Empirical Analysis of The Impact of Industrial Convergence on The Regional Economy of The Yangtze River Delta

Ziqi Zhou[1,*]

[1]Faculty of Arts and Social Science, University of Sydney, China

Abstract. Regional integration is an important measure to promote the development of China's regional economy. Analyzing regional economies through statistical methods and studying the causes of regional economic differences can provide effective analysis and scientific advice on the economic development problems of each region, which is conducive to a more accurate understanding of China's regional economic development and the promotion of the healthy development of each region. Based on a statistical perspective, this paper analyses industrial convergence in the context of regional integration in the Yangtze River Delta region and clarifies the current situation of industrial convergence in the Yangtze River Delta region. Then, using data from four provinces and cities in Anhui, Shanghai, Jiangsu and Zhejiang for three consecutive decades from 1992 to 2021, a fixed-effects panel data regression model is established.t

1.INTRODUCTION

The Yangtze River Delta city cluster is located in the central coastal region of China and includes Shanghai, Zhejiang Province, Jiangsu Province and later Anhui Province. In 1976 the French geographer Gottmann had already listed the Yangtze River Delta as one of the six largest urban agglomerations in the world, giving the Yangtze River Delta a high international profile and influence, making it easier to attract foreign investment. The Yangtze River Delta regional economic integration is designed to break down artificial barriers such as policies to achieve synergistic economic development and steady growth in each region within the Yangtze River Delta.

1.1 Problem Statement

Over the past 35 years, the Yangtze River Delta integration process has made tremendous progress. According to the newly released Yangtze River Delta Integration Development Index Report (2022), the Yangtze River Delta Integration Development Index was 192.56 points in 2021, an increase of 6.49% year-on-year, achieving a breakthrough development. There are a total of 23 cities in China with a GDP of over a trillion, and the Yangtze River Delta accounts for 8 of them. It is evident that the integrated development of the Yangtze River Delta has effectively contributed to the GDP growth of the Yangtze River Delta regions and helped the provinces and cities in the region to achieve economic breakthroughs.

As the economic development of the Yangtze River Delta region continues to advance, there is a greater demand for spillover from all regional economic industries within the Yangtze River Delta (Lu & Huang, 2013). In addition to this, China's efforts to develop regional economic integration in the Yangtze River Delta not only contribute to the economic development of the provinces and cities within the Yangtze River Delta region, but ultimately aim to drive the economic development of cities across the Yangtze River basin, increase the speed of economic development and narrow the regional economic development gap. Therefore, since 2010, some cities in Anhui Province have gradually joined the Yangtze River Delta until the end of 2019, when all of Anhui Province will join the Yangtze River Delta and the Yangtze River Delta region will officially cover four provinces: Shanghai, Jiangsu, Zhejiang and Anhui.

The analysis of industrial convergence and economic growth in the Yangtze River Delta region using statistical principles can effectively clarify the situation of industrial convergence and economic growth in the Yangtze River Delta region, as well as the relationship between the two, and thus provide some support to promote the economic development of the Yangtze River Delta region.

1.2 Objectives

Most previous studies on industrial convergence in the Yangtze River Delta have only analysed Shanghai, Zhejiang and Jiangsu provinces, but have not updated the situation in Anhui Province, which has been added to the Yangtze River Delta, and most of the studies have started from the Yangtze River Delta as a whole, lacking in-depth analysis of the provinces and cities within the Yangtze River Delta. Most of the previous studies are based on a single statistical analysis method of regression

* Corresponding author: zhouziqi202203@163.com

analysis, and there is a lack of in-depth comparative analysis of the industrial convergence data in the Yangtze River Delta region. The aim of this paper is to fill this research gap and help to correctly understand the current industrial convergence in the Yangtze River Delta and its impact, in the hope of helping the Yangtze River Delta economy to develop in a healthy and effective manner.

2.Theoretical Analysis and Research Hypothesis

This paper will analyse the relationship between industrial convergence and economic growth in the context of regional economic integration from two perspectives: marginal cost and overcapacity.

An increase in the level of industrial convergence will increase the marginal cost of each region in an economically integrated region and reduce the efficiency of economic growth. From the perspective of intra-regional economic development, the development of regional economic integration significantly reduces the level of intra-regional transaction costs, supporting the synergistic development of the regional economy. Assuming that economic integration achieves the fully integrated development of multi-provincial regional economies, intra-regional transaction costs are zero. Therefore, with no trade transaction costs, regions will tend to produce lower cost and more profitable products in order to maximise profits. For simplicity of description, the following settings are made: (1) two regions A and B are set to exist in the economically integrated region; (2) two regions A and B produce product 1 and product 2 respectively, both at the same price of x and with no cost trade between the regions; (3) the costs of producing product 1 and product 2 in region A are w and e respectively, and the marginal costs of producing product 1 and product 2 in region B are r and t respectively, where w<r, e>t; (4) set the demand for product 1 and product 2 in both regions to be the same as M, and the volume of product 1 and product 2 traded between the two regions to be m. Then, under this setting, in order to pursue profit maximization, region A will dominate the production of product 1, and region B will dominate the production of product 2, and then conduct regional trade to meet the demand, and the gross economic product of the two regions will be as follows.

$$Y_A = [x - w](M + m) + [x - e](M - m) \quad (1)$$

$$Y_B = [x - r](M + m) + [x - t](M - m) \quad (2)$$

where, Y_A and Y_B are the economic output of the two regions respectively.

In this context, if both regions A and B give up the production of high-cost products and only produce low-cost products, and then trade to meet demand, the industrial convergence between the two regions will be minimised, the output value of the two regions will be maximised and economic growth will be at its highest level. Thus, in the context of regional integration, if all regions in the region base their industrial development on the lowest marginal cost, the level of industrial convergence between regions will reach the lowest, and the increase in industrial convergence means that the marginal cost of industries in the region will increase, and regional economic growth will slow down.

The increase in the level of industrial convergence will lead to the emergence of regional overcapacity and affect the level of economic growth. If all the resources in the region are directed towards a particular industry or sector, this will lead to rapid development of the industry and a significant increase in production capacity, which, if left unregulated, will lead to overcapacity when capacity exceeds market demand. Excess capacity will weaken the market advantage of products in the economically integrated region for export trade outside the region, product prices will begin to decline and competition in the industry will begin to intensify rapidly, which will not only be detrimental to the development of the industry, but will also result in the waste of resources invested in the early stage, leading to a slowdown in economic growth. From the perspective of industrial convergence, industrial convergence means that a certain industry in each region is concentrated and the concentration level of regional resource use increases, which will not only bring the risk of resource use, but also lead to the problem of over-capacity, which will affect the economic growth rate.

As a result, this paper puts forward the following hypothesis: an increase in the level of industrial convergence in each region of an economically integrated region will lead to a slowdown in economic growth in the integrated region.

3.ANALYSIS OF THE CURRENT SITUATION

The paper mainly uses literature analysis, comparative analysis and empirical research methods to carry out the analysis.

Using the empirical analysis method, a fixed-effects regression model was constructed to verify the relationship between industrial convergence and economic development by taking the data related to industrial convergence and economic development of the three provinces and one city in the Yangtze River Delta region for the past 30 years as samples.

Table 1. Selected Variables

Variable Type	Variable Name	Variable Symbols	Variable Definitions
Explained Variables	Economic Development	lngdp	Logarithm of regional GDP
Explanatory Variables	Regional Industrial Convergence	lnsd	Logarithm of the standard deviation of the regional output of the three industries
Controlling Variables	Financial Expenditure	fina	Local fiscal general budget expenditure/GD

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	Railway Distribution	rail	Railway mileage/area area (in kilometres per 10,000 square kilometres)
	Total Imports and Exports	foreign	Total imports and exports/GDP (in millions of US$/billion)

Considering that the purpose of regional economic integration is to promote the synergistic development of regional economy and achieve the improvement of the speed and quality of economic development, this paper adopts the regional gdp level to measure the level of regional economic integration and takes the logarithm of the GDP level.

The explanatory variable in this paper is industrial convergence. Industrial convergence is defined as the degree of similarity of industrial development in the region, so the standard deviation of the three industries is used to measure it. The larger the standard deviation, the higher the degree of dispersion, the greater the variability of the development of the three industries (indicating stronger industrial convergence); the smaller the standard deviation, the smaller the variability of the development of the three industries and the weaker the industrial convergence. The smaller the standard deviation, the smaller the difference between the three industries and the weaker the industrial convergence.

In this paper, the level of fiscal expenditure, railway density and foreign trade dependence are chosen as control variables respectively. The amount of fiscal budget expenditure reflects the financial input of the regional government. Railway density reflects the level of regional road transport development. Last but not least, the higher the level of openness of a country's economy, the better the country's economic development will be supported and the faster the economic development will be.

4.NON-PARAMETRIC TESTS OF INDUSTRIAL CONVERGENCE IN THE THREE PROVINCES AND ONE CITY OF THE YANGTZE RIVER DELTA

Based on the Kruskal-wallis test, the industrial convergence of the three provinces and one city in the Yangtze River Delta over the past ten years is tested. Based on the industrial convergence data used in the analysis of this paper, the share of the three industries in the three provinces and one city in the Yangtze River Delta is analysed separately. In addition, considering that Shanghai, as one of the five municipalities directly under the Central Government of China, has opened up to the outside world earlier than the other three provinces in the Yangtze River Delta, and that there are some differences between the economic development of the city and the other three provinces, the three provinces in the Yangtze River Delta and the three provinces in the Yangtze River Delta are examined separately.

Table 2. Kruskal-Wallis Test Results

Content of Testing	Area of Testing	Chi-square	Progressive Significance
Percentage of Primary Sector	Anhui, Zhejiang, Jiangsu, Shanghai	35.268	0.000
Percentage of Primary Sector	Anhui, Zhejiang, Jiangsu	23.484	0.000
Percentage of Secondary Sector	Anhui, Zhejiang, Jiangsu, Shanghai	22.980	0.000
Percentage of Secondary Sector	Anhui, Zhejiang, Jiangsu	1.814	0.404
Percentage of Tertiary Sector	Anhui, Zhejiang, Jiangsu, Shanghai	21.104	0.000
Percentage of Tertiary Sector	Anhui, Zhejiang, Jiangsu	3.796	0.150

The test results show that the asymptotic significance of the Kruskal-Wallis test results for the secondary and tertiary industries of Anhui, Zhejiang and Jiangsu provinces over the past 10 years are 0.404 and 0.150 respectively, which are both greater than 0.05 and not significant. The convergence of the two and three industries in these three provinces is very obvious

5.MATERIALS AND METHODS

5.1 Equations

A panel data regression model was developed based on a sample of four provinces, Anhui, Shanghai, Jiangsu and Zhejiang, for the consecutive thirty years from 1992 to 2021 to carry out regression analysis, and the model was constructed as follows.

$$lngdp_{i,t} = \alpha_0 + \alpha_1 lnsd_{i,t} + \alpha_2 lnfina_{i,t} + \alpha_3 lnrail_{i,t} + \alpha_4 lnforeign_{i,t} + i.year + \varepsilon_{i,t} \quad (3)$$

whereα_0 is the intercept, and$\alpha_1 - \alpha_5$ is the coefficient of the variable,$\varepsilon_{i,t}$ is the random disturbance term and i.year is the year control variable.

5.2 Descriptive Statistical Analysis

The descriptive statistical analysis was first carried out on the sample data selected for this paper, as shown in the table below.

Table 3. The Descriptive Statistical Analysis to The Sample Data Selected

Variable	Obs	Mean	Std. Dev.	Min	Max
gdp	120	9.425	1.200	6.718	11.664
lnsd	120	7.860	1.513	3.702	10.302
fina	120	0.129	0.051	0.049	0.232
rail	120	0.028	0.020	0.007	0.079
foreign	120	7.661	5.738	0.860	22.154

According to the data in the table, both variables, economic development as measured by the value of GDP and industry convergence, show a mean greater than the standard deviation, indicating a low level of dispersion. Likewise, both also show a large difference in extreme values, indicating a large development gap in some regions in some years.

In addition, there is a large extreme difference between total exports and imports, which is caused by the low level of economic development in the 1990s and the high economic growth that began after joining the World Trade Organisation in 2001.

5.3 Multicollinearity test

In this paper, a regression model is used as the research model. The application of the model requires the assumption that there is no serious co-linearity between the variables in order to achieve good reliability of the model analysis. Therefore, a multicollinearity test needs to be conducted on each variable.

Table 4. The Result of VIF Test for Multiple Cointegration

Variable	VIF	1/VIF
rail	4.33	0.231073
fina	3.32	0.301577
foreign	2.48	0.402738
lnsd	1.75	0.570503
Mean VIF	2.97	

The test results show that the VIF values of all variables are less than 10, indicating that there is no serious problem of multicollinearity among the variables, which will not lead to serious bias in the regression results and ensure the accuracy of the results.

5.4Hausman Test Results

The panel data regression model included both fixed and random effects categories, so the Hausman test was used to verify the strengths and weaknesses of the fixed and random effects of the model.

$$chi2(33)=(b-B)'[(V\_b-V\_B)^{(-1)}](b-B)=137.02$$

$$Prob>chi2=0.0000 \quad (4)$$

The results of the hausman test show that the p-value of 0.000<0.01 significantly rejects the original hypothesis at the 1% level, then the fixed effects model is judged to be superior to the random effects model and the prescribed effects model is chosen as the model for analysis.

5.5Regression Analysis

Based on the regression model in this paper, regression analysis was carried out and the results are shown in the table below.

Table 5. The Results of Regression Analysis

gdp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnsd	0.104	0.029	3.58	0.001	0.046	0.162
fina	-1.119	0.505	-2.21	0.030	-2.124	-0.114
rail	-6.827	1.206	-5.66	0.000	-9.226	-4.428
foreign	0.016	0.004	3.96	0.000	0.008	0.024
Years	Control					
_cons	6.733	0.160	42.01	0.000	6.414	7.052

Based on the regression results, it can be seen that the coefficient of lnsd on gdp is 0.104, which is significant at the 1% level, indicating that an increase in the level of lnsd will bring about an increase in the level of gdp. An increase in lnsd represents a decrease in industrial convergence, and therefore a decrease in industrial convergence can achieve an increase in the level of regional economic development.

5.6Robustness Tests

This paper uses the replacement variable method for robustness testing, replacing the independent variable gross economic product (GDP) with gross domestic product per capita (pgdp) and conducting another regression to verify the robustness of the model, the results are shown in the table below.

Table 6. The Results of Robustness Tests

pgdp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnsd	0.297	0.050	5.97	0.000	0.198	0.396
fina	-1.740	0.867	-2.01	0.048	-3.463	-0.016
rail	-12.091	2.069	-5.84	0.000	-16.206	-7.977
foreign	0.012	0.007	1.71	0.091	-0.002	0.025
Years	Control					
_cons	6.808	0.275	24.77	0.000	6.262	7.355

Replacing GDP with GDP per capita (pgdp), the results are consistent with the direction of impact and significance of the original regression results, indicating good robustness of the model.

6.CONCLUSION

Through quantitative statistical analysis, non-parametric tests and regression analysis of industrial convergence in each of the three provinces and cities in the Yangtze River Delta, this paper finds that the level of industrial convergence in the three provinces and cities in the Yangtze River Delta is on the rise. In Anhui, Jiangsu and Zhejiang, the convergence of secondary and tertiary industries is extremely obvious. The regression analysis verifies the hypothesis that reducing the degree of industrial convergence can achieve an increase in the level of economic development in each region, and draws conclusions.

This paper conducted a regression analysis on sample data from four regions - Anhui, Shanghai, Jiangsu and Zhejiang - over the past 30 years and concluded that industrial convergence does exist in the four regions, and that reducing industrial convergence can achieve an increase in the level of economic development in each region.

In order to achieve healthy and sustainable development of the regional economy and promote the economic integration of the Yangtze River Delta, each city should develop its own advantageous industries and fundamentally reduce the impact of vicious competition for resources caused by the tendency of industrial homogenisation. In addition, it is suggested that the Yangtze River Delta region should strengthen the division of labour among industries. Similar industries can be formed in a stratified industrial chain according to the different advantageous conditions of each region, so that not only can regional advantages be brought into play and competition for resources be reduced, but also economic ties between regions can be strengthened, production efficiency improved and specialised production realised.

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