



# Research on the Coordination Degree of Higher Education and Economy under the Background of Information Education--Based on the Panel Data of 31 Provinces and Cities from 2010 to 2019

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## Abstract

Based on the development trend of informatization education, the coupling coordination degree and spatial effect of higher education and economic development are studied by using the coordination degree evaluation model and Moran scatter diagram. Even though the level of educational informatization in our country is increasing year by year, the coupling coordination degree of Chinese higher education and economy has been in weak coordination for a long time, the coupling degree of East China has been in low coordination, the coupling coordination of central China has changed from weak coordination to low coordination, the coupling degree of North China and South China belongs to weak coordination, and the coupling degree of northeast, southwest and northwest is weak imbalance. In addition, the spatial effect of Chinese higher education and economic coordination degree is weakening, the coupling coordination degree of northeast, northwest and central China has a negative correlation in space, and the negative correlation of northwest is the strongest, which shows the effect of informatization education in China is relatively weak. To improve the coupling and coordination of Chinese higher education and economy, it is very important to build intelligent learning platform, such as constructing an educational technology system framework, exploiting educational software and hardware.

**Keywords:** Information Education, Degree of Coupling and Coordination, Spatial Effect, Intelligent Learning Platform.

## 1 INTRODUCTION

In 2020, China will build a well-off society in an all-round way, which puts forward higher requirements for the coordinated development of higher education and economy. In March 2021, the fourth session of the 13th National People's Congress issued the outline of the 14th five year plan for national economic and social development and the long-term objectives for 2035, in order to accelerate the coordinated development of Chinese education and economy. On October 16, 2021, Xinhua News Agency issued "solidly promote common prosperity", pointing out that we should improve the balance, coordination and inclusiveness of the development of education, economy and other aspects,

and promote the equalization of basic public services in education, economy and other fields.

From the perspective of foreign literature, higher education data mining is conducive to improving educational competitiveness from the perspective of higher education data mining from 2000 to 2017 [3]. In addition, there is the relationship between multiple indicators of education: psychological input, academic achievement, school attendance, destructive behavior, suspension and dropout and teaching efficiency [1]. It shows the relationship between economic status and educational achievements of developing countries and found that the overall relationship between economic status and educational achievements is weak, and the effect is stronger in countries with more developed economies [10]. In addition to these documents, the

imbalance between education and economic development in eastern, central and Western China will lead to unfair access to higher education and reduce the positive effect of education economy [7]. For foreign literature, few scholars study the relationship between education and coordinated economic development.

From the domestic literature, the coupling coordination degree between higher vocational education and economic and social development in China has developed from extreme imbalance to high coordination [9]. The contribution rate of graduate education efficiency to economic growth varies greatly in various regions by calculating the contribution proportion of graduate education to economic growth [6]. Furthermore, the effect of various indicators of education on economic growth, indicating that improving the innovation power helps to enhance the coordination between education and economy [5]. For the domestic literature, whether it is the theoretical analysis or empirical research of the correlation between higher education and economy, few scholars study the coordination for two systems, and lack of in-depth analysis.

The contribution of this paper is reflected in three aspects: firstly, at present, few articles study the coupling coordination degree of higher education and economy based on education system and economic system. In this paper, four primary indicators of higher education are used to measure the evaluation of higher education competitiveness, four primary indicators of economy are used to measure the evaluation of economic competitiveness, and then the coordination degree between higher education and economy is calculated based on the coupling coordination degree model. Secondly, this paper presents the coordination between higher education and economic competitiveness evaluation from the whole country and 7 regions, compares and analyzes the reasons for the differences. Thirdly, based on Moran index and Moran scatter diagram, this paper analyzes the spatial effect of the coupling degree between higher education and economy in the seven regions, so as to provide a theoretical basis for higher education to drive economic development and economic growth to drive the development of higher education. This paper enriches the literature research on the coupling degree between higher education and economic development.

## 2 RESEARCH DESIGN

### 2.1 Construction of Index System

This paper combines with Michael Porter's diamond model, selects indicators according to scientificity, relevance, and data availability, and constructs higher education and economic indicators [2]. The evaluation of higher education competitiveness is measured by 20 secondary indicators and the evaluation of economic

competitiveness is measured by 10 secondary indicators, as shown in Table 1-2.

**Table 1:** Evaluation index of higher education.

Indicators	Secondary indicators	Weight
Education scale	Number of higher education schools (+)	0.079
	Number of graduate students (+)	0.065
	Number of undergraduate students (+)	0.093
Education resources	Footprint (+)	0.035
	Books (+)	0.042
	Fixed asset value (+)	0.037
	Full-time teachers (+)	0.036
	Teacher with senior professional title (+)	0.039
	Expenditure (-)	0.020
Education quality	R&D expenditure (-)	0.016
	Three national S&T awards (+)	0.032
	State council S&T progress award (+)	0.044
	Published S&T works (+)	0.043
	Published academic papers (+)	0.043
	Number of project acceptances (+)	0.041
Education benefit	Number of patents granted (+)	0.040
	R&D results application project (+)	0.079
	Technology service project (+)	0.091
	Income from the sale of patents (+)	0.061
	Technology transfer income (+)	0.064

**Table 2:** Evaluation index of economic.

Indicators	Secondary indicators	Weight
Economic scale	Gross Regional Product ( + )	0.081
	Total retail sales of consumer goods ( + )	0.083
	Total foreign trade import and export ( + )	0.076
Economic structure	The tertiary industry's share of GDP ( + )	0.131
	Primary industry / secondary industry ( + )	0.111
Economic structure	GDP growth rate ( + )	0.086
	Urban unemployment rate ( - )	0.115
Economic benefits	GDP per capita ( + )	0.120
	Local public finance budget revenue ( + )	0.093
	Disposable income of urban residents ( + )	0.104

## 2.2 Data Processing

$X_i$  represents the value of the  $i$ th secondary index of the higher education system ( $i = 1, 2, \dots, m$ ), and  $Y_j$  represents the value of the  $j$ th secondary index of the economic system ( $j = 1, 2, \dots, n$ ). In order to eliminate the errors of higher education data and economic data on the order of magnitude, the data are processed in a standardized way, and the processing results are  $X'_i, Y'_j$ . If  $X_i$  is a positive indicator, as shown in formula (1); If  $X_i$  is a negative indicator, it is shown in formula (2).

$$x'_i = \frac{x_i - \min(x_i)}{\max(x_i) - \min(x_i)} \quad (1)$$

$$x'_i = \frac{\max(x_i) - x_i}{\max(x_i) - \min(x_i)} \quad (2)$$

## 2.3 Research Methods

### 2.3.1 Comprehensive Evaluation of Higher Education and Economy

$X'_i$  represents the value of the  $i$ th secondary index of the higher education system ( $i = 1, 2, \dots, m$ ),  $Y'_j$  represents the value of the  $j$ th secondary index of the economic system ( $j = 1, 2, \dots, n$ ),  $a_i$  represents the weight of the  $i$ th secondary index of the higher education system ( $i = 1, 2, \dots, m$ ),  $b_j$  represents the weight of the  $j$ th secondary index of the economic system ( $j = 1, 2, \dots, n$ ).  $a_i$  and  $X'_i$  multiply and accumulate to get  $u(x)$ , indicating the

comprehensive score of the higher education system;  $b_j$  and  $Y'_j$  multiply and accumulate to get  $w(y)$ , indicating the comprehensive score of the economic system. The higher the  $U(x)$  score, the better the development of higher education in this region; if the  $w(y)$  score is higher, it indicates the economic development of the region has more advantages.

### 2.3.2 Coupling Coordination Degree

Evaluation model coupling coordination degree is to measure the degree of collaborative development among multiple systems. The research object of this paper is Chinese higher education system and economic system. Only the coupling degree between the two systems is considered. The calculation of coupling coordination degree is shown in formulas.

$$C = 2\sqrt{u(x)w(y)}/[u(x) + w(y)] \quad (3)$$

$$T = \alpha u(x) + \beta w(y) \quad (4)$$

$$D = \sqrt{CT} \quad (5)$$

$C$  is the coupling degree,  $T$  is the comprehensive index of higher education system and economic system, among  $\alpha$  and  $\beta$  are the undetermined coefficients. Since Chinese higher education system and economic system are very important, there are two undetermined coefficients in this paper  $\alpha=\beta=0.5$ , that is, the higher education system and the economic system take the same proportion.  $D$  represents coupling coordination of higher education and economics [4]. Referring to the division standard of coupling coordination degree, the coupling coordination degree of higher education and economy is divided into three major categories and 10 sub categories, as shown in Table 3 [8].

**Table 3:** Coupling coordination degree classification.

Big category	Small category	Coupling coordination
Coordination class	Quality coordination	0.9 - 1.0
	Highly coordinated	0.8 - 0.9
	Moderate coordination	0.7 - 0.8
Transition class	Low coordination	0.6 - 0.7
	Weak coordination	0.5 - 0.6
	Weakness disorders	0.4 - 0.5
	Low disorders	0.3 - 0.4

Disorders	Moderately disordered	0.2 - 0.3
	High derangement	0.1 - 0.2
	Extremely out of balance	0.0 - 0.1

### 2.3.3 Spatial Correlation

Using the coupling coordination degree model to calculate the coupling coordination between higher education and economy in China, and then we can easily explore whether the coupling coordination degree has spatial correlation. This paper uses Moran index to measure spatial correlation, as shown in formula (6).

$$I = \frac{\sum_{i=1}^n \sum_{j=1}^n W_{ij} (d_i - \bar{d})(d_j - \bar{d})}{S^2 \sum_{i=1}^n \sum_{i=1}^n W_{ij}} \quad (6)$$

N is the total number of regions,  $D_i$  and  $D_j$  are the characteristic values of region I and region J respectively,  $\bar{D}$  is the average number of characteristic values,  $S^2$  Represents the variance of the characteristic value.  $W_{ij}$  represents the spatial weight. If region I is adjacent to region J,  $W_{ij} = 1$ ; If region I is not adjacent to interval J or  $I = J$ ,  $W_{ij} = 0$ . The larger the absolute value of I is, the more obvious the spatial effect of coupling coordination degree is.

## 3 COUPLING COORDINATION DEGREE

### 3.1 National Coupling Coordination Dispatching

According to the higher education score  $u$  and the economic score  $w$ , the coordination degree  $D$  of Chinese higher education and economy coupling from 2010 to 2019 is calculated, as shown in Table 4. In 2010, the

comprehensive score of Chinese higher education was 0.299, the comprehensive score of economy was 0.283, and the coupling coordination degree was 0.540. After 10 years of development, in 2019, the comprehensive score of Chinese higher education was 0.311, the comprehensive score of economy was 0.294, and the coupling coordination degree reached the max value of 0.566 in 2014 and the min value of 0.538 in 2018. It can be seen coordination degree of higher education and economy coupling in China has slightly increased, which has always belonged to the weak coordination level.

**Table 4:** Coordination of higher education and economy.

Year	Higher education $u$	Economics $w$	Coupling coordination
2010	0.299	0.283	0.540
2011	0.307	0.295	0.549
2012	0.299	0.285	0.540
2013	0.303	0.289	0.544
2014	0.298	0.346	0.566
2015	0.294	0.287	0.539
2016	0.293	0.314	0.551
2017	0.302	0.295	0.546
2018	0.304	0.276	0.538
2019	0.311	0.294	0.550

### 3.2 Regional Coupling Cooperative Dispatching

The comprehensive scores of higher education and economy of seven regions in China from 2010 to 2019 are calculated, and the coupling and coordination of higher education and economic development in each region in the past 10 years is obtained, as shown in Table 5.

**Table 5:** Coupling and coordination degree by region.

Year	North	Northeast	East	Central	South	Southwest	Northwest
2010	0.559	0.515	0.636	0.579	0.560	0.431	0.417
2011	0.576	0.526	0.638	0.578	0.568	0.459	0.419
2012	0.554	0.515	0.635	0.576	0.557	0.456	0.408
2013	0.562	0.527	0.628	0.582	0.559	0.470	0.417
2014	0.585	0.562	0.639	0.626	0.562	0.494	0.450
2015	0.556	0.501	0.631	0.585	0.558	0.460	0.408
2016	0.574	0.507	0.637	0.597	0.568	0.472	0.433

2017	0.566	0.505	0.632	0.593	0.567	0.472	0.423
2018	0.553	0.477	0.630	0.586	0.556	0.455	0.430
2019	0.554	0.481	0.638	0.616	0.575	0.486	0.427

The degree of coupling and coordination in East China fluctuates slightly around 0.634. On the whole, higher education and economic development in East China have been at a low level of coordination for a long time. The degree of coupling coordination in Central China increased from 0.579 in 2010 to 0.616 in 2019, from weak coordination to low coordination. The coupling degree between North China and South China is [0.550, 0.590], with small fluctuation range, belonging to weak coordination. It may be at a weak coordination level in the next few years. The degree of coupling and coordination in Northeast China gradually decreases, from weak coordination in 2010 to weak imbalance in 2019, and may become moderate imbalance in the future. The coupling degree of southwest and Northwest China is weak degree imbalance from the tabulation, but coupling coordination degree of Southwest China is increasing, and may reach weak degree coordination in the future, while the coupling coordination degree of Northwest China is relatively stable, and may maintain the level of weak degree imbalance in the future.

#### 4 SPACE EFFECT

##### 4.1 National Moran Index

According to the coupling coordination degree of China from 2010 to 2019, the spatial Moran index is calculated, and then spss26 is used to analyze the significance of the Moran index of the coupling coordination degree of higher education and economy, which is significant at the level of 5%. As shown in Figure 1, Chinese Moran index decreased from 0.145 in 2010 to 0.092 in 2019, showing a decreasing trend, especially to 0.047 in 2014. It shows that there is a positive correlation effect between the coupling

coordination degree of higher education and economy, and the correlation between adjacent provinces is weakened.

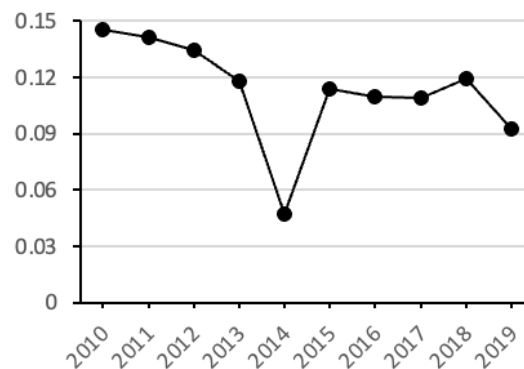


Figure 1: 2010-2019 National Moran Index.

##### 4.2 Moran Index by Region

Referring to the calculation method of the national Moran index, we can get the Moran index by Region (7 regions) from 2010 to 2019, as shown in Table 6. According to the Moran index, it is not difficult to find that the Moran index in East China, Southwest China, South China and North China shows a positive correlation, among which the Moran index in East China has the strongest positive correlation and the Moran index in North China has the weakest correlation. Northeast China, Northwest China and central China are negatively correlated in space. The Moran index of Northeast China and central China is basically unchanged, while the Moran index of Northwest China becomes smaller, indicating that the spatial negative correlation of the coupling coordination degree of education and economy in Northwest China is stronger.

Table 6: Moran index by region from 2010 to 2019.

Year	North	North east	East	Central	South	South west	Northwest
2010	0.061	-0.024	0.716	-0.112	0.116	0.157	0.104
2011	0.025	-0.029	0.705	-0.075	0.121	0.246	-0.004
2012	0.031	-0.022	0.680	-0.102	0.145	0.210	-0.001
2013	0.028	-0.016	0.670	-0.135	0.133	0.222	-0.077
2014	0.077	0.005	0.599	-0.364	0.017	0.218	-0.223
2015	0.019	-0.046	0.734	-0.107	0.170	0.148	-0.121

2016	0.022	-0.078	0.777	-0.087	0.157	0.122	-0.144
2017	0.011	-0.065	0.762	-0.093	0.181	0.124	-0.158
2018	0.028	-0.089	0.808	-0.039	0.183	0.039	-0.096
2019	0.003	-0.051	0.769	-0.087	0.269	0.002	-0.258

In order to study the change trend of local spatial effect in the last 10 years, the coupled co scheduling of higher education and economy in 7 regions (2010 and 2019) was standardized to obtain Moran scatter diagram, as shown in Figure 2 and Figure 3. In 2010, East China, South China and North China with high observation values were surrounded by regions with high values, Northeast China with low observation values was surrounded by regions with high values, Northwest China and southwest China with low observation values were surrounded by regions with low values, and central China with high observation values was surrounded by regions with low values.

2019, showing high high adjacency; Northeast, northwest and southwest regions are surrounded by high value regions, showing low high adjacency; Central China is surrounded by low value areas, showing high low adjacency. The quadrants of East China, South China, North China, Northeast China and central China remain unchanged, and the spatial effect of the coupling coordination degree of higher education and economy is stable. The spatial lag factor of northwest and southwest regions changes from negative to positive, indicating the increase of coupling coordination degree of northwest and southwest regions is helpful to enhance the coupling coordination of adjacent regions.

### 5 CONCLUSIONS

Based on the higher education and economic data of 31 provinces and cities in China from 2010 to 2019, build a measurable higher education system and economic system, calculate the comprehensive score of higher education, comprehensive score of economy and development balance, then measure the coupling and coordination degree of higher education and economic development, and explore the spatial effect through Moran index and Moran scatter diagram. The empirical analysis results show:

Firstly, the balance between higher education and economy in China is close to "1", indicating that the development of higher education and economy in 31 provinces and cities in China is relatively balanced. Secondly, the degree of coupling and coordination between higher education and economy in China has long belonged to weak coordination. The degree of coupling and coordination in East China is at a low level. The degree of coupling and coordination in Central China has changed from weak coordination to low coordination. The degree of coupling and coordination in North China and South China fluctuates slightly and belongs to weak coordination. The degree of coupling and coordination in Northeast China has decreased from weak coordination to weak imbalance, and the degree of coupling and coordination in southwest and Northwest China is weak imbalance, The degree of coupling coordination in Southwest China may increase to weak coordination in the future, while the degree of coupling coordination in Northwest China will maintain the level of weak imbalance for a long time. Thirdly, through the analysis of Moran index and Moran scatter diagram of coupling coordination degree, the spatial effect of higher education

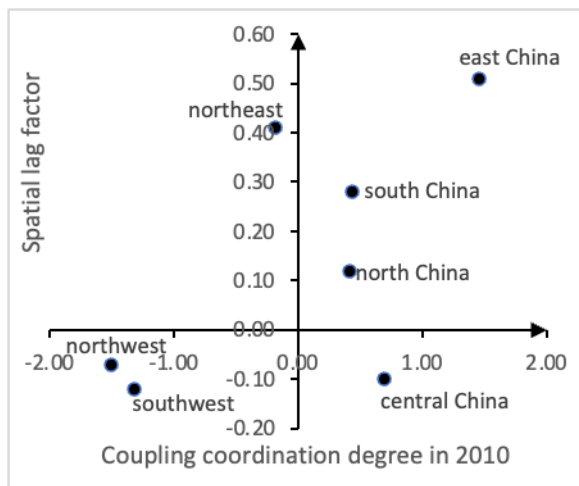


Figure 2: Moran scatter plot for 2010.

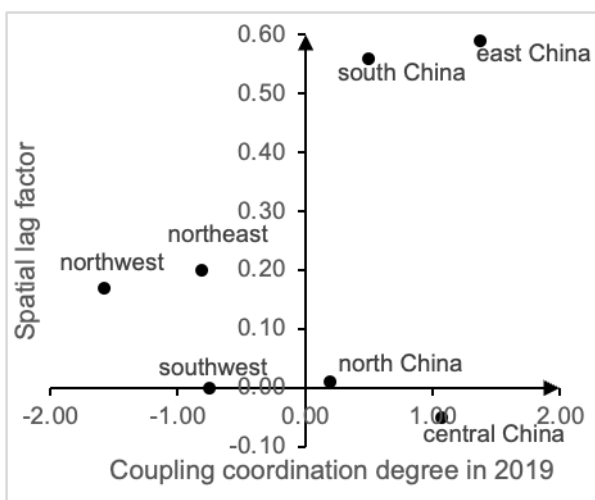


Figure 3: Moran scatter plot for 2019.

After 10 years, East China, South China and North China will be surrounded by regions with high values in

and economic coordination degree in China has been weakened. The coupling coordination degree of East China, Southwest China, South China and North China presents a positive correlation spatial effect, and the positive correlation of East China is the strongest; The coupling coordination degree of Northeast China, Northwest China and central China is negatively correlated in space, and the spatial negative correlation of the coupling coordination degree of education and economy in Northwest China is becoming stronger and stronger.

To improve the coupling and coordination of Chinese higher education and economy, it is very important to build intelligent learning platform, such as constructing an educational technology system framework, exploiting educational software and hardware.

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