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# Higher Education and Employment Development: Analysis of the Coupling Coordination and Dynamic Response

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## Abstract

Accurately grasping the coupling and coordination relationship between higher education and employment and its spatial and temporal evolution characteristics is crucial for establishing a high-quality higher education system, particularly for promoting high-quality and full employment. Based on this premise, by constructing an evaluation index system of higher education and employment, this study uses a comprehensive evaluation model and a coupling coordination model to analyze the level and evolution characteristics of the coupling coordination between higher education and employment from 2008 to 2020. It also adopts the VAR model to explore the dynamic influence relationship between them. The comprehensive development of higher education and employment shows a positive upward trend. The coupling coordination degree of higher education and employment also exhibits a positive upward trajectory, evolving from "slight imbalance" to "superior coordination." There is a long-term equilibrium coordination relationship between higher education and employment, with evidence of a Granger causality relationship between the two. The improvement of the higher education system is influenced by both its internal dynamics and employment, while the optimization of the employment system is affected by its internal dynamics and higher education. However, the two systems differ in the time trajectory and strength of the impulse impact. The findings of the study have significant policy implications for promoting regional coordination in higher education development, enhancing employment creation vitality, strengthening employment absorption capacity, and fostering the dynamic and virtuous development of higher education and employment systems.

***Keywords:*** *Higher education, Employment, Coupling and coordination, VAR model*



## 1. Introduction

Employment is the most basic livelihood. In the report of the 20th National Congress of the Communist Party

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of China, General Secretary Xi Jinping emphasized, "We should strengthen the priority employment policy, improve the employment promotion mechanism, and promote high-quality and full employment." As a new development goal set by the 20th National Congress, high-quality and full employment aims to improve the employment level from both quantitative and qualitative aspects and solve the employment problem of key groups such as college graduates from the aspects of expansion and quality improvement. As the main channel of talent cultivation and the main position of talent output, higher education (H.E) takes adapting to economic and social development as the guidance and promoting the employment of college graduates as the orientation, which is the basis of promoting high-quality and full employment (EM). As an important embodiment of the utilization degree of talent resources in the labor market, employment is an important part of adjusting the structure of higher education and an important driving force for improving the quality of higher education. At the important intersection of the "education priority development strategy" and the "employment priority strategy", examining the coupling level of higher education and employment and promoting their coordinated development are the keys to improving the quality of talent cultivation in higher education and solving the employment problem of university graduates. It is also an important prerequisite for stabilizing social order and promoting social harmonious development. Based on this, by constructing an evaluation index system for the development of higher education and employment, using comprehensive evaluation models, coupling coordination models, and impulse response models, this paper explores the regional characteristics and mutual influence degree of the coordinated development of higher education and employment, providing policy insights for improving the high-quality development of higher education, promoting higher-quality and fuller employment, and building a long-term mechanism for the coordinated development of higher education and employment.

## 2. Literature Review and Research Hypothesis

### *2.1. The Comprehensive Development Level and Regional Differences of Higher Education*

Since the 1990s, with the sharp increase in the number of people receiving higher education, many Asian countries such as Japan and Singapore have entered the stage of popularizing higher education (Huang, 2015). Compared with these countries, China entered the popularization stage relatively late, but it only took 17 years to complete the transition from the popularization of higher education to its universalization, creating a miracle in the history of higher education both in China and abroad (Wu, 2023). After more than 20 years of development, China has become the largest higher education system in the world in terms of enrollment scale (Wu, 2022). The structure of higher education has been gradually improved and optimized, and the quality of higher education training has been continuously improved, making China a veritable big country in education. However, the traditional higher education structure is influenced by the economic layout and lacks consideration of population size and regionally balanced development (Gao, 2019). Under the influence of economic, historical, demographic, and geographical factors, the distribution of higher education resources in China is uneven among regions, resulting in differences in the level and quality of higher education between regions (Bie, 2018). Some scholars have analyzed the characteristics of the distribution of higher education resources and regional development differences in China from three dimensions: education scale, teacher quality, and funding input. They found that the distribution of higher education resources in China is unbalanced, and there are obvious regional differences in the development level of higher education (Feng, 2021). Other scholars have used quantitative methods to measure the development level of higher education in China and found and verified that although the overall level of higher education in China has improved, there is a significant imbalance in the development of higher education among provinces (Ren, 2022). Based on the above analysis, it can be seen that the regional imbalance of higher education in China is increasingly serious. Based on this, this paper proposes research hypothesis 1:

> *$H_1$: The overall development level of higher education in China continues to improve, but there are certain gaps in the development level of inter-provincial higher education, and this gap will continue to expand.*

### *2.2. Level of Employment Development and Regional Differences*

More sufficient and higher-quality employment has long been the focus of academic circles due to its significant role in coordinating economic development, promoting common prosperity, and safeguarding social harmony.

In the 1990s, the International Labor Organization proposed during the global transition period the goal of ensuring that women and men around the world have decent work. This is the most universal demand for national development and is shared by every society and people at different stages of development (International Labour Office, 1999). After the concept of "decent work" was put forward, it aroused domestic and foreign scholars to evaluate and research issues related to employment development. Foreign scholars have theoretically proposed that macro factors such as the operating status of the labor market, the efficiency of labor resource allocation, and the level of public employment services reflect the overall operating status of a country's (or region's) labor market and can be used to study the level of employment development in a country (or region) (Van, 2002). In terms of quantitative research, foreign scholars have constructed indicators of employment development from three dimensions: salary level, employment security, and employment conditions, and evaluated and analyzed the employment development status of Latin American countries (Schroeder, 2020). Based on the actual situation of China's labor market, domestic scholars have constructed a measurement and evaluation index system for social employment that includes dimensions such as employment environment, employment ability, employment status, employment opportunities, and employment compensation (Tan, 2022; Xin, 2012). They have adopted diversified evaluation models to measure the employment development level of various provinces. The study found that the overall level of employment quality is low, with significant differences in employment quantities between regions and coordinated development of comprehensive employment levels (Lai, 2011). Some scholars also believe that under the influence of socio-economic development and national policy guarantees, the overall employment level of various provinces has shown a steady upward trend, and differences in employment development between regions have gradually narrowed (Qi, 2020), indicating that China's overall employment level is improving year by year (Su, 2013). Based on this, this paper proposes the following research hypothesis:

> *$H_2$: The overall level of employment development in China is continuously improving, and the differences in inter-provincial employment development will gradually narrow.*

### *2.3. The Coupling and Coordination Relationship between Higher Education and Employment*

Coupling refers to the phenomenon where two (or more) systems influence each other through various interactions to achieve coordination. Coupling coordination refers to the proper cooperation, harmony, and virtuous cycle relationship between systems or their components (Qian, 2012). In 1978, John. S. Brubacher proposed that "people regard higher education as an opportunity to prepare individuals for life (in a general sense) and for a particular profession or specialty (in a specific sense) (Brubacher, 2001)." Theodore W. Schultz proposed the theory of human capital, revealing that the stock of human capital is an endogenous driving force for national economic development (1999). The rapid development of higher education can promote the accumulation of human capital, increase the stock of human capital, and promote social and economic development through multiple pathways. Higher education enhances the quality of human capital by improving the knowledge level and innovative ability of workers, improves the efficiency of human resource allocation, promotes the effective connection between supply and demand in the labor market, and achieves high-quality and full employment (Paul, 2001). By adjusting its professional structure, higher education strengthens the effective alignment of professional dynamic adjustments with industrial development trends, cultivates labor with specialized skills, adapts to the needs of industrial structure optimization and upgrading, reduces the risk of structural unemployment among college graduates, and promotes fuller employment (Maria, 2018). Employment is an important factor that affects the functional release of higher education, and the "quantity" and "quality" of employment reflect to a certain extent the number of college graduates entering the labor market and the extent to which the labor market utilizes college graduates (Li, 1982). The existential meaning and social value of higher education manifest in improving the cultural and technical level of workers and promoting effective growth and rational allocation of human resources. The issue of social employment, in essence, is how to utilize existing human resources and how to leverage labor talent, and there is a mutually promoting and constraining relationship between the two (Hanushek, 2016). It can be said that higher education and employment interact and influence each other, forming a coupled interactive system of integration, growth, and coordinated development. Based on this, this paper proposes research hypothesis 3:

*$H_3$: There is a coupling and coordination relationship between higher education and employment in China, but there are significant differences in the degree of coupling and coordination between provincial higher education and employment.*

### *2.4. Dynamic Response Effect of Higher Education and Employment*

For decades, higher education in many countries has faced pressures of diversification and multiplicity, being required to contribute to national economic recovery and social development (Son-Turan, 2021). The instrumental value of higher education has also been repeatedly mentioned on various occasions both domestically and internationally. In 2015, the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development at its 70th session, which outlined 17 Sustainable Development Goals (SDGs) and provided a clear direction for countries worldwide to achieve sustainable development within 15 years. Among them, Target 4.4[1] emphasizes the need for skills required for employment and decent work, which aligns with SDG 8[2] which aims to "promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all." Although the potential impact of higher education is not limited to these two goals, its importance in enhancing the output of high-quality talents and promoting employment has become very prominent (Li, 2020). Domestic scholars have conducted a comprehensive analysis of the "employment effect" brought by the improvement of higher education quality in various regions of China by calculating the higher education quality index. They found that higher education improves the overall employment level through "direct effects" and indirectly increases the employment rate by promoting technological innovation (Ma, 2017). "Employment is an important direction for higher education reform. Combining the needs of the labor market, technological changes, and industrial transformations, employment status should be continuously taken as an important content for the adjustment of higher education's structural layout (Wu, 2022)." With the continuous input of new technologies into production, the demand structure for talent levels in China has changed, requiring higher education to adjust its hierarchical structure to adapt to the changing levels of demand in the labor market. As a new round of technological revolution and industrial transformation emerges, higher education needs to change its talent cultivation model and adjust its professional settings to provide high-level and capable labor for emerging industries, thereby enhancing their productivity (Geng, 2021). It can be seen that the development of higher education and full employment in society require interaction between the two. However, due to the influence of different factors, their impact effects exhibit different characteristics. Based on this, the following Hypothesis 4 is proposed in this paper:

*$H_4$: There are differences in the interactive effects between higher education and employment, but they are all positive and promotional.*

## 3. Research Design

### *3.1. Research Method*

#### *3.1.1. Comprehensive Evaluation Model*

The entropy method determines the weight of indicators based on the degree of variation of each index value and the amount of information provided by each quantitative indicator. It is a highly objective weighting method that can avoid the subjective influence of human factors (Ye, 2022). Based on determining the weight of each index in the higher education and employment system using the entropy weighting method, a comprehensive evaluation model is employed to calculate the comprehensive development level evaluation value of the higher education and employment system.

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[1] Transforming our WordÿThe 2030 Agenda for Sustainable Development0was passed at the 70th session of the United Nations General Assembly in 2015 and officially launched on January 1, 2016. The agenda calls on all nations to take action and strive to achieve 17 Sustainable Development Goals over the next 15 years. Goal 4.4, which reads, "By 2030, substantially increase the number of youth and adults who have relevant skills including technical and vocational skills, for employment, decent jobs and entrepreneurship" is a specific target under Goal 4, "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all."

[2] Goal 8, as originally stated, is "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all."

### *3.1.2. Coupling Coordination Model*

The coupling coordination degree model analyzes the coordination between systems based on the coupling model to explore the dynamic and coordinated evolution process among different systems (Zhou, 2018). To investigate the coupling relationship between higher education and employment, the coupling concept and coefficient model from physics are used to construct and measure the coupling degree. To further analyze the level and characteristics of the coordinated development of the coupling between higher education and employment (Zhou, 2022), the coupling coordination degree is divided into 10 grades based on existing research results (Table 1).

**Table 1: Criteria for Judging the Degree of Coupling and Coordination Relationship**

| Type | Coupling Coordination Degree | Level of Coordinated Development | Coupling Coordination Degree | Level of Coordinated Development |
|---|---|---|---|---|
| Disharmony Stage | 0<D≤0.1 | Extreme imbalance | 0.2<D≤0.3 | Moderate imbalance |
| | 0.1<D≤0.2 | Severe imbalance | 0.3<D≤0.4 | Slight imbalance |
| Transitional Stage | 0.4<D≤0.5 | Borderline disorder | 0.5<D≤0.6 | Barely coordination |
| Coordination Period | 0.6<D≤0.7 | Primary coordination | 0.8<D≤0.9 | Good coordination |
| | 0.7<D≤0.8 | Moderate coordination | 0.9<D≤1 | Superior coordination |

### *3.1.3 Vector Autoregression Model*

The Vector Autoregression (VAR) model is used to analyze or predict the dynamic relationships among multiple variables as well as the reactions of system variables to disturbances and shocks. Observing the impact of random disturbances on endogenous variables in the current and future periods explains the effect of shocks on system variables. The expression of the VAR model is as follows:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + B_1 x_t + \cdots + B_r x_{t-r} + \varepsilon_t \ (t = 1, 2, \cdots, n) \quad \ldots(1)$$

## *3.2. Index Selection and Data Description*

To accurately measure and analyze the actual situation and genuine level of coupling and coordination between higher education and employment, it is necessary to comprehensively and reasonably construct an indicator system that can represent both the higher education and employment systems. Drawing on existing achievements (Huang, 2002; Chen, 2019) and combining the contents and goals of the "China's Education Modernization 2035" issued by the CPC Central Committee and the State Council, as well as the "14th Five-Year Plan for Employment Promotion" (GF [2021] No. 14) issued by the State Council, regarding the development of higher education and employment, 15 specific indicators are selected from five dimensions, including education scale, teaching staff, school conditions, expenditure, and research output, to build an evaluation indicator system for the higher education system. Meanwhile, 14 specific indicators are selected from four dimensions, including employment environment, employment structure, employment status, and employment protection, to represent the indicator system of employment development levels, as shown in Table 2.

In the education system, the scale of education reflects the degree and speed of development of higher education, measured by the number of ordinary colleges and universities, the number of college enrollments, and the number of college students currently enrolled. The teaching staff reflects the level and quality of teachers in colleges and universities, assessed by the number of faculty and staff, the number of full-time teachers, and the number of teachers with associate senior titles or above. The conditions for running a school represent the material foundation for the survival and development of higher education, measured by the area occupied by colleges and universities, the number of books, the number of computers, and the total value of fixed assets. The output of scientific research reflects the influence and achievements of higher education, evaluated by the number of research papers published, the number of R&D projects, and the number of patent applications in colleges and universities.

In the employment system, the employment environment is a direct reflection of the level of employment supply in economic development. It is measured by per capita gross domestic product, employment elasticity, and the ratio of non-local to local registered residence, indicating the level of economic development, flexibility of the job market, and labor market segmentation, respectively. The employment structure reflects the job

**Table 2: Evaluation Indicators for Higher Education and Employment**

| Coupling System | Dimension | Indicator | Type |
|---|---|---|---|
| HE System | HE Scale | Number of ordinary colleges | + |
| | | Number of college enrollments | + |
| | | Number of students currently enrolled in colleges | + |
| | HE Teaching Staff | Number of faculty and staff in colleges | + |
| | | Number of full-time teachers in colleges | + |
| | | Number of teachers with associate senior titles or above | + |
| | HE Running Condition | The area occupied by colleges | + |
| | | Number of books in colleges | + |
| | | Number of computers in colleges | + |
| | | The total value of fixed assets in colleges | + |
| | HE R&D Expenditure | Educational expenditure in colleges | + |
| | | Internal expenditure on R&D funding in colleges | + |
| | HE Research Productivity | Number of research papers published by colleges | + |
| | | Number of R&D projects in colleges | + |
| | | Number of patent applications in colleges | + |
| EM System | EM Environment | Per capita gross domestic product (GDP) | + |
| | | Employment elasticity | - |
| | | The ratio of non-local to local registered residence | + |
| | EM Structure | Proportion of non-agricultural employment | + |
| | | Proportion of employment in units | + |
| | | Proportion of urban employment | + |
| | EM Situation | Urban registered unemployment rate | - |
| | | Number of employed people with a college degree or above | + |
| | | Number of employment training institutions per capita | + |
| | EM Protection | The incidence rate of work-related accidents | - |
| | | The average salary of employees in urban units | + |
| | | The coverage rate of pension insurance for urban employees | + |
| | | The coverage rate of medical insurance for urban employees | + |
| | | Trade union participation rate | + |

creation and accommodation capacity of the economic structure, measured by the proportion of non-agricultural employment, the proportion of employment in units, and the proportion of urban employment. These indicators illustrate the job creation capabilities of the secondary and tertiary industries, labor efficiency, and urban employment capacity. The employment status embodies the degree of job absorption in the labor market, assessed by the registered urban unemployment rate, the number of employed individuals with college degrees or above, and the number of employment training institutions per capita. These metrics represent job opportunities, the educational level of the labor force, and the potential for labor force development. Employment protection is a crucial aspect of social security and employment stability, gauged by the incidence of work-related accidents, average wages of urban employed personnel, coverage of pension insurance for urban workers, coverage of medical insurance for urban workers, and union participation rate. These indicators elucidate job safety, employment benefits, social security, and labor relations.

The research primarily selects data including vector data and statistical data. The vector data, which includes the geographical boundaries of various provinces and cities, is sourced from the National Geomatics Center of China (Map Examination Number: GS(2020)4619). The statistical data is mainly derived from the China Statistical Yearbook, China Education Statistical Yearbook, China Education Finance Statistical Yearbook, China Population and Employment Statistical Yearbook, China Science and Technology Statistical Yearbook, and the statistical yearbooks of various provinces (autonomous regions, municipalities directly under the central government). Due to the lack of data for Hong Kong, Macao, and Taiwan, these regions have been excluded from the analysis in this study.

## 4. Results

### *4.1. The Spatiotemporal Evolution of the Comprehensive Development Level of HE*

#### *4.1.1. Timeline Evolution of the Comprehensive Development Level of HE*

Based on the temporal evolution results of the comprehensive development level of higher education (Figure 1), China's higher education showed a steady upward trend from 2008 to 2020, indicating a good development momentum. From the perspective of the scores of various indicators within the higher education system, the score of school running conditions is higher than that of education scale, teaching staff, research output, and expenditure. Specifically, the score of school running conditions increased from 0.0027 in 2008 to 0.2849 in 2020, the score of education scale increased from 0.0026 to 0.2183, the score of teaching staff increased from 0.0018 to 0.2145, the score of research output increased from 0.0024 to 0.2116, and the score of expenditure increased from 0.0020 to 0.1406.


**Figure 1: The Timeline Evolution of the Comprehensive Development Level of HE**

In terms of growth rates, the increases in school running conditions and education scale within the higher education system are relatively high, thanks to the guidance of relevant national policies. In 2004, the Ministry of Education revised and issued the "Basic School Running Conditions Indicators for Regular Colleges and Universities (Trial)" which took indicators such as per capita land area, the number of computers for teaching per 100 students, and per capita books as important bases for measuring the basic school running conditions of regular colleges and universities and determining the annual enrollment scale. Since 2006, the Ministry of Education has decided to suspend enrollment (red card) or restrict enrollment (yellow card) for universities that do not meet the requirements for land use and basic school running conditions and to publish the results accordingly. Since then, various regions across the country have increased their investment in higher education school running conditions and improved them.

Adding the education scale within the higher education system, China implemented a policy of expanding higher education enrollment nationwide in 1999, leading to a sharp increase in the number of enrollees and students in higher education. Specifically, the number of higher education enrollees increased from 6.0766 million in 2008 to 9.6745 million in 2020, and the number of students increased from 20.2102 million to 32.8529 million, resulting in an overall improvement in the score level of the education scale. Overall, both the overall score of higher education and the scores of various indicators within the higher education system showed a stable upward development trend.

### *4.1.2. The Spatial Evolution in the Comprehensive Development Level of HE*

The study utilized ArcGIS 10.2 spatial analysis software to visualize the comprehensive development level of higher education in various provinces in 2008, 2012, 2016, and 2002, and a spatial evolution map (Figure 2) was created accordingly. Specifically, the comprehensive development level of higher education in the eastern region is higher than that in the central region, and the central region is higher than that in the western region, forming a spatial pattern of "high-medium-low" from east to west. This indicates that higher education has not yet achieved balanced development in its spatial pattern. The comprehensive scores of higher education in 31 provinces in 2020 were divided into four levels. Nine provinces, such as Tibet, Qinghai, Xinjiang, and Gansu, scored between 0-0.2. Eleven provinces scored between 0.2-0.4, seven provinces between 0.4-0.6, and four provinces, such as Jiangsu and Guangdong, scored above 0.6. Comparing the inter-provincial comprehensive level of higher education from a time series perspective, it was found that the development gap between provinces has gradually widened. Comparing the provinces with the highest and lowest comprehensive development levels of higher education, the gap between Jiangsu, which had the highest score in 2008, and Qinghai, which had the lowest score, was 0.827. By 2020, this gap had widened to 0.840.

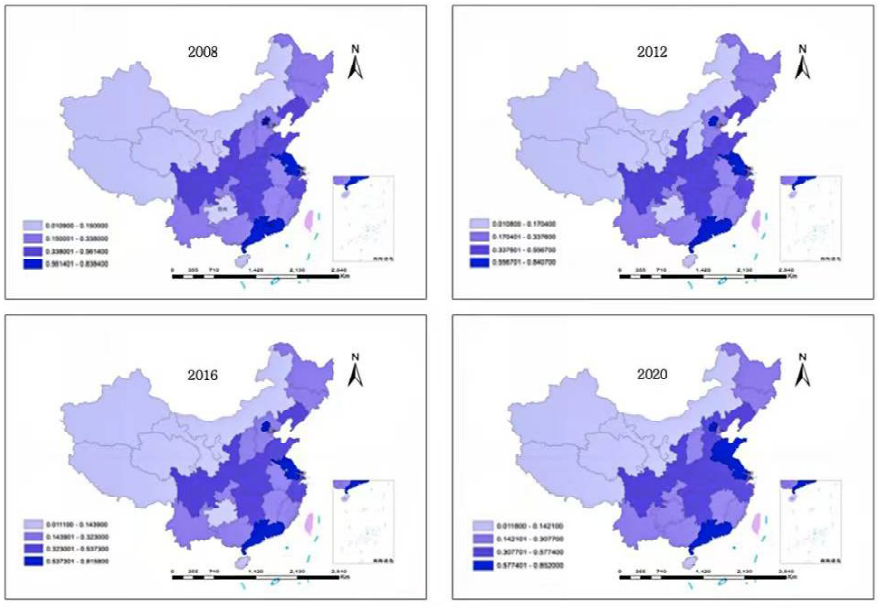


**Figure 2: The Spatial Evolution in the Comprehensive Development Level of HE**

In summary, by analyzing the spatial and temporal evolution characteristics of the comprehensive development level of higher education, it is found that China's higher education has steadily improved its comprehensive development level, but there are significant development gaps between provinces, and these gaps have gradually widened over time. Hypothesis 1 has been confirmed.

## *4.2. The Spatiotemporal Evolution of the Comprehensive Development Level of EM*

### *4.2.1. The Timeline Evolution of the Comprehensive Development Level of EM*

From the temporal evolution results of the comprehensive development level of employment (Figure 3), China's comprehensive employment score has increased from 0.2884 in 2008 to 0.7911 in 2020, indicating an overall upward trend in the comprehensive development level of employment in China. The continuous growth of the comprehensive development level of employment is attributed to the country's implementation of multiple measures to support employment policies. Since the introduction of proactive employment policies in 2002, China has intensified its support for employment policies, optimized the employment environment from multiple dimensions, and made every effort to stabilize and expand employment, thus expanding employment capacity and improving employment quality to a certain extent. The scores of the employment system indicators show that the employment environment and employment status have shown a continuous upward trend, while the employment structure has experienced significant fluctuations. Specifically, the employment environment score has increased the most, from 0.0792 in 2008 to 0.3032 in 2020, with an average annual growth of 0.1860. The employment status has increased from 0.0360 in 2008 to 0.1285, with an average annual growth of 0.0077, and employment protection has increased from 0.1360 in 2008 to 0.2288. Although employment status and employment protection also showed a continuous upward trend, the growth rates were both lower than the employment environment.

During the study period, the employment structure showed significant fluctuations and a potential decline, decreasing from 0.1454 in 2016 to 0.1406. The employment structure reflects the employment innovation capacity of the economic structure, which is measured by the proportion of non-agricultural employment, the proportion of employment in enterprises and units, and the proportion of urban employment. The decline in the employment structure indicates to some extent that the absorptive capacity of the secondary and tertiary industries has decreased, and the potential for urban areas to absorb surplus rural labor needs to be improved. Therefore, the analysis of the temporal evolution of the comprehensive development level of employment shows that employment has shown a steady upward development trend overall, but under the impact of external environments, significant fluctuations have appeared.

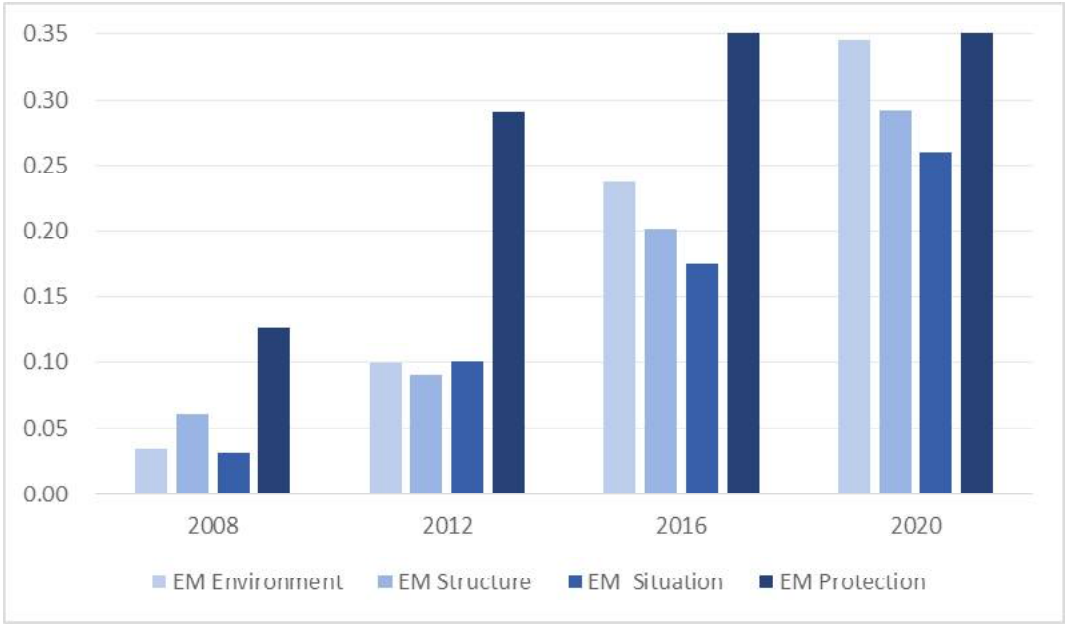


**Figure 3: The Timeline Evolution of the Comprehensive Development Level of EM**

## *4.3. The Spatial Evolution in the Comprehensive Development Level of EM*

From the spatial perspective (Figure 4), the distribution pattern of China's comprehensive employment development level is unbalanced and unstable, with significant differences in provincial development that gradually narrow over time. From 2008 to 2020, Beijing has consistently ranked first in terms of its comprehensive employment development level, while Shanghai has maintained a stable comprehensive score in the range of 0.6-0.7, ranking second. About the stability of the comprehensive employment scores of provinces ranking at the forefront, provinces with the lowest scores have exhibited complexity and variability during the study period. In 2008 and 2012, Guizhou Province had the lowest comprehensive score nationwide. However, in 2016, Guizhou Province shed its "last place" status, and Yunnan Province took its place. Then, in 2020, Guizhou Province once again fell to the bottom. When comparing the highest and lowest provincial scores during the same period, we find that the polarization in 2008, 2012, 2016, and 2020 was 0.6680, 0.6311, 0.5975, and 0.6289, respectively. This indicates that although there are significant differences in employment development among the 31 provinces, the overall gap is gradually narrowing. It should be emphasized that similar to the development characteristics of the national comprehensive employment score, the comprehensive employment scores of all 31 provinces showed a significant upward trend during the study period, but they also experienced a decline in 2020, primarily due to the impact of the COVID-19 pandemic.

In summary, by analyzing the Spatial evolution characteristics of comprehensive employment development, it is found that China's comprehensive employment development level has steadily improved, but there are significant differences in development between provinces. However, these differences are gradually narrowing over time, thus confirming Hypothesis 2.

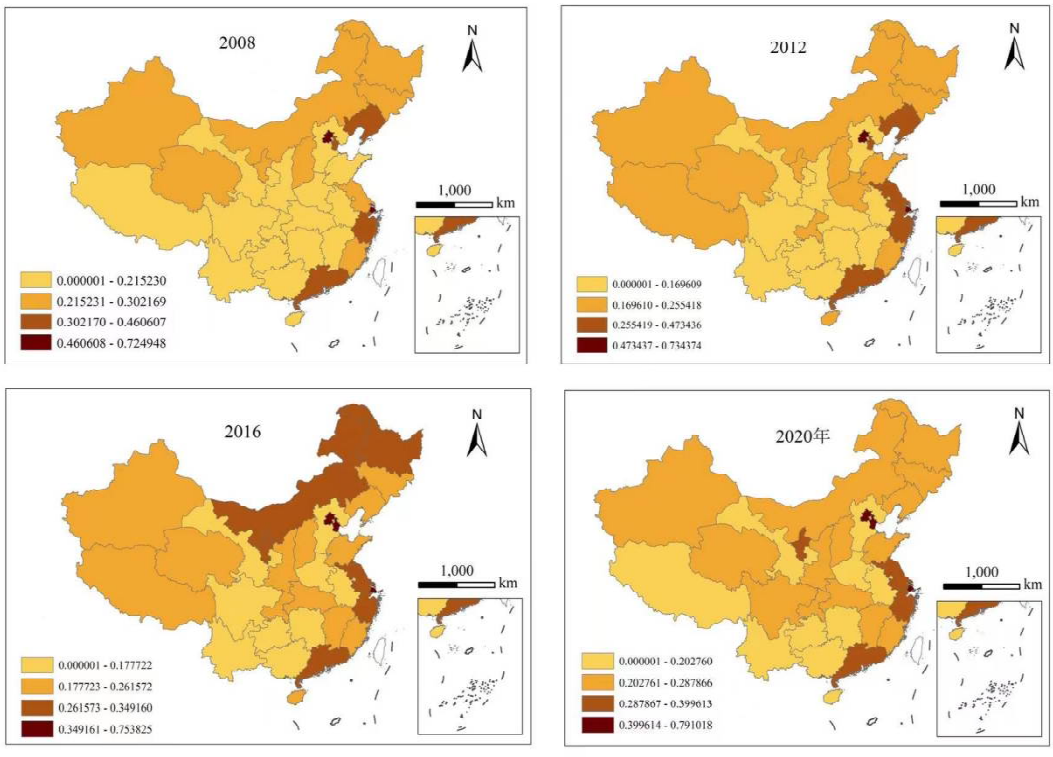


**Figure 4: The Spatial Evolution in the Comprehensive Development Level of EM**

## *4.4. The Spatial-Temporal Evolution of the Coupling and Coordination between HE and EM*

### *4.4.1. The Timeline Evolution of the Coupling and Coordination between HE and EM*

The temporal evolution analysis of the coupling and coordination between higher education and employment shows that the degree of coupling and coordination has increased over time during the study period, as illustrated in Figure 5. In 2008, the coupling and coordination degree between higher education and employment

was 0.3024 (Slight imbalance). This rose to 0.6180 (Primary coordination) in 2012, 0.7998 (Good coordination) in 2016, and 0.9359 (Superior coordination) in 2020. The coupling and coordination relationship has undergone a transition from "Slight imbalance" to "Superior coordination", indicating that the coupling and synergistic effect between higher education and employment are tending towards orderly development, and the development coordination between the two systems is gradually strengthening. Overall, the coupling and coordinated development of higher education and employment can be divided into three stages: the imbalance stage (2008-2010), the transition stage (2011-2016), and the coordination stage (2017-2020). In the first stage, the coupling and coordination between higher education and employment were imbalanced, indicating that they had a significant positive interaction but did not develop synergistically. In the second stage, with the continuous improvement of technological innovation and infrastructure in higher education as well as the refinement of employment policies, the coupling and coordination between the two rapidly transitioned and surpassed from "imbalance" to "coordination." In the third stage, the coupling and coordination between higher education and employment evolved from good coordination to excellent coordination, demonstrating a deep integration of the two. In 2017, the strategic deployment of the 19th CPC National Congress report to "achieve higher-quality and more sufficient employment" and "achieve connotative development of higher education" played a crucial role in promoting high-quality development and fostering positive coupling and coordinated development between the two.

Comparing the comprehensive scores of higher education and employment, it can be observed that before 2010 (including 2010), the comprehensive score for employment was slightly higher than that of higher education. However, since 2011, the comprehensive score of higher education has been higher than that of employment, indicating that the level of employment development lags behind the level of higher education development. Therefore, improving the employment environment and conditions, as well as adjusting and optimizing the employment structure, has become an important path to promote the development of higher education and strengthen the coupling and coordination between higher education and employment. In summary, while the coupling and coordination degree between higher education and employment has gradually improved over time during the study period, due to the comprehensive score of employment, it not only lags behind the development level of higher education but also leads to fluctuations and declines in the coupling and coordination degree between the two.

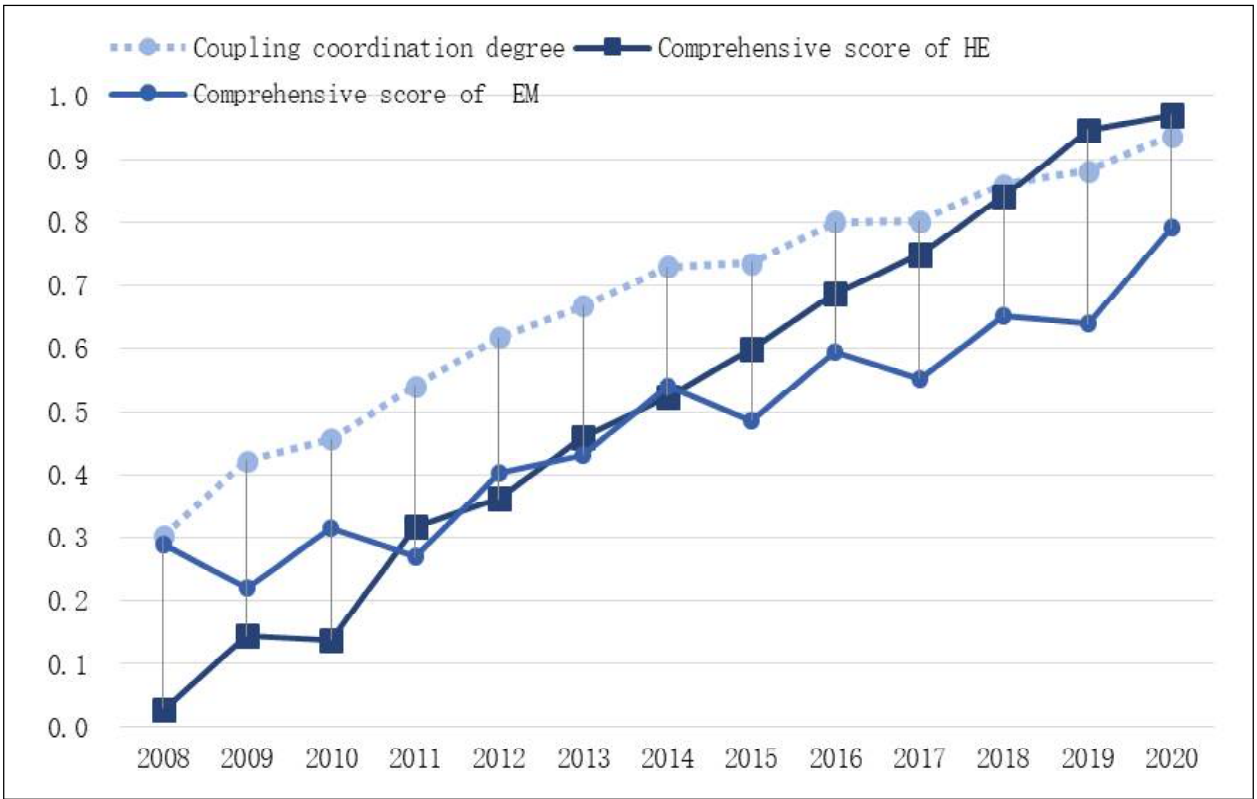


**Figure 5: The Timeline Evolution of the Coupling and Coordination between HE and EM**

### *4.4.2. The Spatial Evolution of the Coupling and Coordination between HE and EM*

Based on the spatial evolution pattern of the coupling and coordination degree between higher education and employment in China's 31 provinces (Figure 6), there are relatively significant differences in the coupling and coordination degree between provinces, with the eastern regions generally having a significantly higher coupling and coordination degree than the western regions. During the study period, the degree of differentiation in the coupling and coordination between provinces showed a tendency to expand. In terms of the characteristics of changes in the coupling and coordination degree levels, various provinces exhibited different evolution patterns, which can be classified into four types: upward change in coupling and coordination level, stable coupling and coordination level, downward change in coupling and coordination level, and irregular change in coupling and coordination level: (a) Upward change in coupling and coordination level: For example, Hainan Province underwent a transition from moderate imbalance (0.2998 in 2008) to slight imbalance (0.3137 in 2020), while Chongqing experienced a shift from a borderline imbalance (0.4711 in 2008) to barely coordinated (0.5133 in 2020). (b) Stable coupling and coordination level: Guangdong Province (0.7083 in 2008 and 0.7458 in 2020) has consistently remained at moderate coordination, while Hunan Province (0.5009 in 2008 and 0.5501 in 2020) has remained barely coordinated throughout the study period. (c) Downward change in coupling and coordination level: Heilongjiang Province, for instance, experienced a shift from barely coordinated (0.5331 in 2008) to borderline imbalance (0.4968 in 2020). (d) Irregular change in coupling and coordination level: Ningxia experienced a transition from a slight imbalance (0.3087 in 2008) to the verge of moderate imbalance (0.2978 in 2012), then to a slight imbalance again (0.3037 in 2016), and finally to a slight improvement (0.3309 in 2020).

In terms of the differences in coupling and coordination degrees among provinces, there are significant disparities between provinces, and these disparities continue to expand over time. Beijing consistently ranks first among the 31 provinces in terms of the coupling and coordination degree between higher education and employment, with scores of 0.8878 in 2008, 0.8697 in 2012, 0.87056 in 2016, and 0.9078 in 2020. Compared to Tibet, which has consistently been at the bottom in terms of coupling and coordination degree, the disparity is gradually widening. In summary, there are significant differences in the coupling and coordination degree between higher education and employment among provinces in China, and these differences are gradually expanding over time, confirming Hypothesis 3.

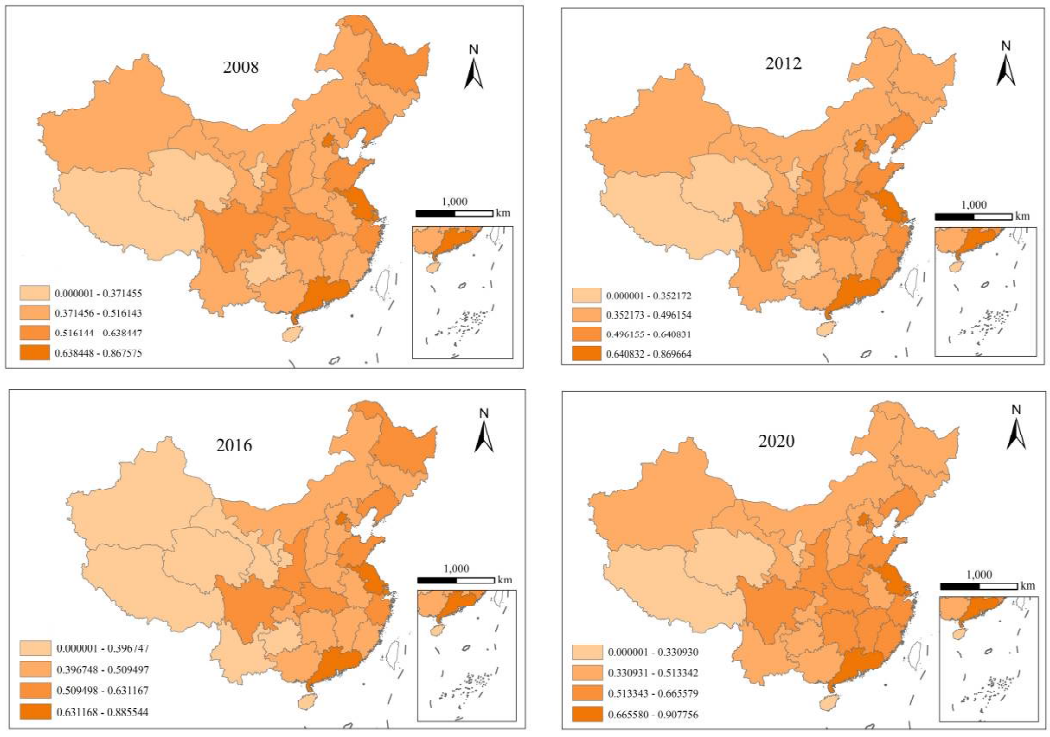


**Figure 6: The Spatial Evolution of the Coupling and Coordination between HE and EM**

## *4.5. The Dynamic Response of Higher Education to Employment*

### *4.5.1. Unit Root Test*

The stationarity of variables is a prerequisite for building a VAR model. To eliminate the impact of heteroscedasticity, the time series data of higher education and employment are respectively log-transformed to obtain LNHE and LNEM (employment). To avoid the occurrence of spurious regression, the ADF unit root test is used to test the stationarity of LNHE and LNEM. It is found that both the second-order differenced series are stationary, and the test results are shown in Table 3. According to Table 3, the ADF test values of variables LNHE and LNEM have corresponding P-values of 0.0001, indicating that both series are stationary at the 5% significance level, and there are no unit roots present. Therefore, a VAR model can be established.

**Table 3: Results of Unit Root Test**

| Variable | Test Value | Critical Value | | | P | Test Result |
|---|---|---|---|---|---|---|
| | | 1% | 5% | 10% | | |
| LNHE | -29.3516 | -4.2971 | -3.2127 | -2.7477 | 0.0001 | Stationary |
| LNEM | -20.1846 | -4.2970 | -3.2127 | -2.7477 | 0.0001 | Stationary |

### *4.5.2. Cointegration Test*

The VAR model requires a cointegration relationship between variables. This paper adopts the Johansen cointegration test to examine the cointegration relationship between LNHE and LNEM. Before testing the cointegration relationship, a VAR model needs to be established, and the optimal lag order of the model is determined based on the AIC, SC, and LR tests, which are set at 2 lags. Based on this, the Johansen cointegration test is performed on the two variables, and the results are shown in Table 4. Under the null hypothesis of no cointegration relationship, the trace test statistic value (31.2622) is greater than the critical value (15.4947), and the P-value is 0.00001, which is less than the set significance level of 0.05, thus rejecting the null hypothesis. Under the hypothesis of having at most one cointegration relationship, the trace test statistic value (0.2594) is less than the critical value (3.8415), and the P-value is 0.6105, which is greater than the set significance level of 0.05, thus conforming to the null hypothesis. Therefore, it can be concluded that there is a stable equilibrium relationship between higher education and education from 2008 to 2020.

**Table 4: Results of the Cointegration Test**

| Null Hypothesis | Eigenbalue | Trace Statistic | | P |
|---|---|---|---|---|
| | | Statistic | Critical Value | |
| None* | 0.9550 | 31.2622 | 15.4947 | 0.0001 |
| At most 1* | 0.0256 | 0.2594 | 3.8415 | 0.6105 |

### *4.5.3. Analysis of Impulse Response*

Based on the cointegration test, there exists a long-term stable equilibrium relationship between higher education and employment. However, the aforementioned analysis does not reflect the magnitude of this relationship. Therefore, an impulse response function is adopted to further determine the direction and extent of the impact between higher education and employment (Figure 7). In the figure, the horizontal axis represents the number of observation periods (unit: year), while the vertical axis indicates the degree of response change in the variables. The solid blue line represents the impulse response function, which depicts the dynamic response to shocks in the variables. The solid red line indicates the confidence band of plus or minus 2 standard deviations. Figures 7(a) and 7(b) show the impulse response of higher education to itself and employment, respectively. As seen in Figure 7(a), higher education immediately reacts to a one-standard-deviation shock to itself, reaching a maximum value of 0.08910 in the first period and then exhibiting a declining trend, ultimately converging to 0.0023. This indicates that higher education has a positive and promoting effect on its development, but this positive effect is gradually weakening. Figure 7(b) reflects the impact of higher education on employment,

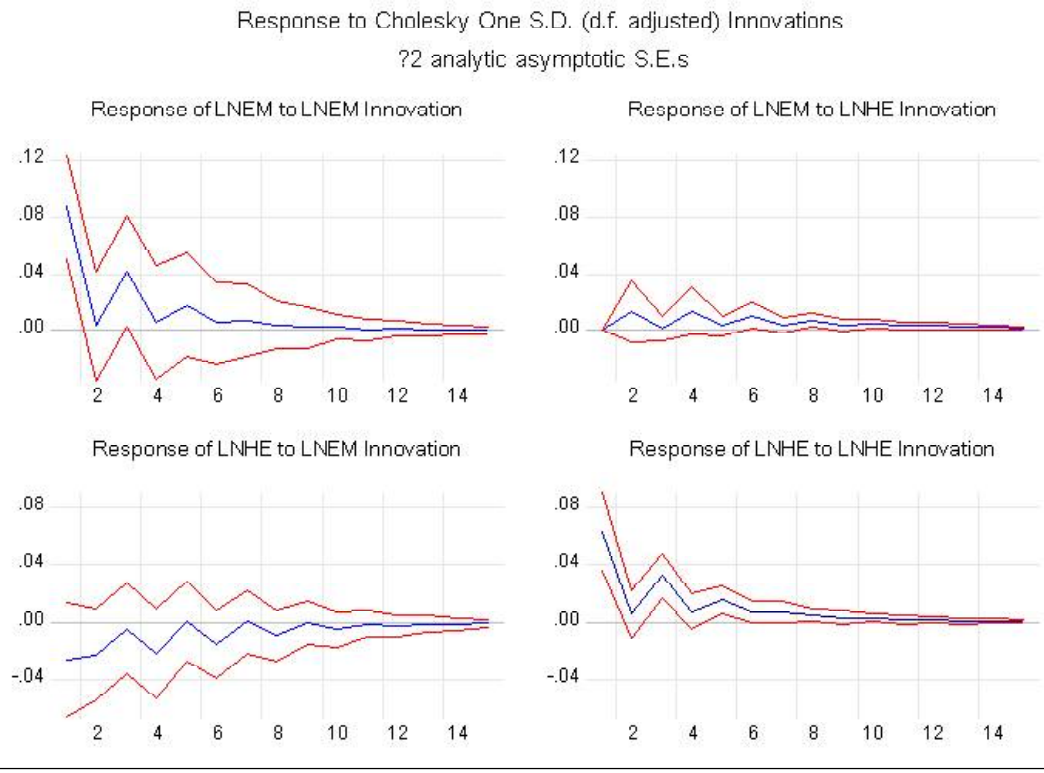


**Figure 7: The Spatial Evolution of the Coupling and Coordination between HE and EM**

showing that there is no immediate reaction or significant impact in the first period, but it gradually increases and reaches a maximum value of 0.0134 in the fourth period. Subsequently, it fluctuates around the value of 0.002 over time. The impulse response curve of higher education to employment generally exhibits a fluctuating positive impact, indicating that higher education has a positive and promoting effect on employment, but its promoting effect will gradually diminish and tend to be stable.

Figures 7(c) and 7(d) represent the impulse response of employment to itself and higher education, respectively. As shown in Figure 7(c), when employment gives a one-standard-deviation shock to higher education, higher education experiences certain changes in response. The direction of change is initially negative and reaches its maximum negative value inthe first period. Then, it turns positive and reaches its maximum in the fifth period, followed by unstable fluctuations and tends to stabilize in the tenth period. The impact of employment on itself reaches a positive maximum of 0.0630 in the first period, then declines, and exhibits a significant fluctuating upward trend in the fifth and seventh periods. From the seventh period onwards, it continues to decline, reaching 0.000 in the fifteenth period. Based on the overall analysis of Figure 7, it can be seen that both higher education and employment have a positive and promoting effect on their development, indicating that both rely on their inertia and cumulative effects to varying degrees. Regarding the extent andtrajectory of their interaction, different patterns emerge, i.e., higher education has a positive promoting effect on employment, while employment has a negative restrictive effect on higher education. Therefore, Hypothesis 4 does not hold.

## 5. Discussion

The comprehensive development levels of higher education and employment in China both show a fluctuating upward trend, but the comprehensive development level of employment lags behind higher education. From the analysis results, it can be seen that the comprehensive development level of employment in China exhibits an upward trend, but the overall level is not high. The employment market is a market of supply and demand, which is vulnerable to complex and changing external environmental factors. When the international and domestic economic environments are affected, it directly impacts China's employment market, leading to cyclical unemployment shocks and highlighting long-term structural employment contradictions. At the same time, issues such as structural employment contradictions, prominent employment polarization, and impeded

labor mobility caused by supply-side structural reforms and the development of innovative economies have brought new challenges to employment quality.

The differences in provincial higher education have continued to widen over time, while the differences in employment between provinces have gradually narrowed. From the perspective of provincial higher education levels, the comprehensive scores of higher education in the eastern region are higher than those in the central region, and the comprehensive scores in the central region are higher than those in the western region, forming a distribution pattern of "high-medium-low" from east to west. Moreover, the degree of provincial differentiation has shown an increasing trend over time. Under the provincial development pattern of higher education, the interaction of various factors such as economic development level, administrative planning, population factors, and geographical location has increasingly prominent effects on the scale of provincial higher education, total resources, and expenditure, resulting in an unbalanced development of higher education in China.

In terms of the comprehensive development level of provincial employment, there are significant differences between provinces, but these differences show a narrowing trend over time. Existing research has found that factors such as employment policies, industrial structure, and information technology level play a role in promoting the comprehensive development level of employment in various provinces. Employment policies, as an important means of ensuring social employment, enhance the comprehensive development level of employment by providing employment services and increasing diversified employment channels for workers. With the deepening and broadening of national employment policies, the optimization and adjustment of economic structure and industrial structure have stimulated the employment-creation potential and capabilities of economic development and improved the employment absorption capacity of the labor market. This has gradually narrowed the development gap in provincial employment over time, promoting a steady qualitative improvement and effective quantitative growth in employment.

The coupling coordination between higher education and employment has been strengthened over time during the study period, and the level of coupling coordination has undergone a leap from "minor imbalance" to "high-quality coordination". However, there are significant differences in the degree of coupling coordination between provinces, which have gradually widened over time. From the perspective of the national coupling degree between higher education and employment, the two have maintained a steady and progressive development trend for a long time, indicating an increasing dependence on each other. From the perspective of the national coupling coordination status between higher education and employment, it has achieved leapfrog development, and the "high-quality coordination" status will remain stable in the long term, indicating that the coupling and synergistic effect between higher education and employment is continuously tending towards orderly development. From the perspective of inter-provincial coupling coordination, there are significant differences in the coupling coordination degree between higher education and employment among provinces, which have gradually widened over time. Therefore, it is necessary to face up to the significant gap between backward and developed regions.

The empirical research results of the Vector Autoregression Model (VAR) indicate that there exists a long-term balanced and coordinated relationship between higher education and employment. The stability of the improvement in the higher education system is influenced by both its internal factors and employment, while the optimization of the employment system is also influenced by both its internal factors and higher education. However, the two systems exhibit different characteristics in terms of the degree and path of their interactions. Higher education has a positive and long-lasting impact on both itself and employment in terms of impulse response, indicating a stable effect. While employment has a positive impact on itself, it initially has a significant negative effect on higher education before gradually turning positive.

## 6. Policy-Making Suggestions

By analyzing the coupling coordination and dynamic response between higher education and employment, we can grasp the comprehensive development level of higher education and employment in China, as well as the development gaps between the two systems among provinces. It can also clarify the interactive relationship between the coupling coordination and dynamic healthy development of higher education and employment. To promote the advancement of higher education and employment towards the optimal state based on high-quality development, this article proposes the following policy recommendations:

To promote the orderly flow of higher education elements, we should explore differentiated and diversified development paths for inter-provincial higher education, and foster regional coordinated development of higher education. Research has found that the national level of higher education development has been steadily improving, but provincial differences are constantly widening. Facing the distribution pattern of "high in the east, medium in the central, and low in the west" in the comprehensive development level of higher education, local governments should adopt differentiated development strategies based on the actual situation of provincial higher education development. Leveraging their superior geographical conditions and prominent "first-mover advantages" the eastern regions should enhance their ability to transform scientific research achievements, strengthen their human capital delivery capabilities, and ensure the coordination between higher education and industrial and employment structures within the regions, striving for optimized and coordinated development in terms of scale, structure, quality, and efficiency. Through "quadruple collaboration" and "joint construction by ministries and provinces" we can strengthen the radiating and correlation effects of advanced regions in higher education development on backward regions in terms of resources, teachers, and scientific research, promote the flow of resource elements between regions and among various universities, enhance the level of higher education teachers in backward regions, and improve the relevance of talent cultivation.

Backward regions in the central and western regions should lay a solid foundation, address weaknesses, strive to improve the quality of higher education development, develop higher education with local characteristics, and reduce the relative differences in the level of regional higher education development. At the national level, we should appropriately increase financial support for higher education in backward regions in the central and western regions, ensure stable funding for higher education development, strengthen the construction of "hardware and software" for higher education; through policy inclinations, increase special projects to improve scientific research output, and strengthen teacher exchanges and cooperation to enhance teachers' research, teaching, and instructional abilities. From the perspective of school development, universities in the central and western regions should clarify their school-running and development orientation, optimize their academic structure, enhance their research capabilities, optimize their education scale, and resolve the contradiction between limited educational capacity and sustained talent demand based on local conditions.

Based on institutional guarantees, we should stimulate the employment creation vitality of the economic structure and enhance the employment absorption capacity of the labor market. Continuous efforts should be made to optimize the employment structure. Employment is the greatest livelihood issue, and in the face of increasingly complex international and domestic environments, instability and uncertainty in employment still exist. Research results show that the employment environment is a prerequisite for improving employment quality and ensuring full employment, and the level of economic development and differences in economic development levels between regions are important factors that cause differences in the employment environment. Therefore, starting from accelerating the transformation of economic development patterns, we should focus on improving the quantity and quality of employment through economic development, stimulating the employment creation vitality and employment supply capacity of the economic structure, and improving the differences in employment quality caused by the employment environment. Secondly, in the face of the mechanism of industrial structure affecting job opportunities and adjusting employment structure, local governments should attach importance to industrial restructuring and coordinate the compatibility between industrial structure and employment structure. Emphasis should be placed on the rationality of regional distribution in industrial restructuring, supporting high-tech and knowledge-intensive industries, accelerating the upgrading and transformation of traditional industries, further promoting the transformation and development of social labor quality and human capital, and enhancing the employment absorption capacity of the labor market. Finally, it is necessary to cultivate a market incentive mechanism for mass entrepreneurship and innovation, increase local government financial investment in public employment services, carry out employment information services and statistical monitoring projects, and improve the government's service level for regional employment and entrepreneurship.

To strengthen the interactive relationship between higher education and employment, it is crucial to promote the coordinated and dynamic development of higher education and employment. The goal of achieving coordinated coupling between higher education and employment is not merely to pursue resonance between

the two but to strive for a high-level mutual development that maintains long-term and stable coordination. In May 2022, the Third World Higher Education Conference held by the United Nations Educational, Scientific and Cultural Organization released a report titled "Beyond Limits: New Ways to Reinvent Higher Education", which advocated for the transformation and upgrading of higher education institutions, the adjustment of talent skill training to match the job market, and active integration into local ecosystems and society.

With the advent of information technology and the popularization of higher education, cultivating students with knowledge and skills that align with their majors, enabling them to adapt to the labor market, and enhancing their fit with the job market has become a top priority for higher education development in the new era. Taking the cultivation of innovative talents in American universities as an example, while focusing on knowledge transmission, they revise talent cultivation programs promptly through innovative education to make students practical innovative talents who meet the needs of the labor market.

Therefore, colleges and universities must actively respond to new changes, aiming at improving quality and optimizing the internal development of the structure. They should actively explore new school-running models and industrial forms under the background of a new round of technological revolution and industrial transformation, innovate talent cultivation models in keeping with the times, play the role of higher education as a bridge for students' future career development, and enhance the relevance of higher education to the job market. At the same time, it is necessary to improve the coordination mechanism between higher education and employment, optimize policies, regulations, and social resource support systems that ensure their coordinated development, improve the management mechanism of the collaborative governance platform between higher education and employment, scientifically handle the contradictions and conflicts between higher education and employment, and promote the coordinated, dynamic, and healthy development of higher education and employment.

## Author Contribution

Mengdi Jin: Conceptualization, Methodology, Investigation, Formal analysis, Data collection, Visualization, Writing-original draft, and Writing-review and editing. Xiao Rong Wu: Conceptualization, Writing-review and editing, and Supervision.

## Data Availability

The authors do not have permission to share data.

## Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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