 0.27%, 0.16%, and 0.13%, respectively. With convergence, the half-life cycles of the backward provinces catching up with the developed provinces in each region are 84.53 years, 256.72 years, 433.22 years, and 533.19 years; the conditions of convergence from fast to slow are Northeast, East, West, and Central, respectively, 0.70% , 0.31%, 0.13%, 0.11%, under the conditions of convergence, the half-life cycles of the backward provinces to catch up with the developed provinces are 99.02, 223.60, 533.19, and 630.13 years. This result shows that: first, within the region, innovation did not promote the convergence of the central and northeast regions, but inhibited it. It did not promote or inhibit the western region, but accelerated the convergence of the eastern region. Only in the eastern region, the technological learning and crowding effect is greater than the factor crowding effect. Second, between regions, the central and western convergence rates under the model framework are slower than those in the economically developed eastern regions, which is expected to catch up economically. Because the region's convergence rate is much higher than that of the east, and the degree of economic development is far behind that of the east, a faster convergence rate means a lower final economic level and cannot narrow the economic gap with the east.

In summary, the regional economic growth has obvious characteristics of absolute convergence and conditional convergence. The economically underdeveloped northeast region converges faster than the economically developed eastern region. This is consistent with Guastella & Timpano (2015) 's study of European countries as sample data. The conclusion is that the slower the rate of economic convergence in the less developed regions is the opposite.

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At the same time, innovation only accelerates the economic convergence of the eastern region. The reason may be that the innovative economy in the eastern region is more active, and there is a strong economic interaction in the region, which reduces the cost of internal technology learning and imitation, thus promoting economic convergence. The role is strong; the development of the Northeast is relatively backward, the innovation base is weak, and innovation activities are relatively blocked; the central region has a large internal economic difference, and innovation has a restraining effect on economic convergence. The convergence of economic growth between regions in China is related to the adjustment of regional development policies (Lu Ming, 2017). The above results indirectly reflect the poor implementation of the Northeast Revitalization Strategy and the Central China Rising Strategy, which failed to play a leading role in local economic development. The western region, which is also lagging behind, may benefit from the effective implementation of the western development strategy, but the effect is relatively weak, so the economic growth response to innovation is not obvious.

6. CONCLUSIONS AND POLICY IMPLICATIONS

Based on the β convergence equation of Barro (1992), this paper uses the panel data of 30 provinces and cities in China from 2004 to 2016 to carry out empirical research on the period, region and industry level, and further introduces three types of spatial weight matrix to establish spatial measurement. The model conducts an in-depth analysis and more comprehensively characterizes the convergence of China's economic growth, so as to respond to the question of whether China's regional economy is being "flattened." The main conclusions are as follows:

First of all, during the period under review, there was a phenomena of absolute convergence and conditional convergence in China's overall economy. Innovation is one of the important means of “placing” China ’s economic gap. Innovation has accelerated the rate of economic convergence and shortened the balanced development cycle of the regional economy. The realization path is mainly to promote the convergence of the secondary industry, thereby promoting the overall economic convergence. At the current level of innovation and development speed, it will take at least more than a century for China's backward areas to catch up with developed areas and achieve economic flattening. Secondly, there are also significant club convergence characteristics in the eastern, central, western and northeastern regions of China. The convergence rate is faster in areas where the economy is lagging behind. In absolute convergence northeastern area is faster than eastern area and middle area, and western area comes last. While the conditional convergence speed is Northeastern> Eastern> Western> Midddle area. For the middle and western regions, it is still expected to catch up with the eastern region, while the northeastern region is difficult to catch up, and the economic gap between the eastern and northeastern regions is likely to widen. Finally, from a spatial perspective, the role of innovation in economic convergence is uncertain. It may be due to the different convergence trends of regional conditions at different development stages and different resource endowments. It may also be that innovation has a threshold effect on economic convergence. Innovation can only promote economic convergence if it accumulates to a certain degree. The main manifestation is that innovation has a stronger promotion effect on the economic convergence in the east, and has a certain inhibitory effect on the economic convergence in the central and northeast regions. . In a nutshell, China's regional economy is slowly "smoothed" by its own potential external factors and innovation and other external factors. When only considering innovation, the rate of economic convergence is only about 0.3%.

In view of the above conclusions, this paper proposes the following policy implications for the development of China's regional economy:

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Firstly, vigorously promote the innovation-driven strategy and gradually optimize the industrial structure. The research in this paper believes that the spatial spillover effect of innovation can "smooth out" the economic gap in China. Because the convergence of the secondary industry has made a significant contribution to the overall economic convergence, innovation activities are also mainly concentrated in the secondary industry, thus promoting the process of coordinated regional development. In China, it is not feasible to blindly develop the tertiary industry and ignore the secondary industry. To pursue the industrial structure dominated by the tertiary industry, China still needs a long process of development and evolution. We can start with the secondary industry, vigorously develop emerging industries such as advanced manufacturing and high-tech industries, and gradually optimize the industrial structure through industrial innovation. Therefore, it is necessary to further increase human capital investment. On the one hand, it can increase local investment in education and technology, strengthen the cultivation of scientific and technological innovative talents, and strive for the national "Thousand Talents Plan" and "Ten Thousand Persons Plan" for the Midwest and Northeast China. Regional priority support; On the other hand, we must constantly improve the supply of supporting welfare policies such as pensions, medical care, and housing purchases in backward areas to attract the accumulation and development of innovative talents.

Secondly, focus on revitalizing the Northeast regional economy and actively cultivate new economic momentum. For the Northeast region, relying solely on innovation is not enough to catch up with other economically developed regions. Therefore, it is urgent to introduce other supportive policies and measures to cultivate a competitive advantage with Northeast ’s own characteristics and make it develop in a short-term direction. Or reduce the speed of convergence. For example, the development of modern agriculture in the Northeast has a unique geographical advantage. It is recommended that it take the development of advantageous agriculture and moderate scale operations to optimize the industrial structure of products as an important starting point, vigorously develop e-commerce agriculture, rural ecotourism, and expand the agricultural industry chain and The value chain is based on the promotion of agricultural science and technology, cultivation of agricultural science and technology talents as the innovation approach, and the strengthening of agricultural science and technology innovation drive as the technical support. Through a series of agricultural system and mechanism innovations, the Northeast economy is transformed into a sustainable and ecologically sustainable direction.

Thirdly, formulate regional development strategies and establish cross-regional and multi-level cooperation mechanisms based on local conditions. The development process of different regions in China is different, and regional innovation policies suitable for local development should be formulated instead of adopting "one size fits all" measures. The eastern region has a sound economic foundation and rich innovation achievements. It should give full play to its role of supporting and leading the country's innovation and development, continue to attach importance to knowledge innovation and accumulation, seek original technological innovation, enhance endogenous innovation capabilities, and further promote the export-oriented economy. Development; the central region should accelerate the upgrading of traditional industries in terms of new industrialization, informatization, urbanization, agricultural modernization and greening, and develop technology-intensive industries and new industries in a timely manner; While improving the level of economic development in Northeast China and other underdeveloped regions, technology import and learning should be strengthened in order to achieve innovative breakthroughs in some key areas and applicable technologies. At the same time, on the basis of encouraging each region to give full play to its own advantages, it is also necessary to make full use of the spillover effects and radiation effects of economic agglomeration, and strengthen cross-regional and multi-level integration of industry, university, research, and other governments, enterprises, and universities in the east and less developed

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regions Cooperation to establish and improve the counterpart assistance mechanisms in the east and northeast, central and west regions, in order to better "move up" the economic gap between different regions, and enhance China's comprehensive innovation capability and competitiveness.

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