Regional Disparities and Convergence in Higher Education Fiscal Expenditures in China: An Empirical Analysis

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Abstract: *This research investigates the disparities and convergence in higher education fiscal expenditures across different regions in China. The study utilises Gini coefficient analysis and σ-convergence/β-convergence tests to quantify the extent of disparities and explore convergence trends over a twelve-year investigation period (2007–2018). The results shed light on the imbalances in resource allocation and provide valuable insights into the efforts required to achieve a more equitable distribution of fiscal resources for higher education. The findings reveal significant disparities in higher education fiscal expenditures between the Eastern, Central, Western, and Northeastern regions, with the Eastern region exhibiting the largest gap compared to others. Remarkably, the disparity between the Eastern and Central regions is even greater than that between the Eastern and Western regions, emphasising the need for targeted interventions to address regional imbalances. Over the study period, the gap between the Eastern and Central regions remained consistently higher than other regional disparities. Moreover, the research shows a general trend towards narrowing regional fiscal expenditure disparities, with the most pronounced convergence observed between the Central and Northeastern regions. The Western region exhibits slightly larger disparities than the Central and Northeastern regions, possibly attributed to greater fiscal policy support and lower student enrollments. Nevertheless, the fiscal expenditure gap between the Western and Central regions has shown a trend towards reduction. The study also explores absolute and conditional β-convergence, revealing notable convergence patterns in the Eastern and Central regions. However, the Western and Northeastern regions exhibit varying degrees of convergence, indicating the necessity for region-specific convergence mechanisms. To achieve a balanced allocation of financial resources for higher education across regions, the study recommends targeted fiscal policies, additional funding, and improved transparency and accountability. Policymakers should focus on enhancing convergence mechanisms to ensure a more equitable distribution of resources and foster the sustainable development of higher education throughout the country. While this research provides valuable insights, it is essential to consider other potential factors influencing fiscal expenditure disparities, such as policy orientation, economic disparities, and demographic structures, for a more comprehensive understanding. Future research may benefit from qualitative investigations to further explore the complexities of higher education fiscal expenditure imbalances and identify effective policy interventions.*

Introduction

The world is undergoing profound and complex changes, such as economic globalisation, political multipolarity, social informatization, diverse challenges, intensified international competition, rapid advancements in science and technology, and a fiercer competition for talent. Both technological development and the cultivation of talent depend on education. Particularly, higher education functions as the foundation for enhancing a nation's scientific and technological level and cultivating exceptional talent. The report of the 18th National Congress of the Communist Party of China makes clear the need to accelerate the implementation of the strategy of revitalizing the country through science and education and strengthening the nation through talent in order to cultivate a large number of strategic and technological talents, leading talents in science and technology, young talents in science and technology, and high-level innovation teams with international standing. Therefore, it is necessary to prioritise the development of higher education, which is conducive to accelerating the implementation of the strategy for revitalizing the country through science and education and fortifying the nation through talent.

Due to the scarcity and limited nature of higher education resources, there is a demand for resource allocation and a discussion about the fairness, efficacy, and sufficiency of resource allocation in higher education. Currently, China's allocation of resources for higher education displays significant imbalances, including regional imbalance, inter-institutional imbalance, and disciplinary imbalance. Among these, the impact of unequal allocation of resources for higher education between regions is the most extensive and well-studied. The unbalanced distribution of higher education resources between regions not only hinders the realisation of educational equity but also prevents the resources from being fully utilised.

Fairness is one of the objectives of achieving a proportionate allocation of educational resources. The Gini coefficient is the most prominent and applicable direct measurement indicator among research indicators for the equity of educational resources. In addition, by combining the study of changes in the level of the fiscal resource allocation gap between regions with research on fiscal expenditure convergence, one can gain a comprehensive and intuitive understanding of the shifting trends in the balanced allocation of financial resources for higher education between China's regions. Using the Gini coefficient and convergence, this paper will investigate the regional differences and convergence of China's higher education financial expenditures.

Literature Review

Since 2012, China has proposed to "vigorously promote educational equity and gradually narrow the gap between schools, urban and rural areas, and regions," highlighting the need to "vigorously promote educational equity and rationalise the allocation of educational resources." To promote equity in higher education and accomplish a balanced allocation of financial resources, it is crucial to address the significant disparity between regional expenditures on higher education. Gu (2009) summarises the equitable distribution of higher education resources across regions in terms of four factors: scope, efficiency, quality, and structure, as well as the balance between entities. Chang (2010) notes that the balance of higher education between regions is reflected not only in macro aspects like scope but also in micro aspects like the balance of majors and disciplines. To promote implementation and achieve balance in both macro and micro aspects of higher education, the disparity in financial expenditures between regions must be reduced. The current allocation of financial resources for higher education in China has not yet reached a state of equilibrium, with a notable phenomenon of disparate expenditures between regions (Lu Jianfei et al., 2005; Gao Yanan, 2017; Ren Wenlong, 2018; Tang Yipeng, 2019). By examining the current situation of the development gap in financial expenditures for higher education between regions in China, it is possible to analyse the factors impeding the balanced allocation of financial resources for higher education and provide suggestions for closing the gap and achieving a more equitable distribution of financial resources.

When conducting research on the regional disparity in the allocation of higher education financial resources, Chinese scholars frequently employ inequality indices like the Gini coefficient and the Theil index to examine the disparity between eastern, central, and western regions as well as within regions. Zhu (2003) examined the allocation of higher education resources among China's provinces using the Gini coefficient and discovered that the aggregate imbalance in educational resource investment between provinces grew annually. Zhang (2009) examined the situation of fiscal investment in higher education in China over the past decade and found that fiscal investment in higher education exhibited a pattern of "high in the east, low in the west, and collapse in the middle," with the Gini coefficient between provinces hovering around 0.4, indicating a significant imbalance in fiscal investment in higher education between provinces. Using the Theil index, Yang and Wang (2014) analysed the distribution of fiscal expenditure resources for tertiary education in eastern, central, and western China. They discovered that the fiscal expenditure disparity for higher education in the eastern region was considerably greater than in the central and western regions. The intra-regional disparity contributed more to the overall disparity than the inter-regional disparity, indicating that attention must be paid not only to the balanced distribution of higher education resources between provinces, but also to the balanced distribution within neighbouring regions.

Using game theory, Qu (2012) investigated how to reconcile the equitable and efficient allocation of resources in higher education. He discovered that investments in Tibet, Inner Mongolia, Gansu, and Xinjiang's higher education resources, while adequate, were relatively ineffective. The government, as the ultimate authority in the process of allocating higher education resources, should adhere to a scientific and rational concept and optimise the allocation pattern of higher education resources in different regions based on the local industrial structure and natural resource advantages, thereby enhancing fair competition and incentive mechanisms. Using principal component analysis, Dai et al. (2015) analysed the allocation of higher education resources in nine provinces and two municipalities along the Yangtze River. The agglomeration effect of educational resources widened the disparity within the region. They proposed enhancing cooperation between higher education institutions in the region in order to establish a mechanism for coordinated long-term development. Liu (2017) investigated the distribution of educational resources across China's central-level institutions using the Gini coefficient and the entropy weight method. In terms of the number of central-level institutions and the resources obtained, the central and western regions remained at a disadvantage. Regional and material capital differences substantially contributed to the unequal distribution of educational resources. Similarly, Gao (2017) took an ecological approach to the equitable allocation of resources for higher education. The study noted that China's higher education has developed significantly over the past two decades; however, the development of the scale and allocation of higher education resources among provinces and regions has been highly uneven, with the disparity between developed and underdeveloped regions growing. Therefore, colleges and universities in each region should determine their own "ecological niche" and implement ecological allocation of higher education resources as a prerequisite and basis for ensuring educational equity.

However, both the Gini coefficient, Theil index, and other inequality indices, as well as methods such as principal component analysis, used to measure the allocation of higher education financial resources, can only analyse cross-sectional data and provide information about a specific point in time. They cannot clearly illustrate the sustainability of the reduction in the gap in higher education financial expenditures in China and the trend of balanced allocation of financial resources. Therefore, the concept of economic convergence has gradually gained favour among scholars to describe the changing trend of the gap in higher education financial expenditures between regions. Economic convergence is an important component of neoclassical growth theory, which suggests that a country's per capita income will converge to the steady-state equilibrium value of economic growth. It was first discovered and proposed by American economists Barro and Xavier (1992), who introduced the concepts of σ-convergence and β-convergence, which refer to the decreasing income gap over time and the "catch-up" of poor regions to wealthier regions, respectively. Subsequently, Mankiw et al. (1992) further proposed absolute convergence and conditional convergence. Today, with the deepening research on economic convergence theory, it has been widely applied not only in explaining economic growth trends but also in various other fields of social economics such as economics and public finance. Hawk and Ding (2005) studied the relationship between transfer payment systems and regional economic convergence and found that regional economic convergence was not influenced by transfer payment systems. Wang (2014) studied the convergence of local fiscal revenue in China and found

the existence of σ-convergence, absolute β-convergence, and conditional β-convergence in fiscal revenue between regions. Chen and Wang (2020) explored the regional differences and convergence of the tourism economy in Sichuan and found that the overall tourism economy in Sichuan showed σ-convergence, but there was a local σ-divergence trend in eastern Sichuan. In the field of education and human capital, Smith and Sab (2001) used three-stage least squares to study the convergence of educational and human capital and found that it was conditional. Stamatkis and Petrakis (2006) evaluated the convergence of enrollment rates among OECD countries and found that there was convergence in human capital within countries but no convergence between countries. Afzal (2012) studied the convergence of education and welfare in different regions of Pakistan and concluded that the literacy rate over the past fifty years showed significant β-convergence, while gender equality in enrollment and the level of accommodation conditions had improved. Gu (2016) analysed the convergence of regional vocational education development in China and discussed the role of neighbouring structures in regional vocational education development. The application of convergence analysis in the field of education has been increasing, and domestic scholars have also conducted relevant research. Fan (2009) explored the convergence of the educational gap between urban and rural areas in China by using indicators such as per capita fiscal expenditure and the number of teachers in compulsory education, providing suggestions for the reasonable division of government responsibilities for compulsory education, and improving the transfer payment system.

In summary, in the existing literature, the methods used to study the imbalance in the allocation of higher education resources in China mainly include the Gini coefficient, Theil index, comparative analysis, principal component analysis, game theory, etc. There is limited research on the convergence of higher education, and it is mainly focused on the convergence of fiscal expenditures within regions. The study of the convergence of higher education resources within regions is relatively weak. In-depth research on the disparity in provincial higher education financial expenditures and their convergence can help us understand the robust trends of problems and characteristics in the process of higher education development in China and provide policy recommendations to promote the balanced development of higher education.

Therefore, it can formulate two hypotheses:

H1: *Higher education fiscal expenditures in China exhibit significant disparities between regions, with the eastern region displaying the largest gap compared to other regions. Additionally, the disparities between the eastern and central regions are even greater.*

H2: *There is a trend of narrowing disparities over time in higher education fiscal expenditures, with the most prominent convergence observed between the central and northeastern regions.*

H3: *The western region demonstrates slightly larger disparities compared to the central and northeastern regions. The convergence between the western and northeastern regions is less evident.*

H4: *Policy interventions can effectively address the disparities, promote convergence, and enhance the balanced regional development of higher education fiscal expenditures in China.*

Methodology and research methods

Coefficient Gini and its decomposition：In this study, we will calculate the disparity in the allocation of fiscal resources for higher education between China's 31 provinces and municipalities. Based on previous literature on indicators for measuring higher education fiscal resources, we intend to calculate the Gini coefficient using the fiscal expenditure on higher education in each province and municipality. In addition, we will use Dagum's method for calculating and decomposing the Gini coefficient to assess the disparity in China's allocation of fiscal resources to higher education between regions. The regions will be divided into eastern, central, western, and northeastern sub-regions. At both the global and subregional levels, the Gini coefficient will be determined. Following is the specific formula for calculating the global Gini coefficient (G):

$$G = \frac{1}{2N^2 \overline{Y}_t} \sum_{j=1}^{k} \sum_{h=1}^{k} \sum_{i=1}^{n_j} \sum_{r=1}^{n_h} \left| y_{jit} - y_{hrt} \right|$$

(1)

In the equation, G represents the value of the overall Gini coefficient, which is the Gini coefficient of higher education fiscal expenditure in China. N (n) denotes the number of economic entities or units being measured, where N is the total number and n represents the number of units within a region. In this case, N refers to the total number of students in regular higher education institutions nationwide, while n represents the number of students in each regional higher education institution.

j (h) represents the different subgroups or regions, namely the Eastern, Central, Western, or Northeastern regions. k denotes the number of sample regions, and in this study, we divide the regions into four, so the number of regions is 4.

i (r) represents the number of students in each sampled region. Y (y) indicates the amount of per capita higher education fiscal expenditure, where Y represents the national per capita higher education fiscal expenditure and y represents the per capita higher education fiscal expenditure for each region.

Therefore, $y_{jit}(y_{hrt})$ represents the per capita higher education fiscal expenditure in region j (h) at time t, and $n_j(n_h)$ represents the number of provinces (municipalities) in region j (h). $\overline{Y}_t$ is the average value of national per capita higher education fiscal expenditure.

The calculation process is as follows:

$$\overline{Y_t} = \frac{1}{N}\sum_{j=1}^{k}\sum_{i=1}^{n_j} y_{jit}$$ (2)

The calculation formula for the Gini coefficient involves computing the differences between each pair of regions, exhaustively considering all possible "inequality" scenarios. Dagum's decomposition method further breaks down the overall Gini coefficient (G) into three components: within-group disparity (G_w), between-group net contribution (G_{nb}), and between-group transdensity contribution (G_t). The transdensity contribution measures the impact of cross-term interactions among subgroups on the overall Gini coefficient, which arises from the process of decomposing the overall Gini coefficient.

The formula for calculating the within-group gap is as follows:

$$G_w = \sum_{j=1}^{k} G_{jj}\, p_j s_j$$ (3)

Gjj denotes the Gini coefficient within region j, calculated as:

$$G_{jj} = \frac{\frac{1}{2\overline{y}_j}\sum_{i=1}^{n_j}\sum_{r=1}^{n_j}\left|y_{ji}-y_{jr}\right|}{n_j^2}$$ (4)

p_j represents the student share in the j region, which is the proportion of the number of students in the jth region to the total number of students in the country, $p_j = n_j/N$, and $\sum p_j = 1$. Similarly, s_j represents the expenditure share in the j region, which is the proportion of the expenditure in the jth region to the total expenditure, $s_j = p_j \overline{y}_j/\overline{Y}$, and $\sum s_j = 1$.

The formulae for the net contribution to the gap between groups and the contribution to the hypervariable density between groups are, respectively:

$$G_{nb} = \sum_{j=2}^{k}\sum_{h=1}^{j-1} G_{jh}\left(p_j s_h + p_h s_j\right)D_{jh}$$

$$G_{nb} = \sum_{j=2}^{k}\sum_{h=1}^{j-1} G_{jh}\left(p_j s_h + p_h s_j\right)\left(1-D_{jh}\right)$$ (5)

where G_{jh} is the inter-regional Gini coefficient for j-h, calculated as follows:

$$G_{jh} = \frac{\sum_{i=1}^{n_j}\sum_{r=1}^{n_h}\left|y_{ji}-y_{hr}\right|}{n_j n_h \left(\overline{y_j}+\overline{y_h}\right)}$$

(6)

D_{jh} represents the relative impact of higher education financial expenditure between regions j and h, while djh represents the difference in higher education financial expenditure between regions j and h, which is the weighted average of all cases where y_{ji} - y_{hr} > 0. The definitions of D_{jh} and d_{jh} are given by the following formulas:

$$D_{jh} = \frac{d_{jh}-p_{jh}}{d_{jh}+p_{jh}}$$

$$d_{jh} = \int_0^\infty dF_j(y)\int_0^y (y-x)dF_h(x)$$

(7)

Here F_j (F_h) represents the cumulative density distribution function of region j (h), and p_{jh} denotes the hyper-variable first moment. It represents the mathematical expectation of all cases where y_{ji} - y_{hr} > 0 for regions j and h. The calculation formula is as follows:

$$p_{jh} = \int_0^\infty dF_h(y)\int_0^y (y-x)dF_j(x)$$

(8)

Convergence testing model: The absolute β convergence model, based on the approach proposed by Bernard and Jones (1996), is used for estimation. The model is defined as follows:

$$(\ln y_{iT} - \ln y_{i0})/T = \alpha + \beta \ln y_{i0} + \varepsilon$$

（9）

In the equation above, yiT and yi0 represent the data values of the ith unit in the reporting period and the initial period, respectively. In this study, they correspond to the per capita general budgetary funding for higher education in the i province (or city). T represents the time span, α and β are the estimated parameters, and ε is the random error term. Based on the relationship between β and 0, we can determine whether there is absolute β convergence in the observed objects. When β < 0, absolute β convergence exists. Additionally, the convergence speed λ and convergence time τ can be calculated from the estimated β value using the following formulas:

$$\beta = -(1-e^{-\lambda T})/T$$

(10)

$$\tau = \ln(2)/\lambda$$

(11)

The test model for absolute β convergence is essentially a cross-sectional regression, and its results are sensitive to the time span T. It may be affected by short-term fluctuations or outliers within a specific time period. Therefore, this study conducted regional and time-period-specific validations when estimating absolute β convergence.

Due to the small sample size of cross-sectional data, the estimation accuracy is limited, and the regression results may not accurately reflect the long-term convergence trend of higher education funding. They only represent the growth trend within the period from 2001 to 2010. Furthermore, using this method can only indicate whether there is a conditional β convergence trend during this specific time period. Additionally, apart from the three explanatory variables used, there may be other omitted variables that could affect the convergence of higher education funding. Therefore, this study selects panel data on per capita general public budgetary funds for higher education from 2007 to 2018 to investigate conditional β convergence, thereby expanding the scope and foundation of the research.

In the study of conditional β convergence under the total factor productivity framework, a panel data fixed effects model is employed to estimate the conditional β convergence of general public budgetary funds for higher education. The estimation method of the panel data fixed effects model can control for time and cross-sectional effects while considering that different individuals have different steady-state values. In other words, each province has a different convergence trend, which leads to a more accurate estimation of convergence. Additionally, the panel data fixed effects model can avoid endogeneity issues arising from omitted variables. The specific regression model is as follows:

$$\ln(y_{it} / y_{i,t-1}) = \alpha + \beta \ln y_{i,t-1} + \varepsilon_{it} \tag{12}$$

The formulas for calculating convergence time and convergence speed are as follows:

$$\beta = -(1 - e^{-\lambda T}) \tag{13}$$

$$\tau = \ln(2) / \lambda \tag{14}$$

Data sources and sample analyses: This article primarily focuses on studying the Gini coefficient and convergence of higher education financial resource allocation in various provinces and cities in China. The data used in this study are the expenditure of higher education finance (represented as 'exp' in billions of yuan) and per capita general public budgetary funds for higher education (represented as 'Di' in ten thousand yuan). The data sources include official statistics from the website of the Ministry of Education and the annual "China Education Statistical Yearbook." Please refer to Table 1 for specific details.

Table 1 Data descriptive statistics

exp	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Mean	180.61	169.90	145.07	136.76	118.66	112.14	116.07	89.41	60.86	49.71	44.04	34.65
Standard deviation	120.94	112.21	91.91	86.94	78.74	70.12	69.78	58.58	46.73	40.73	35.62	30.31
Maximum value	587.01	514.69	386.11	370.25	353.97	285.25	281.57	259.10	202.82	174.67	142.78	123.92
Minimum value	18.25	14.69	11.70	11.29	7.09	8.36	8.40	7.97	4.92	3.58	3.76	2.91
D_i	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Mean	2.26	2.16	1.87	1.83	1.56	1.56	1.65	1.40	0.96	0.79	0.75	0.62
Standard deviation	1.12	1.09	0.86	0.96	0.87	0.75	0.73	0.80	0.59	0.50	0.43	0.38
Maximum value	6.33	6.66	5.57	6.13	5.85	4.76	4.76	4.41	3.45	2.98	2.44	2.14
Minimum value	1.46	1.37	1.22	1.11	1.11	1.01	1.10	0.76	0.43	0.42	0.37	0.29

Sources: developed by the authors.

From the data in the table, it can be observed that the expenditure on higher education and the per capita general public budget for higher education have significantly increased from 2007 to 2018 in various provinces and municipalities. Although there has been an increase in the absolute difference between the maximum and minimum values, there has been a certain degree of reduction in the relative difference. The specific regional disparities in higher education financial resources and the convergence situation will be further analysed in the subsequent research results.

Results

Based on the research methods described above, this study will calculate the Gini coefficient and its decomposition, σ convergence, absolute β convergence, and conditional β convergence of higher education expenditure in China and its sub-regions. The aim is to explore the disparities and convergence trends in higher education expenditure and determine if an appropriate convergence path has been found.

Analysis of regional disparities in financial expenditure on higher education: By comparing the data, it can be observed that the analysis of regional disparities in China's higher education expenditure reveals the uneven distribution of higher education resources between regions. In order to visually demonstrate the changes in the regional distribution of higher education financial resources over the past decade, ArcGIS software was used to create spatial distribution maps of higher education expenditure in the 31 provinces and municipalities in China in 2007 and 2018, as shown in Figures 1 and 2.
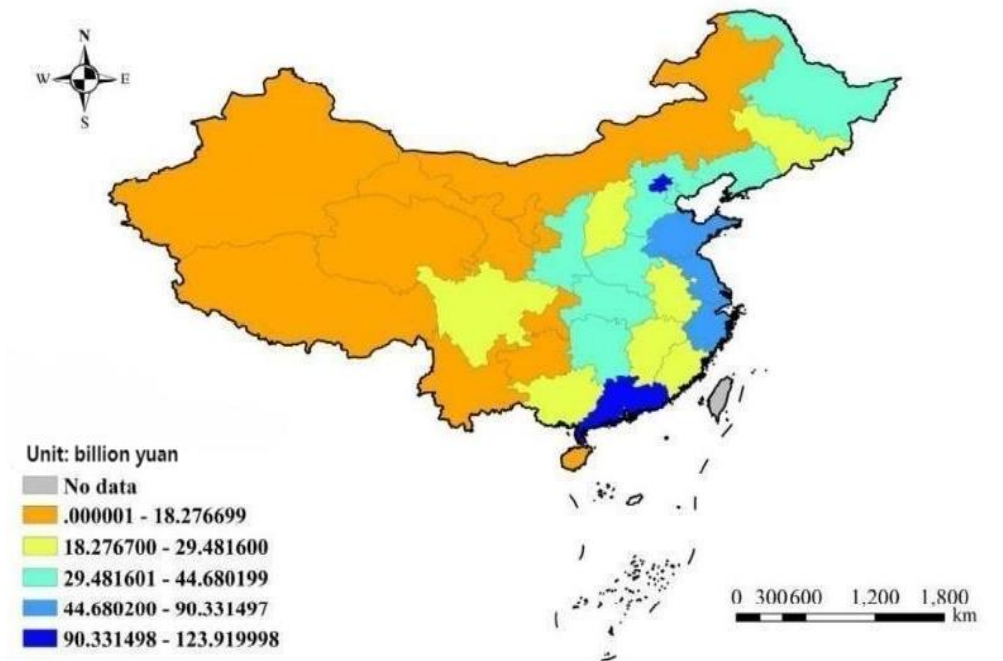
Figure 1. Spatial distribution of financial expenditure on higher education in China, 2007
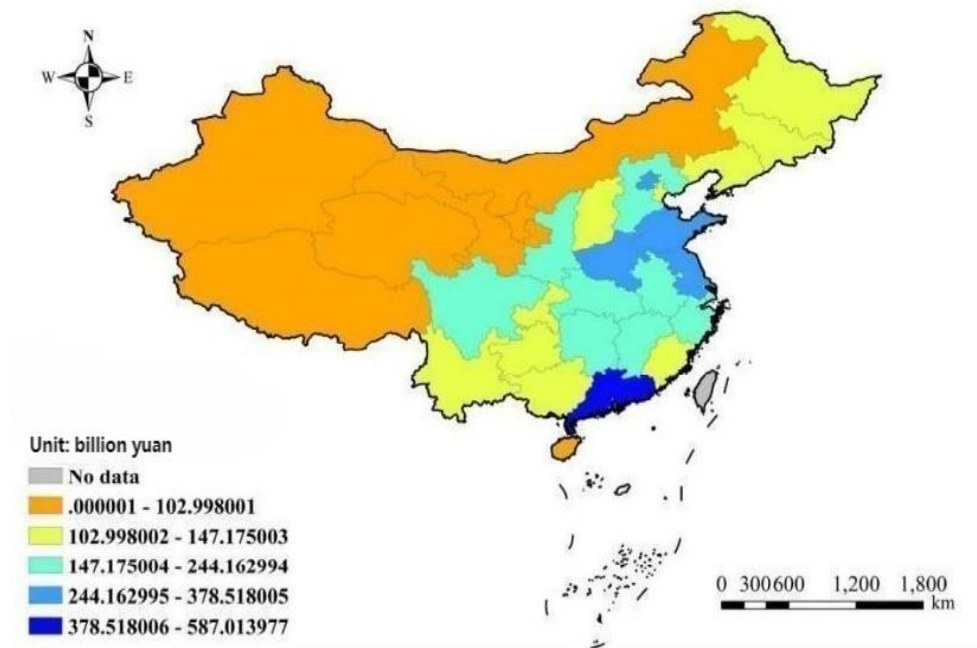
Sources: developed by the authors.

Figure 2. Spatial distribution of financial expenditure on higher education in China, 2018

Sources: developed by the authors.

According to Figures 1 and 2, the spatial distribution of higher education expenditures in China in 2007 and 2017 exhibits similar regional clustering patterns. In general, expenditures in the eastern littoral regions are higher than those in the western regions. Particularly in Guangdong province, Beijing municipality, Shandong province, and Jiangsu province, the total expenditure on higher education remains higher in the eastern coastal areas. The western regions, including Inner Mongolia Autonomous Region, Ningxia Hui Autonomous Region, Gansu Province, Xinjiang Uygur Autonomous Region, Tibet Autonomous Region, and Hainan Province, have consistently lower expenditure values.

Additionally, the northeastern region is characterised by lower expenditures on higher education, with Heilongjiang and Liaoning provinces experiencing a decline in expenditures from 2007 to 2017, indicating a widening disparity between the northeastern region and other regions. In contrast, Sichuan province, Yunnan province, Guizhou province, Chongqing municipality, Jiangxi province, and Anhui province have experienced an increase in their expenditure levels, indicating a reduction in the disparity with other regions. This demonstrates the initial success of the government's higher education support policies in the central and western regions.

This study estimated the Gini coefficients of higher education expenditure in China for the period 2007–2018 based on the regional divisions of the eastern, central, western, and northeastern regions. The results are presented in Table 2, which exhibits several notable characteristics:

Table 2. Regional Gini coefficients and their decomposition of financial expenditure on higher education in China, 2007-2018

Year	Overall Gini coefficient	Intra-regional Gini coefficient				Inter-regional Gini coefficient						Contribution Rate (%)		
		East	Central	West	Northeast	East-Central	East-West	East-Northeast	Central-West	Central-Northeast	West-Northeast	Intra-regional	Inter-regional	Hypervariable Density
2007	0.2721	0.3123	0.0937	0.1873	0.0238	0.4130	0.3005	0.2815	0.2447	0.2073	0.1380	0.2864	48.60%	22.76%
2008	0.2599	0.2775	0.0582	0.1976	0.0732	0.3977	0.2707	0.2790	0.2628	0.1645	0.1646	0.2708	51.11%	21.81%
2009	0.2617	0.3124	0.0593	0.1707	0.0373	0.3904	0.2871	0.3160	0.2258	0.1069	0.1519	0.2866	50.82%	20.52%
2010	0.2659	0.3138	0.0849	0.1682	0.1171	0.4036	0.2739	0.3061	0.2672	0.1630	0.1748	0.2797	48.02%	24.01%
2011	0.2532	0.3212	0.0285	0.2159	0.0908	0.3041	0.2831	0.2628	0.2369	0.1404	0.1823	0.2913	43.99%	26.31%
2012	0.1883	0.2514	0.0937	0.1505	0.0624	0.2280	0.2202	0.2023	0.1458	0.0928	0.1280	0.3082	30.22%	38.96%
2013	0.1923	0.2643	0.0523	0.1320	0.0227	0.2596	0.2257	0.2364	0.1403	0.0473	0.1168	0.2941	46.82%	23.71%
2014	0.1838	0.2762	0.0278	0.1096	0.0150	0.2586	0.2304	0.2197	0.1029	0.0538	0.0784	0.3013	50.43%	19.45%
2015	0.2068	0.2635	0.0533	0.1598	0.0760	0.2774	0.2276	0.2184	0.1891	0.1092	0.1369	0.2816	43.54%	28.30%
2016	0.1932	0.2283	0.0583	0.1653	0.0700	0.2480	0.2130	0.2162	0.1721	0.0780	0.1493	0.2775	37.06%	35.15%
2017	0.2137	0.2537	0.0534	0.1804	0.0594	0.2750	0.2366	0.2631	0.1776	0.0596	0.1694	0.2772	39.92%	32.32%
2018	0.2183	0.2420	0.0487	0.2080	0.0849	0.2698	0.2433	0.2473	0.1843	0.0802	0.1772	0.2728	38.06%	34.66%

Sources: The data is sourced from the official website of the Ministry of Education for education data statistics, "Annual Statistical Report on Education Expenditure" and "China Education Statistical Yearbook".

During the study period from 2007 to 2018, which spanned 12 years, the Gini coefficient for the nation's higher education fiscal expenditure fluctuated downward. After reaching its lowest point of 0.1838 in 2014, there was a slight increase, but the overall trajectory was a significant decline from 0.2721 to 0.2183. Figure 3 depicts the situation and general trend of the income disparity in higher education fiscal expenditures in China over the past twelve years. This indicates that the overall disparity in China's higher education fiscal expenditure is progressively narrowing, and additional effective measures should be taken to promote the equitable allocation of fiscal resources in higher education.
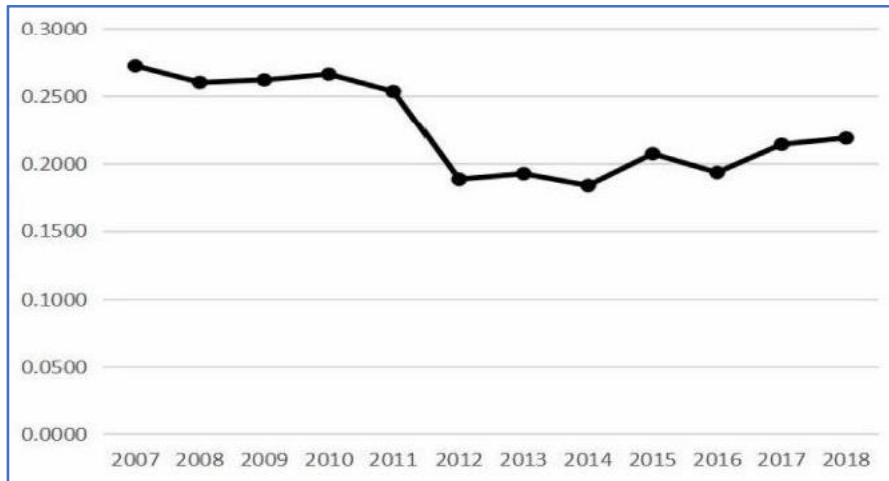
Figure 3. Evolutionary trend of regional disparities in China's overall tertiary education financial expenditures`

Sources: developed by the authors.

After dividing the country into the East, Central, West, and Northeast regions, we can observe from the regional disparities in higher education fiscal expenditure that the East region has the greatest disparities between provinces (cities) in terms of higher education fiscal expenditure. Throughout the twelve-year study period, the Gini coefficient for the East region exceeded 0.2, reaching as high as 0.3212 in 2011. This indicates exceedingly uneven growth in East Asian higher education fiscal expenditures. As shown in Figure 4, the East region exhibits the most significant decline in the regional Gini coefficient among the four regions.

The West region has comparatively large differences in higher education fiscal expenditure between provinces (cities), with a decreasing trend and an increasing trend. In 2014, the Gini coefficient attained its lowest value of 0.1096, but 2015 marked a turning point. After that, the regional Gini coefficient for the West began to increase, and by 2018, it had surpassed the 2007 level of 0.1873.

Compared to the East and West regions, regional disparities in higher education fiscal expenditure are relatively lesser in the Central and Northeast regions. In all years, the Central Region had Gini coefficients below 0.1. Nonetheless, the Northeast region exhibits a fluctuating upward trend in regional disparities in higher education fiscal expenditure, indicating a decline in the regional balance of higher education fiscal expenditure. This merits our consideration and concern.
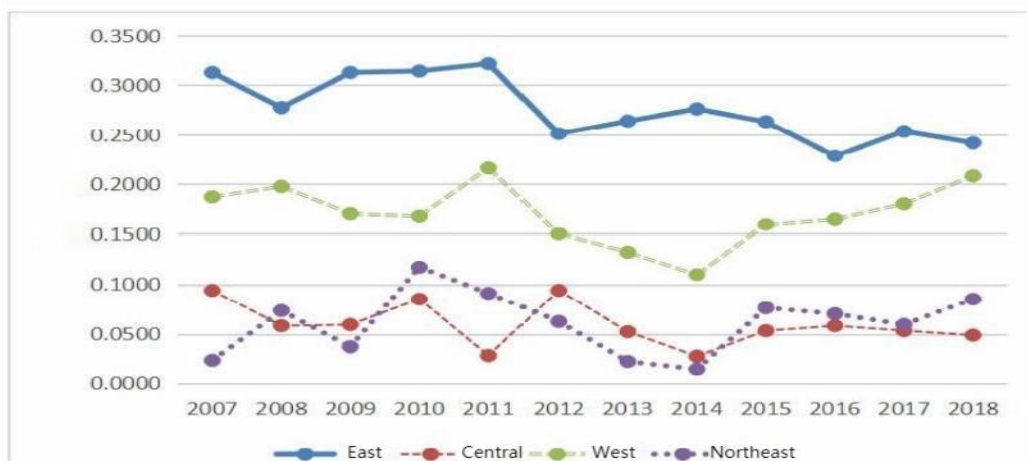

Figure 4. Evolutionary trend of regional disparities in financial expenditures on higher education within each region of China

Sources: developed by the authors.

According to the Gini coefficient, the disparities in higher education fiscal expenditures between the East region and the other three regions are significantly greater than the disparities between the other regions. This is due to the East region's higher level of economic development and concentration of higher education institutions, which is consistent with the findings of prior research emphasising the significant imbalance in China's allocation of fiscal resources to higher education. Notably, the largest disparity in higher education fiscal expenditures exists not between the East and West regions but between the East and Central regions. Throughout the duration of the twelve-year investigation, the Gini coefficient between the East and Central regions remained greater than disparities between other regions. Even in 2012, the year with the lowest Gini coefficient between the East and Central regions, its value was still greater than the 0.2202 observed between the East and West regions in that year, and the Gini coefficient between the East and Central regions consistently exceeded 0.2.

Notable is the trend towards narrowing higher education fiscal expenditure disparities between the East region and other regions, with the most pronounced trend observed between the East and Central regions. As depicted in Figure 5, the Gini coefficient between these two regions fell from 0.4130 in 2007 to 0.2698 in 2018. The disparities between the West, Central, and Northeast are marginally greater than those between the Central and Northeast. This may be primarily due to the government's greater financial policy support for Western region universities compared to the other two regions, as well as the relatively lower number of students in Western region universities. The Western region therefore has greater access to higher education resources than the Central and Northeast regions. In addition, based on the trend of Gini coefficients, the gap in higher education fiscal expenditures between the Western and Central regions has shrunk, whereas the gap between the Western and Northeast regions has shown a less pronounced widening tendency.
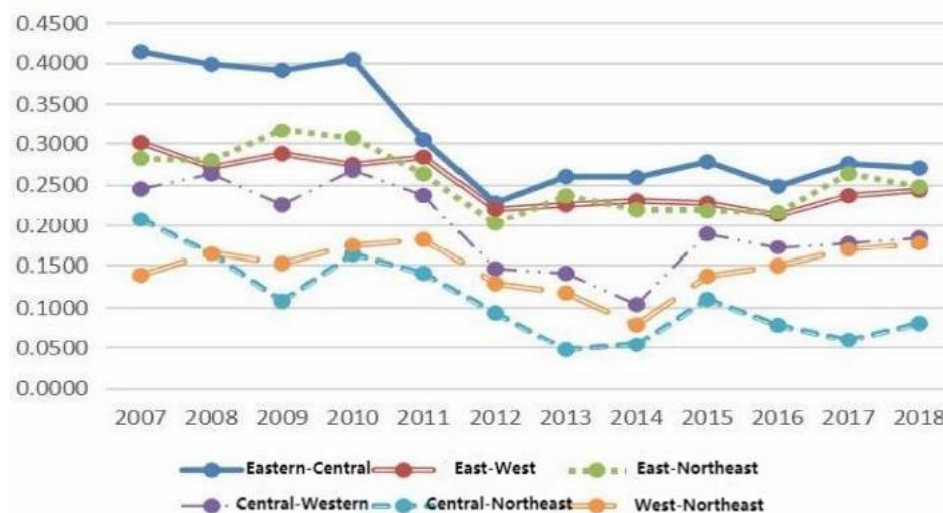

Figure 5. Convergence test for national and sub-regional per capita general public budget funding for tertiary education σ

Sources: developed by the authors.

Except for 2007, when it was greater than the disparity between the Western and Northeast regions, the region with the smallest disparity is the one between the Central and Northeast regions, whose Gini coefficient is consistently less than 0.2. Moreover, the disparity between the Central and Northeast regions has decreased the most rapidly. In 2018, the Gini coefficient fell from 0.2073 in 2007 to 0.0802, a reduction of nearly 62%.

In terms of how various differences influence the aggregate Gini coefficient of higher education spending in China, the net contribution of regional differences remains the most significant, with a contribution rate of over 40% for the majority of the study period. In recent years, however, the regional disparity contribution rate has decreased from 48.6% in 2007 to 38.06% in 2018. In contrast to the trend of regional disparities, the hypervariable density contribution rate is rising, reaching 34.66 percent in 2018. This indicates that regional expenditures on higher education are increasingly overlapping and intersecting. The contribution rate of internal disparities remained relatively stable throughout the investigation period, ranging from 27% to 31%.

In conclusion, there is still a degree of disparity in the fiscal expenditure on higher education across China's different regions, especially between the Eastern, Central, Western, and Northeastern regions. The disparity

between the Eastern region and other regions is greater. To achieve a balanced allocation of financial resources for higher education across regions, additional work is required.

Convergence of σ Results: Utilising standard deviation and coefficient of variation, this study focuses on the σ convergence of (standard deviation) in China's higher education fiscal expenditure. The objective is to investigate the level trend of government spending on higher education over time. The selected data for analysis are the per capita general public budgetary funds for higher education in each Chinese province, as reported in the annual "China Education Statistical Yearbook." The calculated results are shown in Figure 6.
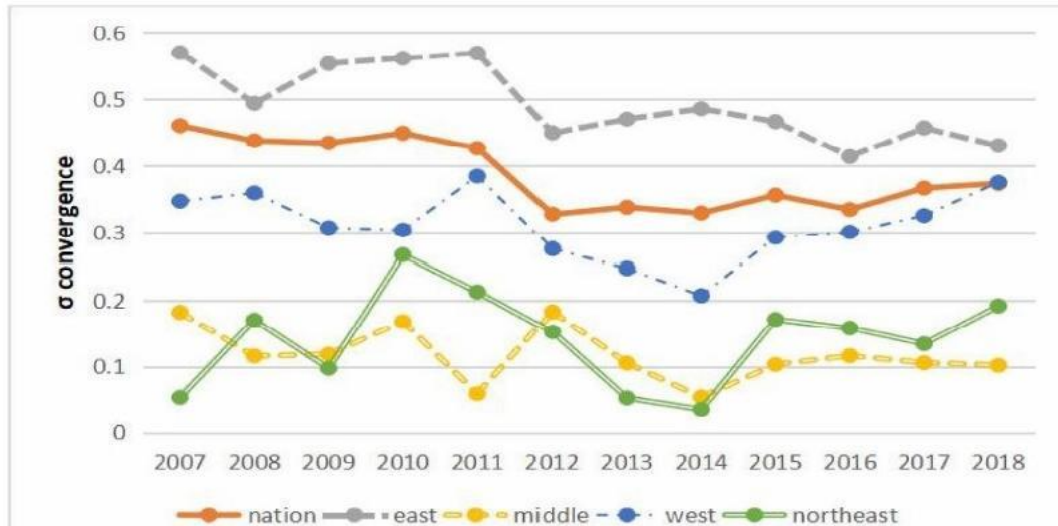

Figure 6. Convergence test for national and sub-regional per capita general public budget funding for tertiary education σ

Sources: developed by the authors.

Per capita general public budgetary funds for higher education in China have fluctuated slightly over the course of more than ten years, as depicted in the graph. Nonetheless, there is a general downward trend, indicating that it is converging. China's per capita general public budgetary expenditures for higher education decreased from 0.460 in 2007 to 0.373 in 2018.

From 2007 to 2018, only the eastern region exhibited a relatively stable convergence trend, per the convergence test across various regions. In 2018, the value of per capita general public budgetary funds for higher education in the eastern region fell from its initial value of 0.569 to 0.431. The central region has exhibited an "M"-shaped oscillation, with minor divergence observed in 2008–2010, 2011–2012, and 2014–2016 and a convergent trend in the remaining years. The value of per capita general public budgetary funds for higher education in the central region has decreased from 0.18 in 2007 to 0.101 in 2018, indicating a trend towards convergence. During the period 2010–2014, the western and northeastern regions converged significantly, attaining their lowest values of 0.206 and 0.036, respectively. Since that time, however, both regions have demonstrated an upward oscillation, indicating recent divergence.

In conclusion, the per capita general public budgetary funds for higher education in China exhibit a consistent convergence trend at both the national and eastern regional levels. Other regions show a certain degree of value decline only during specific time periods, then over the past few years, there has been a consistent expansion trend. Consequently, significant convergence is observed at the national level and in the eastern region, but not in the central, western, or northeastern regions. Also, the coefficient of variation, which cancels out the effect of the average scale of per capita general public budgetary funds for higher education, gives a more accurate picture of how the data is spread out. As depicted in Figure 7, this study examines the convergence trend of the coefficient of variation for per capita general public budgetary funds for higher education.
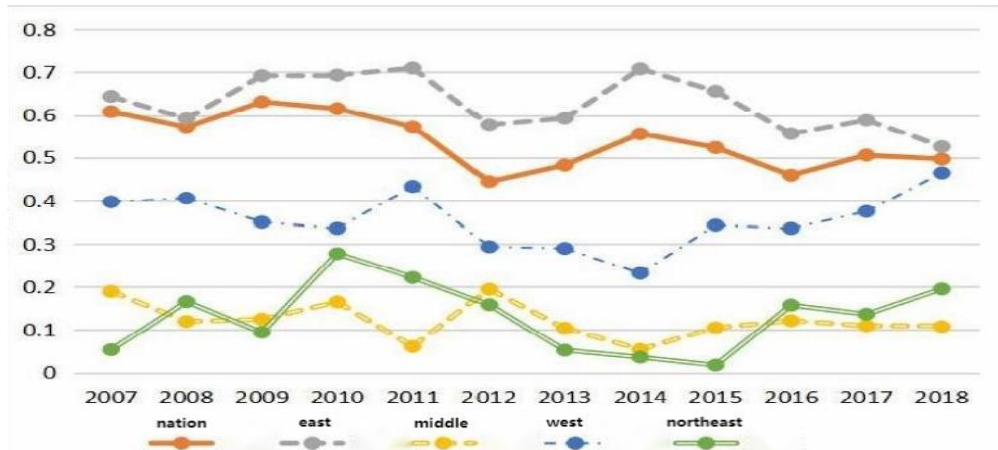
Figure 7. Coefficient of variation of general public budgetary expenditure per student in higher education, nationally and by region

Sources: developed by the authors.

From the above figure, it can be observed that the convergence trends of per capita general public budgetary funds for higher education in China, both at the national level and across different regions, exhibit similar temporal characteristics to those of the standard deviation. This finding further confirms the overall σ convergence trend in the country and the eastern region, while other regions do not show consistent σ convergence trends. Convergence of β Results: The study investigates the absolute β convergence, which explores whether the higher education financial expenditure in different regions converges to the same equilibrium level, indicating the presence of "catch-up effects" among provinces or within regions. The results of the convergence test are presented in Table 3.

Table 3. Absolute β Convergence Test for National and Regional Higher Education Financial Expenditure

	2007 -2018 (T=12)				2007 -2018 (T=6)			
	β	R^2	λ	τ	β	R^2	λ	τ
Nation	-0.026***	0.347	0.031	22.242	-0.078***	0.497	0.105	6.590
	-0.007	[0. 325]			-0.014	[0. 479]		
East	-0.028**	0.459	0.034	20.313	-0.064*	0.377	0.081	8.584
	-0.011	[0. 392]			-0.028	[0. 299]		
Middle	-0.103***	0.853	///	///	-0.157*	0.469	0.475	1.461
	-0.021	[0.816]			-0.083	[0. 336]		
West	-0.004	0.187	0.004	169.094	-0.067**	0.347	0.086	8.089
	-0.126	[0. 091]			-0.028	[0.312]		
Notheast	-0.035**	0.995	0.045	15.270	0.008	0.131	///	///
	-0.003	[0. 989]			-0.072	[0. 097]		
	2007 -2011 (T=5)				2012 -2018 (T=7)			
	β	R^2	λ	τ	β	R^2	λ	τ
Nation	-0.043***	0.161	0.048	14.317	-0.018*	0.311	0.019	36.028
	-0.018	[0.132]			-0.224	[0. 230]		
East	-0.021	0.152	0.022	31.242	-0.028*	0.141	0.031	22.241
	-0.031	[0.064]			-0.281	[0. 033]		
Middle	-0.192***	0.897	0.644	1.077	-0.091**	0.692	0.145	4.788
	-0.032	[0. 871]			-0.031	[0.615]		
West	-0.015	0.152	0.016	44.454	-0.019	0.156	0.020	33.998
	-0.389	[0. 083]			-0.047	[0. 087]		
Notheast	0.109	0.765	///	///	0.021	0.182	///	///
	-0.061	[0.529]			-0.071	[0. 083]		

Note: Standard deviation in parentheses, adjusted R2 in square brackets, ***, ** and * indicate significance at the 10%, 5% and 1% significance levels, respectively.

Sources: developed by the authors.

To avoid the randomness and abrupt changes in cross-sectional data, this study divided the data from 2007 to 2018 into different time periods and conducted comprehensive tests on the absolute β convergence of national and regional higher education fiscal expenditure. The specific time periods are as follows: First, the entire period from 2007 to 2018 was considered a continuous time period (T = 12); second, the entire period was divided into four shorter periods of 3 years each (T = 6), and the average values of higher education fiscal expenditure for each period were used for convergence estimation; thirdly, the period was divided based on the year 2012, estimating the convergence for the years 2007–2011 (T = 5) and 2012–2018 (T = 7).

According to the test results in Table 3, the absolute β convergence estimates for the four time periods at the national level were -0.026, -0.078, -0.043, and -0.018, with significance levels below 1% for all three periods except for 2012–2018 (T = 7), which showed significance at the 10% level. This indicates a negative correlation between the growth rate of higher education fiscal expenditure and its initial level, suggesting a "catch-up effect" where regions with initially lower per capita general public budgetary funds for higher education catch up with regions with higher initial levels. Furthermore, when conducting absolute β convergence tests in different time periods nationwide, the convergence speeds λ for the three periods were 10.5%, 4.8%, and 1.9%, respectively. The half-life periods τ were 6.590 years, 14.317 years, and 36.028 years, with a half-life period of 22.242 years for the entire time range. This implies that it takes approximately 22 years for the gap between regions with higher and lower per capita general public budgetary funds for higher education to be reduced by half. These findings indicate that the convergence rates of higher education expenditures to the equilibrium point vary across time periods. Nonetheless, they all tend to approach the same equilibrium. In addition, according to the theory of new economic development, the convergence of higher education fiscal expenditures stems from both economic and institutional convergence. This suggests that, as a result of the development of China's social economy and the improvement and unification of its tax management system and transfer payment system, the disparity in higher education fiscal expenditure at the national level is narrowing and moving towards a more balanced development.

Given the significant differences in geographical distribution and socioeconomic development between the eastern, western, and northeastern regions of China, this study examines whether the per capita general public budgetary funds for higher education in these regions exhibit similar convergence patterns to those observed at the national level using equation (1). The results show that both the eastern and central regions exhibit significant β convergence in continuous time periods and most segmented time periods. The eastern region shows no β convergence from 2007 to 2018, but its convergence speed in continuous time (3.4%) is higher than the national level. The central region demonstrates a trend of β convergence in all time periods, although the continuous time period does not have a stable convergence speed. However, the convergence speeds in other segmented periods are much higher than the national level, indicating a notable development of β convergence in the central region during specific time frames, suggesting a "catch-up effect" of higher education fiscal expenditure among regions within the central region. The western region only exhibits significant β convergence from 2007 to 2018 (T = 6), while the northeastern region shows β convergence only in continuous time, and both regions do not show significant β convergence in other time periods, indicating either limited or yet to be identified suitable β convergence paths in these regions. Conditional β convergence is achieved by controlling for factors such as time and omitted variables using fixed effects models. In reality, convergence is usually conditional, and absolute β convergence may not accurately describe the convergence patterns between regions. Therefore, this study conducts conditional β convergence tests by dividing the period from 2007 to 2018 into four cycles of 3 years each. The regression results are presented in the following table:

Table 4. Conditional β Convergence Test of Higher Education Fiscal Expenditure in China at the National and Regional Levels

	Nation	East	Middle	West	Notheast
α	7.369	6.519	8.021	7.07	9.169
β	-0.479***	-0.410***	-0.511***	-0.476***	-0.604***
R²	(0.007)	(0.012)	(0.018)	(0.012)	(0.021)
λ	0.980	0.984	0.976	0.977	0.984
τ	---	---	---	---	---

Note: Standard deviations are shown in parentheses. ***, **, and * indicate significance at the 10%, 5%, and 1% levels, respectively.

Sources: developed by the authors.

According to the analysis of Table 4, it is evident that both the nation as a whole and the individual regions exhibit a significant tendency towards conditional β-convergence in their higher education fiscal expenditure. The estimated values of conditional β are all negative and significant at the 1% level, indicating a convergence pattern. However, the specific convergence speed and time cannot be determined due to the lack of calculable values. This suggests that the higher education fiscal expenditure in the country is currently in a stage of rapid growth and has not yet reached a mature stage, indicating the need for further exploration and improvement of the convergence mechanism.

In conclusion, the research findings indicate an overall β-convergence trend in national expenditures on higher education. Even though the western and northeastern regions do not exhibit unambiguous absolute β-convergence, they do exhibit substantial conditional β-convergence. Both absolute and conditional β - convergence reveal notable convergence patterns in the eastern and middle regions. All regions lack stable convergence speed and time, indicating the absence of an appropriate convergence path. Therefore, it is necessary to continue investigating and refining the regionally specific convergence mechanisms.

Conclusions and Recommendations

This study comprehensively examines the convergence and disparities in higher education fiscal expenditures in China, taking into account both the Gini coefficient analysis and σ-convergence/β-convergence tests. The findings indicate significant disparities in fiscal expenditures between regions, with the eastern region exhibiting the largest gap compared to other regions. However, it is noteworthy that the disparity between the eastern and central regions is even greater than that between the eastern and western regions. Over the study period, the gap between the eastern and central regions remained consistently higher than other regional disparities.

In addition, the study reveals that while there is a general trend towards a reduction in regional fiscal expenditure disparities, convergence is most pronounced between the central and northeastern regions. In contrast, the western region exhibits slightly larger disparities than the central and northeastern regions, which may be attributed to the western region's greater fiscal policy support and lower student enrollments. The analysis also reveals a gradual reduction in the fiscal expenditure disparity between the western and central regions, while convergence is less evident between the western and northeastern regions.

In terms of policy recommendations, the study suggests the following:

Address the regional disparities in higher education fiscal expenditures: Efforts should be made to promote a more balanced distribution of fiscal resources. The government should allocate additional funding and implement targeted fiscal policies to support higher education in regions with lower fiscal expenditures, particularly in the central, western, and northeastern regions.

Enhance the convergence of fiscal expenditures: It is crucial to establish effective mechanisms to ensure the convergence of fiscal expenditures across regions. This can be achieved through consistent monitoring, evaluation, and adjustment of policies to facilitate the convergence of fiscal resources towards a more equitable distribution.

Strengthen regional development of higher education: In addition to addressing disparities between regions, attention should be given to promoting balanced development within regions. To ensure equal access to high-quality higher education, it is possible to achieve this by improving infrastructure and resource allocation within each region.

Improve transparency and accountability: Enhancing transparency and accountability in fiscal expenditures is vital for promoting fair distribution and effective utilisation of resources. The government should strengthen oversight mechanisms, promote transparency in budget allocation, and engage stakeholders in decision-making processes to ensure responsible and efficient use of fiscal funds.

Overall, this study highlights the significant disparities in higher education fiscal expenditures between regions in China and provides policy recommendations to promote convergence and balanced development. By addressing these issues, the government can work towards achieving a more equitable distribution of resources and fostering the sustainable development of higher education across the country.

Author Contributions

Conceptualization: Yang Yu.; **methodology:** Li Ruoxi., Yin Tingting.; **software:** Li Ruoxi.; **validation:** Yang Yu.; **formal analysis:** Yang Yu.; **investigation:** Yang Yu., Yin Tingting.; **resources:** Li Ruoxi.; **data curation:** Yang Yu.; **writing-original draft preparation:** Yang Yu.; **writing-review and editing:** Yang Yu.; **visualization:** Yin Tingting., Wang Xinxin.; **supervision:** Wang Xinxin.; **project administration:** Wang Xinxin.; **funding acquisition:** Wang Xinxin.

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