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UDC: 005.915:336.14:351.82:378(510)(047.5)

THE MANAGEMENT OF STATE FINANCIAL RESOURCES IN CHINA'S HIGHER EDUCATION: ENHANCING REGIONAL EQUITY, EFFICIENCY, AND ADEQUACY OF FINANCIAL PROVISION

073 "Management"

07 "Management and administration"

Submitted for the degree of Doctor of Philosophy

The dissertation contains the results of own research.

The utilization of ideas, results and texts of other author

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Sumy – 2024

SUMMARY

Yang Yu. The management of state financial resources in China's higher education: enhancing regional equity, efficiency, and adequacy of financial provision. – Manuscript.

Dissertation for obtaining the scientific degree of Doctor of Philosophy in specialty 073 "Management" (07 "Management and administration"). Sumy State University of the Ministry of Education and Science of Ukraine, Sumy, 2024.

This dissertation addresses a critical scientific problem concerning the optimisation of state financial resource management within the higher education system in China. In the context of growing global competition and the increasing significance of innovative development, higher education plays a decisive role in building human capital, fostering social mobility, and achieving strategic national objectives. However, significant regional disparities in higher education funding in China create substantial barriers to ensuring equitable access and the quality of educational services. This research focuses on the development of theoretical foundations and practical recommendations to improve financial management in this sector.

Higher education is a key element of national development, as it creates a highly skilled workforce for the economy, stimulates innovation, and promotes social integration. In China, currently at the stage of higher education universalisation, the issues of regional equity, efficiency, and adequacy of funding are particularly pressing. The eastern regions of the country receive significantly more resources than the central, western, and north-eastern regions, creating inequalities in development opportunities. The allocation of financial resources in China has a substantial impact on the socio-economic stability and international competitiveness of the country.

The aim of the study is to improve the theoretical and methodological foundations of managing state financial resources in China's higher education system, considering the principles of regional equity, efficiency, and adequacy of funding.

The objectives of the study are as follows: to summarise the theoretical foundations of financial resource management in higher education; to analyse regional

disparities in higher education funding in China; to evaluate the efficiency of financial resource distribution using econometric models; to develop a model for assessing funding adequacy across different regions; and to propose practical recommendations for improving mechanisms of financial resource management.

The research is based on the application of combined methods: a literature review of international experience and contemporary scientific approaches to financial management in higher education; empirical studies utilising methods such as the Gini coefficient to assess regional inequalities; σ- and β-convergence models to determine trends in regional funding convergence; Data Envelopment Analysis (DEA) to evaluate the efficiency of financial resource utilisation; and funding adequacy modelling to assess the alignment of expenditures with educational needs.

The study begins with an analysis of the theoretical foundations of managing state financial resources in higher education, encompassing the key concepts of regional equity, efficiency of resource distribution, and adequacy of funding. A significant aspect of this analysis involves distinguishing between the notions of "equity" as social justice, "efficiency" as the optimal use of resources, and "adequacy" as the alignment of funding with educational requirements. The dissertation defines adequacy of funding as a higher form of equity, incorporating equal access to education across different regions while considering their unique characteristics.

The research systematises the key principles of financial resource management in higher education, specifically: (1) Equity – as the foundation of social justice, ensuring access to education regardless of regional affiliation; (2) Efficiency – achieving maximum outcomes with minimal expenditure; (3) Adequacy – aligning expenditure with actual educational needs.

An analysis of regional disparities in higher education funding revealed that the eastern regions of China receive 40–50% of the total resources, while the western regions receive only 20–25%. The use of the Gini coefficient confirmed a high level of inequality, particularly in access to quality education in the western and north-eastern regions.

Convergence models indicated that, based on σ-convergence calculations, there is

a gradual narrowing of funding levels between regions, although this process remains very slow. β-convergence analysis confirms that less developed regions have the potential for faster growth, but this requires additional financial investments.

The study demonstrated that regional disparities in higher education funding are one of the major challenges in China. Specifically, the eastern regions receive the majority of resources, while the central, western, and north-eastern regions remain underfunded. This creates inequalities in access to quality education and hinders the achievement of social mobility goals. The use of the Gini coefficient and convergence models enabled the identification of trends towards either narrowing or widening regional funding gaps. It was established that during the period 2007–2018 there has been a gradual reduction in interregional disparities. However, the pace of this process remains insufficient, particularly in the western and north-eastern regions.

One of the key aspects of the study is the evaluation of the efficiency of public financial resource distribution. For the first time, a three-stage Data Envelopment Analysis (DEA) was employed to assess the efficiency of higher education funding in China. Using the three-stage DEA analysis, it was identified that the primary source of inefficiency is the mismatch between the scale of funding and the actual needs of the regions. For instance, less developed regions often experience resource shortages, whereas provinces with stable economies do not always utilise resources efficiently.

The DEA model further revealed that in 60% of China's regions efficiency losses are caused by irrational financial distribution. The greatest inefficiencies were observed in provinces with low levels of economic development. The analysis of distribution efficiency highlighted that the key issue is the insufficient consideration of regional needs and specific characteristics. This confirms the necessity of adopting more flexible management approaches that account for regional particularities.

The dissertation introduces a new methodology for assessing funding adequacy, based on calculating standard expenditures per student across different regions. The analysis results indicate that the average adequacy level of higher education funding in China is 0.79, highlighting underfunding in the system. The situation is most critical in central and north-eastern regions, where the gap between actual and required

expenditures is the largest. Meanwhile, in the eastern regions, funding adequacy is significantly higher, providing these areas with additional advantages in attracting students and qualified personnel.

The scientific basis for studying the role of investment in education in stimulating economic growth has been improved, which differs from existing approaches 1) by examining both the direct and indirect (through the level of human and intellectual capital, respectively measured by the average duration of education and the number of patents for innovations) impacts; 2) by employing a production function concept that considers the volume of capital and labour, corrected for urbanisation levels, economic dependence on international trade, and population growth; 3) by utilising a panel regression model with fixed and random effects.

The study also includes an analysis of international practices in higher education financial resource allocation, focusing on examples from the United States, the European Union, and Japan. The use of "financial adequacy" approaches and mechanisms to support less developed regions in these countries has informed recommendations for China. Particularly useful is the experience of developing multi-channel funding systems that integrate government, private, and international sources.

Based on the research findings, recommendations have been developed to improve financial resource management. It is essential to increase transfer payments to less developed regions to ensure they receive the necessary funding levels.

A resource allocation model has been designed to account for regional needs and the actual economic capacities of these regions, enabling the optimisation of resource use. Additionally, the dissertation proposes the establishment of a national platform for evaluating the efficiency of financial resource use, which will help to identify problem areas and facilitate well-informed management decisions.

To reduce the burden on the state budget, the study suggests creating a multi-channel funding model that involves attracting private capital and international investments, as well as fostering partnerships between universities and businesses. To enhance transparency in management and optimise resource distribution, it is

recommended to employ digital technologies and implement automated financial management platforms.

The development of interregional programmes for exchanging experience and resources is also proposed to strengthen cooperation between regions and improve the overall efficiency of the education system.

The findings can be used to refine state policies in higher education funding and to create integrated resource management systems that consider regional characteristics.

Keywords: management, budgetary management, higher education, resource allocation, regional equity, efficiency, adequacy, financial provision, convergence, China.

АНОТАЦІЯ

Ян Ю. Управління державними фінансовими ресурсами у вищій освіті Китаю: підвищення регіональної рівномірності, ефективності та адекватності фінансового забезпечення. – Рукопис.

Дисертація на здобуття наукового ступеня доктора філософії за спеціальністю 073 – Менеджемент (07 – Управління та адміністрування), Сумський державний університет Міністерства освіти і науки України, Суми, 2024.

Дисертаційна робота присвячена вирішенню актуальної наукової проблеми, що стосується оптимізації управління державними фінансовими ресурсами у системі вищої освіти Китаю. У контексті зростаючої глобальної конкуренції та важливості інноваційного розвитку, вища освіта відіграє вирішальну роль у створенні людського капіталу, забезпеченні соціальної мобільності та досягненні стратегічних національних цілей. Однак у Китаї значні регіональні диспропорції у фінансуванні вищої освіти створюють серйозні перешкоди на шляху до забезпечення рівності доступу та якості освітніх послуг. Це дослідження зосереджується на розробці теоретичних основ і практичних рекомендацій для вдосконалення управління фінансами у цій сфері.

Вища освіта є ключовим елементом національного розвитку, оскільки саме вона формує кваліфікований кадровий потенціал для економіки, стимулює інновації та сприяє соціальній інтеграції. У Китаї, що знаходиться на етапі універсалізації вищої освіти, особливо актуальними є проблеми регіональної рівності, ефективності та адекватності фінансування. Східні регіони країни отримують набагато більше ресурсів, ніж центральні, західні та північно-східні, що створює нерівність у можливостях розвитку. Розподіл фінансових ресурсів у Китаї має суттєвий вплив на соціально-економічну стабільність та міжнародну конкурентоспроможність країни.

Метою дослідження є вдосконалення теоретичних і методологічних основ управління державними фінансовими ресурсами у системі вищої освіти Китаю з урахуванням забезпечення регіональної рівності, ефективності та адекватності фінансування.

Завданнями дослідження визначено наступні: узагальнити теоретичні засади управління фінансовими ресурсами у вищій освіті, провести аналіз регіональних диспропорцій у фінансуванні вищої освіти у Китаї, оцінити ефективність розподілу фінансових ресурсів за допомогою економетричних моделей, розробити модель оцінки адекватності фінансування у різних регіонах, запропонувати практичні рекомендації щодо вдосконалення механізмів управління фінансовими ресурсами.

Дослідження ґрунтується на використанні комбінованих методів: літературний аналіз міжнародного досвіду та сучасних наукових підходів до управління фінансами у вищій освіті, емпіричні дослідження включають використання таких методів, як коефіцієнт Джині для оцінки регіональних нерівностей, моделі σ- та β-конвергенції для визначення тенденцій зближення регіонів за рівнем фінансування, для оцінки ефективності використання фінансових ресурсів задіяно Аналіз охоплення даних (DEA), для оцінки відповідності витрат освітнім потребам здійснено моделювання адекватності фінансування.

Робота починається з аналізу теоретичних засад управління державними фінансовими ресурсами у вищій освіті, що охоплює ключові концепції регіональної рівності, ефективності розподілу та адекватності фінансування. Важливим елементом цього аналізу є розмежування понять «рівність» як соціальної справедливості, «ефективність» як оптимального використання ресурсів, і «адекватність» як відповідності фінансування освітнім потребам. У дисертації визначено, що адекватність фінансування є вищою формою рівності, яка включає доступ до освіти на однаковому рівні для різних регіонів з урахуванням їхніх особливостей.

Дослідження систематизує ключові принципи управління фінансовими ресурсами у вищій освіті, зокрема: (1) рівність – як основу соціальної справедливості, що забезпечує доступ до освіти незалежно від регіональної приналежності; (2) ефективність – досягнення максимального результату за мінімальних витрат; адекватність – відповідність витрат реальним освітнім потребам.

Аналіз регіональних відмінностей у фінансуванні вищої освіти показав, що східні регіони Китаю отримують 40–50% загальних ресурсів, тоді як західні регіони – лише 20–25%. Використання коефіцієнта Джині підтвердило високий рівень нерівності, особливо у доступі до якісної освіти в західних та північно-східних регіонах.

Моделі конвергенції показали, що за результатами розрахунку σ-конвергенція можна зробити висновок про поступове зближення рівнів фінансування між регіонами, хоча цей процес є дуже повільним, а β-конвергенція підтверджує, що менш розвинені регіони мають потенціал для швидшого зростання, але для цього потрібні додаткові фінансові інвестиції.

Дослідження засвідчило, що регіональні відмінності у фінансуванні вищої освіти є однією з основних проблем у Китаї. Зокрема, східні регіони країни отримують більшу частину ресурсів, тоді як центральні, західні та північно-східні регіони залишаються недофінансованими. Це спричиняє нерівність у доступі до якісної освіти та ускладнює виконання завдань соціальної мобільності.

Використання коефіцієнта Джині та моделі конвергенції дозволило виявити тенденції до звуження чи розширення регіональних розривів у фінансуванні. Встановлено, що упродовж 2007–2018 років відбувається поступове зменшення міжрегіональних розривів, але темпи цього процесу залишаються недостатніми, особливо у західних і північно-східних регіонах.

Одним із ключових аспектів дослідження є оцінка ефективності розподілу державних фінансових ресурсів. Уперше використано трьохетапну DEA для оцінки ефективності фінансування у вищій освіті Китаю. За допомогою трьохетапного аналізу DEA було виявлено, що основним джерелом втрат ефективності є невідповідність між масштабами фінансування та реальними потребами регіонів. Наприклад, у менш розвинених регіонах часто спостерігається дефіцит ресурсів, тоді як у провінціях зі стабільною економікою ресурси не завжди використовуються раціонально. За допомогою моделі DEA також виявлено, що в 60% регіонів Китаю втрати ефективності спричинені нераціональним розподілом фінансів. Найбільші втрати спостерігаються у провінціях із низьким рівнем економічного розвитку. Аналіз ефективності розподілу дозволив визначити, що ключовою проблемою є недостатнє врахування регіональних потреб і особливостей. Це підтверджує необхідність більш гнучких підходів до управління, що враховують регіональні особливості.

У дисертації представлено нову методику оцінки адекватності фінансування, яка базується на розрахунках стандартних витрат на одного студента у різних регіонах. Результати аналізу свідчать, що середній рівень адекватності фінансування у Китаї становить 0,79, що вказує на недофінансування системи вищої освіти. Найгірша ситуація спостерігається у центральних та північно-східних регіонах, де розрив між реальними та необхідними витратами є найбільшим. Водночас у східних регіонах адекватність фінансування значно вища, що створює додаткові переваги для цих регіонів у залученні студентів і кваліфікованих кадрів.

У дисертації також удосконалено наукове підґрунтя дослідження ролі інвестицій в освіту у стимулюванні економічного зростання, що відрізняється від

існуючих підходів: 1) дослідженням як прямого, так і опосередкованого (через рівень людського та інтелектуального капіталу, виміряними відповідно через середню тривалість навчання та кількість патентів на винаходи) впливу; 2) базуванням на концепції виробничої функції (врахуванням обсягів основного капіталу та робочої сили), скоригованої на рівень урбанізації, економічної залежності від зовнішньої торгівлі та природного приросту населення; 3) використанням моделей панельних регресій з фіксованими та випадковими ефектами.

Робота також містить аналіз міжнародного досвіду розподілу фінансових ресурсів у вищій освіті, зокрема в США, Європейському Союзі та Японії. Використання практик «фінансової адекватності» та механізмів підтримки менш розвинених регіонів у цих країнах дозволило сформулювати рекомендації для Китаю. Особливо корисним є досвід розробки багатоканальних систем фінансування, що поєднують державні, приватні та міжнародні джерела.

На основі проведених досліджень розроблено рекомендації для вдосконалення управління фінансовими ресурсами необхідно збільшити трансфертні платежі для менш розвинених регіонів, забезпечивши їм необхідний рівень фінансування.

Розроблена модель розподілу фінансових ресурсів, яка враховує потреби регіонів та реальні можливості їхньої економіки, дозволяє оптимізувати використання ресурсів. Також в роботі запропоновано створення національної платформи для оцінки ефективності використання фінансових ресурсів, що дозволить ідентифікувати проблемні зони та приймати обґрунтовані управлінські рішення.

Для зменшення навантаження на державний бюджет запропоновано створення багатоканальної моделі фінансування, що передбачає залучати приватний капітал та міжнародні інвестиції, а також стимулювати партнерства між університетами та бізнесом. Для підвищення прозорості управління та оптимізації розподілу ресурсів запропоновано використання цифрових технологій та впровадження автоматизованих платформ управління фінансами.

Розробка міжрегіональних програм обміну досвідом та ресурсами посиле співпрацю між регіонами та підвищить ефективність освітньої системи.

Отримані результати можуть бути використані для вдосконалення державної політики у сфері фінансування вищої освіти, а також для створення інтегрованих систем управління ресурсами, що враховують регіональні особливості.

Ключові слова: менеджмент, бюджетний менеджмент, вища освіта, розподіл ресурсів, регіональна рівномірність, ефективність, адекватність, фінансове забезпечення, конвергенція, Китай.

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financing of education, and the article's conclusions were edited and structured (0,1 printed pages).

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6.   Yu, Y., Tingting, Y., Ruoxi, L., & XinXin, W. (2024). Effectiveness of Higher Education Financing: DEA and SFA Modelling. Business Ethics and Leadership (category B), 8(1), 172−189. https://doi.org/10.61093/bel.8(1).172-189.2024 (0,8 printed pages). *Yu, Y. personal contribution: developed a conceptual framework for researching the efficiency of higher education financing using DEA (data envelopment analysis) and SFA (stochastic frontier analysis) models, carried out modelling using the above methods, and assessed the efficiency of financial resource allocation in higher education (0,5 printed pages). Co-author's contribution: Tingting, Y. – collected and systematized data for empirical analysis using the DEA model (0,1 printed pages); Ruoxi, L. – conducted a theoretical analysis of external factors impact on financing efficiency (0,1 printed pages); Xinxin, W. – analysed the results, formulated conclusions and practical recommendations, and provided structuring and editing of the text of the article (0,1 printed pages).*

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INTRODUCTION

Relevance of the research topic. The relevance of state financial resources management effectiveness in higher education on a global scale cannot be overstated. It is a critical factor in determining the quality and accessibility of education, which in turn affects a nation's ability to compete in the global marketplace and foster social mobility. Effective state management ensures that higher education institutions are well-funded, which can lead to improved research capabilities, better faculty recruitment, and enhanced learning environments. This, in turn, can drive innovation and contribute to the development of a skilled workforce. On a global scale, countries with robust state management in higher education are better positioned to attract international students and academic talent, further bolstering their economic and cultural influence. Moreover, effective management of state financial resources can help to reduce the digital divide and ensure that higher education opportunities are not limited to those in wealthier regions, thereby promoting global equity and social justice.

In the context of China enhancing regional equity, efficiency and adequacy of financial provision in higher education is a pressing issue. The interregional imbalance in financial resources for higher education is a significant challenge, with the eastern region receiving higher financial inputs compared to the central, western and north-eastern regions. This disparity can lead to unequal educational opportunities and outcomes, which is detrimental to the overall development and cohesion of the country. The trend of convergence in national financial expenditure on higher education is a positive sign, particularly in the eastern and central regions, but the western and north-eastern regions require further attention. To achieve stable growth in higher education financial expenditures, it is imperative to address this imbalance by allocating resources more equitably. This not only involves increasing funding in underprivileged regions but also ensuring that the allocation is efficient and targeted to areas that will yield the most significant impact on educational quality and accessibility. The research on the allocation of financial resources for higher education

is vast, but there is a need for more studies that focus on the efficiency of the current allocation from a single perspective. This is crucial because higher education resources are limited and must be allocated in a manner that is reasonable, balanced, and effective to maximize their impact. The exploration of China's higher education financial expenditures' balanced status quo and the promotion of effective allocation are of both theoretical and practical significance, as they contribute to the understanding of how to best allocate these scarce resources to achieve the desired educational outcomes and regional balance.

The effectiveness of management tools in implementing higher education policy has been the subject of study by a range of well-known and respected researchers, including: Besley T., Charnes A., Koczar J., Mankiw N., Papanastasiou C., Sorenson R D., Stamatkis D., and others.

Chinese scholars Chen Xiru, Dai Pingsheng, Dai Shengli, Gao Yuchang, Liu Yuanyuan, Wang Xiaoping, Zhang Bisheng, Huang Bin, Li Yining, Tang Yipeng, and others have conducted in-depth research on many aspects of China's higher education resource allocation, covering areas such as fairness in higher education, efficiency evaluation, regional differences and convergence analysis, and other areas. Their work provides a solid theoretical and empirical foundation for this study.

The problems of regional equity, efficiency and the adequacy of financial provision in the implementation of management tools in higher education have also been the subject of research by Ukrainian scientists, including: Artyukhov A., Danko Y., Dluhopolskyi O., Lyeonov S., Liuta O., Novikova I., Pedchenko N., Petrushenko Y., Samoilikova A., Vasylieva T., Volk I., Vorontsova A., Zatonatska T. Zhylinska O., and others.

Despite the existing scientific achievements on the research topic, a number of aspects needs to be developed in order to improve the management of state financial resources in the field of higher education, in particular: to generalize the theoretical principles, as well as Chinese and international experiences in the context of regional equity, efficiency and sufficiency of financial support for higher education; to develop methodical approaches to measure disparities in the distribution of financial resources

for higher education among regions; to identify convergent and divergent trends in ensuring equity of financial support for higher education at the national and sub-regional levels; to assess the effectiveness of the existing distribution of financial expenditures on higher education; to substantiate the sufficiency of regional economic potential for the effective development of regional education in the context of ensuring compliance between the needs for highly qualified specialists and the scales of economic development of the region; to assess the level of differentiation of state regional expenditures on education; to optimize the system of horizontal transfer payments for a balanced interregional distribution of state resources in China.

Relation of the work to scientific programs, plans, topics. This dissertation is based on the China Education Modernization 2035 (promulgated by the Central Committee of the Communist Party of China (CPC) and the State Council on February 20, 2019) and the Circular on the Implementation Plan for the Project to Promote a Stronger Education in the 14th Five-Year Plan Period (issued by the National Development and Reform Commission, the Ministry of Education, the Ministry of Human Resources and Social Security on May 10, 2021), and the Notice on the Opinions on Further Improving the Level of Per-Pupil Allocation for Local General Undergraduate Colleges and Universities (issued by the Ministry of Finance of the People's Republic of China on November 30, 2010) and other relevant materials.

The major findings of the dissertation align with the scientific research conducted at Sumy State University. Within the framework of scientific research work "Socio-economic challenges in the conditions of digitalization of social relations" (state registration number: 0121U114364), the author's findings for impact of socio-economic challenges for management of state financial resources in higher education were taken into account. Within the framework of scientific research work "Convergence of economic and educational transformations in the conditions of digitalization" (state registration number: 0121U114570) the author's findings for optimizing the processes of regional resource distribution in the field of higher education were considered. Within the framework of scientific research work "The innovative drivers of the growth of the country's macroeconomic stability" (state

registration number: 0121U114396) the author's findings according to interconnection between effectiveness of the management of state financial resources in higher education and macroeconomic stability were taken into account. Within the framework of scientific research work "Transformation of the financial system and strategic priorities of its development" (state registration number: 0121U114477) the author's findings according to the factors influencing higher education investment in regional economic development were considered.

Aim and tasks of research. The **aim of this dissertation** is to advance the scientific and methodical approaches and practical tools for management of state financial resources in higher education in China to enhance regional equity, efficiency, and the adequacy of financial provision.

In order to achieve the aforementioned aim, the **following tasks** were identified as being necessary:

- to synthesize the theoretical foundations, China's and international experience of implementing the management of state financial resources in higher education in the context of regional equity, efficiency and adequacy of financial support;

- to improve the methodical basis for measuring the disproportions in the distribution of financial resources of higher education between regions in the context of the management of state financial resources in higher education;

- to develop a methodical approach to evaluating the effectiveness of the management of state financial resources in higher education in terms of identifying convergent and divergent trends in ensuring equality of financial support for higher education at the national and subregional levels;

- to improve the methodical basis for assessing the effectiveness of the existing distribution of financial expenditures of higher education within the management of state financial resources in this field;

- to improve the scientific basis for substantiating the sufficiency of regional economic potential for the effective development of regional bachelor's education in

the context of ensuring consistency between the need for highly qualified specialists and the scale of economic development of the region;

- to improve the scientific basis for studying the role of investment in education in stimulating economic growth;

- to develop an index of differentiation of state regional expenditure on education, which synthesizes several indicators reflecting differentiation of regions by natural, economic and social development;

- to improve the scientific basis for the optimization of the horizontal transfer payments system for the balanced inter-regional distribution of state resources within the framework of the management of state financial resources in higher education in China.

The object of this study is economic relations that are formed between the population, providers of educational services, state and municipal authorities, and economic entities in the process of management of state financial resources in higher education.

The subject of the study is the scientific and methodical approaches and practical tools of the management of state financial resources in higher education in China.

Methods of research. The methodological basis of the dissertation work is the fundamental concepts of economic theory, state regulation of the economy, management, finance, analysis of socio-economic processes, economic and mathematical modelling, the concept of educational development and management in higher education, as well as the results of scientific research in the field of the management of state financial resources in higher education.

The effort employed the following general scientific and specialized research methodologies as per the established tasks: induction and deduction, analysis and synthesis, scientific abstraction are employed to generalize organizational and economic principles as well as contemporary trends in the education system's operation. Logical-historical analysis and the grouping method are utilized to examine the economic foundations and organizational support for the execution of the state

financial resources management in higher education across various countries. Bibliometric analysis and logical generalization are applied to structure scientific research on the advancement of the higher education system. Graphic and tabular methods, dynamic and statistical analysis are employed in the investigation of regional disparities and convergence in the allocation of financial resources for higher education. Descriptive statistics, correlation analysis, single-factor and multifactor regression modelling are utilized in the assessment of generalizations and comparisons regarding the efficiency of financial expenditures on higher education. The method of structural decomposition and functional analysis is applied in the examination of the allocation of financial resources for higher education. Regression analysis (2SLS) and production functions is applied to evaluate the relationship between financial inputs in education and economic growth.

We conducted all empirical computations and modelling in this study using MS Excel, VOSviewer v. 1.6.10 software, and statistical data analysis programs. STATISTICA 12, STATA/SE 18.0, ARCGIS.

The information and factual basis of the dissertation are based on the reports and analysis data provided by the statistics department of the People's Republic of China (official data and statistical databases of the National Bureau of Statistics of the People's Republic of China), as well as relevant laws and regulations. In addition, the study draws upon regulations of the People's Republic of China, major documents of the Ministry of Finance of the People's Republic of China and the Ministry of Education of the People's Republic of China, as well as analytical reviews and scientific publications on the financial allocation of higher education. The information and factual basis of the dissertation was also derived from international regulatory and legal acts, as well as from analytical and reporting data from a number of international organizations, including the World Bank, the United Nations, UNESCO, Eurostat, the World Economic Forum, the global data and business analytics platform "Statista", and from the results of scientific and analytical research on the implementation of management of state financial resource sin the field of higher education.

The scientific novelty of the research results lies in the improvement of existing methods and the substantiation of several new scientific and methodical approaches for the management of state financial resources in higher education in China in order to enhance regional equity, efficiency and the adequacy of financial provision. The most significant scientific findings of the study are as follows:

for the first time:

To evaluate the effectiveness of the management of state financial resources in higher education regarding the equalization of its financial support, a systematic approach has been proposed that combines the calculation of σ-convergence, absolute β-convergence, and conditional β-convergence of per capita general public budget funding for higher education. This approach enables: 1) exploring the horizontal trend of higher education financial expenditures over time (σ-convergence) to assess whether disparities in financial allocations are decreasing across regions; 2) examining whether the financial expenditures on higher education in each region converge toward the same steady-state equilibrium level, identifying the "catching-up effect" in inter-provincial or intra-regional units, estimating the speed of convergence trends, and determining the time required to reduce gaps between regions (absolute β-convergence); 3) accounting for the influence of structural factors on convergent/divergent trends in the distribution of state financial resources for higher education, controlling for time and omitted variables (conditional β-convergence). This approach evaluates the effectiveness of the management of state financial resources in higher education in China over a ten-year retrospect in terms of convergent and divergent trends in the uniformity of financial support for higher education, both on a national scale and at the sub-regional level.

have been improved:

−the methodical foundations of ensuring regional equality within the management of state financial resources in higher education, that unlike existing approaches, proposed to base on analyzing disparity in allocating higher education financial resources among regions using Dagum's Gini coefficient measurement (based on municipal higher education financial expenditures and the per capita higher education

public budget funding). This approach enabled: 1) mapping China's regions by the level of higher education funding; 2) describing the nature and dynamics of intra-regional disparities (across four subregions) and inter-regional disparities (pairwise comparisons among all subregions) in higher education funding; 3) identifying evolutionary trends in the transformation of the gap in the allocation of higher education financial resources among regions over a ten-year retrospective period; 4) assessing the contribution of inter-regional and intra-regional disparities to the overall level of educational inequality; 5) developing proposals to ensuring regional equality within the management of Chinaєs state financial resources in higher education;

−the methodical foundations for evaluating the efficiency of the existing distribution of financial expenditures on higher education within the framework of the management of state financial resources in higher education, that differs from existing methods through: 1) the application of a modified three-stage DEA model based on the input-oriented BCC efficiency prompt model; 2) the combination of the BCC model with the SFA (stochastic frontier analysis) method to exclude statistical noise and the influence of the external environment; 3) the use of the number of students, the number of full-time teachers, and the new value-added of fixed assets as output efficiency indicators; 4) the use of financial expenditures on higher education as input efficiency indicators; 5) the use of per capita GDP of each region, the environment of university clusters, and the degree of government decentralization as external environmental indicators. This approach enabled the analysis of the efficiency of financial expenditures on higher education in China every five years over a ten-year retrospective period across all Chinese provinces and provided relevant recommendations for improving the management of state financial resources in higher education;

−scientific justification of mechanisms for consideration of unequal opportunities for young people from different regions in access to education in the process of conducting the management of state financial resources in higher education, which differs from existing approaches by developing an index of differentiation of state regional expenditure on education, which, using geometric regression, synthesizes a

number of indicators reflecting differentiation of regions by natural, economic and social development. This creates a basis for a fairer, more equal and sufficient distribution of financial expenditure on higher education between regions, a scientifically based consideration of regional differences within the framework of the management of state financial resources in higher education;

−the scientific basis for studying the role of investment in education in stimulating economic growth, which differs from existing approaches 1) by examining both the direct and indirect (through the level of human and intellectual capital, respectively measured by the average duration of education and the number of patents for innovations) impacts; 2) by employing a production function concept that considers the volume of capital and labour, corrected for urbanisation levels, economic dependence on international trade and population growth; 3) by utilising a panel regression model with fixed and random effects.

have been further developed:

−the scientific basis for the investigation of regional imbalances in the management of state financial resources in higher education, which differs from the existing ones by developing a methodological approach to justifying the adequacy of the economic potential of the region (estimated by regional GDP in general and per capita) for the effective development of bachelor's education in the region (estimated by the number of higher education institutions with bachelor's programs, the number of enrolled bachelor's students, the number of full-time teachers, the amount of funding in general and per bachelor's student). The proposed approach systematically combines elements of correlation and regression analyses, as well as coherence analysis, allows clustering regions depending on the level of coordination between economic and educational development, designing regional management strategies to ensure coherence between the needs for highly qualified professionals and the scale of economic development in the region;

−the scientific basis for the optimization of the system of horizontal transfer payments for the balanced inter-regional distribution of state resources within the framework of the management of state financial resources in higher education in China,

which, unlike the existing practice in China (calculation of normative expenditures for the sphere of education based on the number of persons studying at the certain level of education, the expenditure norm for this level of education, and the deviation coefficient), is based on the calculation of the coefficient of financial sufficiency of higher education for all provinces in China as the ratio between the optimal (taking into account the natural and socio-economic specifics of each province) and the current factual expenditure on higher education. This provides a scientific basis for the strategy of dynamic, constant adjustment of the number of resources allocated by the state depending on changes in the socio-economic development conditions of each province, its adaptation to endogenous and exogenous changes in the Chinese economy.

The practical significance of the findings is that the theoretical and methodical proposals and practical recommendations presented in the dissertation can be utilized by Chinese state authorities when reforming the organizational and economic foundations of the higher education system; by Chinese local authorities when managing the financing of educational institutions within the scope of their powers; and by educational service providers when developing and implementing internal development strategies, prioritizing areas of activity, and establishing their interaction with stakeholders in the educational services market. They provide a theoretical basis for national and local governments to formulate policies that optimize the balanced allocation of national and regional higher education resources. The recommendations can be applied at the national, local and university levels to improve the efficiency of the use of financial resources for higher education and promote the balanced allocation of financial resources for higher education across regions.

A methodical approach for evaluating the efficiency of the existing budgetary financial expenditure on higher education (based on the modified three-stage DEA model and the combination of the BCC model with the SFA method) was implemented in the educational activities of Sumy State University. Conclusions and recommendations on the comparison of international experience in the implementation of public management, with a specific focus on regional equity, efficiency and the adequacy of financial support in higher education were implemented in the activities

of the European Marketing and Management Association (EUMMAS) (the confirmation letter from 19 September, 2024). Approaches related to the clustering of regions based on the level of coordination between economic and educational development, as well as the design of local management strategies to ensure coherence between the demand for highly qualified professionals and the scale of economic development of local communities were used by the NGO "Center for Lifelong Education" (reference number 1−08 dated 15 August, 2024). Proposals on the optimization of the system of horizontal transfer payments, with a view to achieving a balanced interregional distribution of public resources were implemented in the activities of the Eastern European Association for Civic Education (EENCE) (№1 dated 10 October 2024). Recommendations on the analysis of educational inequality and disparity in the distribution of financial resources for higher education between regions, employing the Dagum's Gini coefficient were implemented in the activities of the Centre of Sociological Research, Poland (reference number 1/17/7/24 dated 17 July, 2024). All these statements are presented in the Dissertation Appendix.

Personal contribution of the applicant. The dissertation is a completed scientific research. The scientific provisions, conclusions, recommendations and developments submitted for defence were obtained independently, they reflect the main content of the study and are set out in published works. The results published in co-authorship are used in the dissertation only within the limits of personal contribution.

Approbation of research results. The main provisions of the dissertation were reported, discussed and received favourable evaluation at 4 international scientific and practical conferences, namely: Digital transformations and innovative technologies in the economy: challenges, realities, strategies: materials of the International Scientific and Practical Conference (Sumy, 17−19 May, 2023); Socio-Economic Challenges (Sumy, 14−15 November, 2022); Financial Markets, Institutions and Risks (Sumy, 20−22 November, 2021); Problems and prospects for the development of the financial and credit system of Ukraine (Sumy, 4−5 December, 2023).

Publications. The key findings and conclusions of the dissertation have been published in 11 scientific works with a total volume of 6,62 printed pages, including: 1 article in a scientific journal indexed by the international scientometric database "Web of Science", 6 articles in specialized scientific journals of Ukraine of the "B" category, 4 conferences proceedings. Among these works, the author has personally authored 4,85 printed pages.

Structure and scope of the dissertation. The dissertation consists of an introduction, three main chapters, conclusions, a list of references and appendices. The total volume of the dissertation is 260 pages, including 213 pages of the main text, 28 tables, 37 figures, 5 appendices, the list of references contains 240 references and is located on 22 pages.

CHAPTER 1. THE MANAGEMENT OF STATE FINANCIAL RESOURCES IN HIGHER EDUCATION: THEORETICAL BASIS, CHINA'S AND INTERNATIONAL EXPERIENCE IN THE CONTEXT OF REGIONAL EQUITY, EFFICIENCY AND ADEQUACY OF FINANCIAL PROVISION

1.1. Theoretical basis of the management of state financial resources in higher education in the context of regional equity, efficiency and adequacy of financial provision

The theoretical analysis seeks to establish a research foundation and a guiding framework for the study, elucidating the theoretical origins, logical linkages and attainment objectives of the succeeding research.

Finance, representing the government's fiscal authority, is a primary instrument for regulating resource allocation. Enhancing the effectiveness of financial resource allocation for higher education alleviates the disparity between the availability of higher education resources and the sector's growth, thereby fostering the comprehensive advancement of higher education.

In the foreign language database "Web of Science Core Collection", I conducted a literature search on the issue "higher education resources allocation" from 1990 to 2020, yielding a total of 238 articles. The "Web of Science Core Collection" database allows for the retrieval of literature pertaining to the theme "higher education resources allocation" from 1990 to 2020, yielding a total of 238 relevant publications, with the developmental trend illustrated in Figure 1.1. The study on higher education resource allocation progressed slowly in the early 1990s but accelerated significantly in the past decade. This phenomenon may be attributed to the rapid economic development, which has heightened inter-regional investment in educational resources, leading to an uneven distribution of higher education resources that has garnered scholarly attention. Additionally, since the 20th century, global economic advancement has transitioned into the information technology era, where scientific and technological progress has become increasingly vital for national development. Consequently, investment in

higher education is intricately linked to a country's scientific and technological advancement, underscoring the growing significance of research on the rational allocation of higher education resources. Conversely, since the 20th century, global economic development has transitioned into the era of information, wherein the advancement of science and technology plays an increasingly pivotal role in fostering the progress of nations, and investment in higher education is intricately linked to a country's level of scientific and technological development.
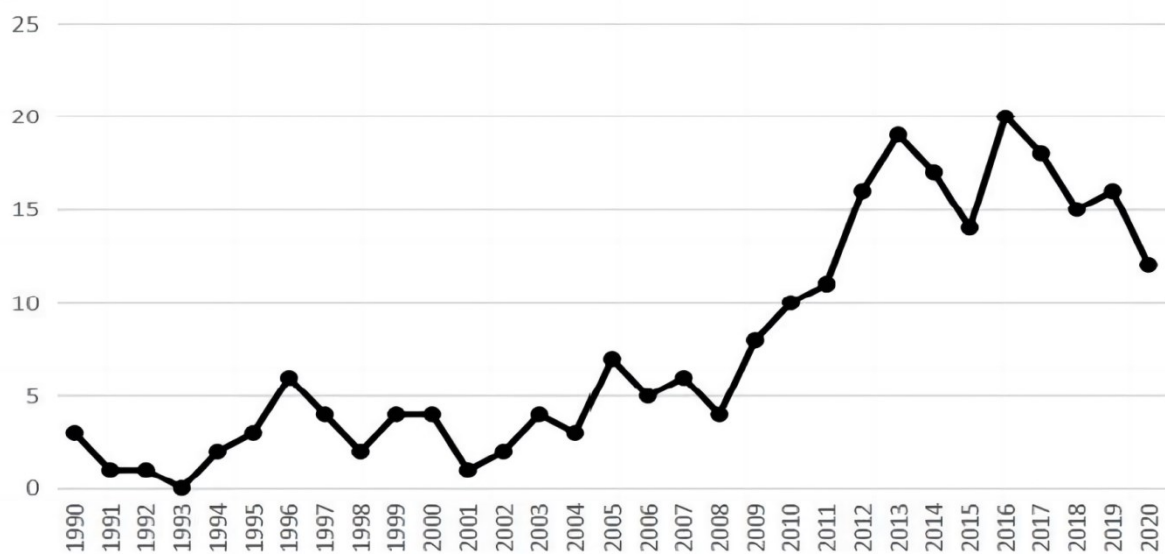
Figure 1.1 − Trend in the number of research literature on resource allocation in foreign higher education during 1990-2020

Source: Search in the database "Web of Science Core Collection"

Despite the later initiation of research on the allocation of higher education resources in China compared to foreign nations, the advancement of a balanced distribution of these resources aligns with China's fundamental policy objectives and holds substantial importance. Therefore, elucidating the current state of China's research on higher education resource allocation and its developmental trajectory is advantageous for enhancing the depth of inquiry in this domain. Upon querying CNKI with the topic keyword "higher education resource allocation", I observed a gradual increase in the volume of research literature pertaining to higher education resource

allocation in China, as illustrated in Figure 1.2. The search results include 1,062 academic journal articles, 301 dissertations, and 26 conference papers. Research on the allocation of financial resources in higher education and the financial system constitutes the second largest category of literature, comprising 19.2%, following studies related to educational theory and management. Scholars increasingly focus on the significance of financial resources in the allocation of higher education resources.
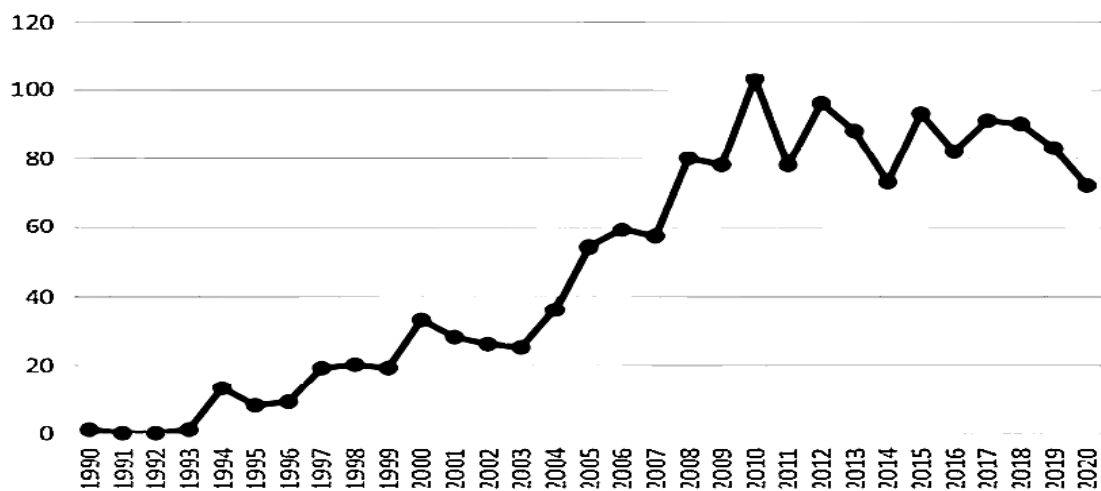
Figure 1.2 − Trend in the number of research literature on domestic (China) higher education resource allocation between 1990 and 2020

Source of data: Search in the Knowledge Network, 2020 data are projections

Overall, the volume of research literature regarding the allocation of higher education resources has increased in recent years, signifying that this area has garnered significant attention from the academic community, with the research content becoming more comprehensive and in-depth. The research primarily examines the implications of higher education resource allocation, the equilibrium dynamics among stakeholders, and the factors influencing the equilibrium distribution of higher education resources.

The primary discourse regarding the distribution of higher education resources centres on the interplay between governmental and market forces. The influence of internal factors on the equitable distribution of higher education financial resources primarily stems from the divergent interests among the key stakeholders involved.

This results in the establishment of a balanced allocation pattern, wherein the government, market, and educational institutions engage in a collective decision-making process to achieve a state of equilibrium [18].

The interaction between the government and the market in the distribution of educational resources is a primary topic of scholarly interest. The allocation of obligations between the government and the market has long been a subject of controversy in economics, and the delineation of responsibility for the provision of higher education resources, which possess characteristics of quasi-public goods, remains ambiguous. Early classical economic theory posits that the market's "invisible hand" primarily regulates resource allocation through price and demand mechanisms, asserting that this approach is the most effective. Consequently, the government's role in economic operations during this period is minimal, embodying a "small government" philosophy. It was a condition of "minimal government". Nonetheless, the economic crisis that emerged in the 1930s called into question the market's ability to autonomously regulate the economy, leading to the prominence of Keynesian theories advocating for government intervention. The United States and other nations achieved a temporary economic recovery through robust governmental involvement; however, the practical application of this "big government" model proved to be flawed. Nonetheless, the "big government" approach is not flawless in application, and the economic stagflation of the 1970s resulted from excessive governmental intervention [19]. Since then, scholars have engaged in extensive discussions regarding the relationship between government and market in resource allocation, generally concluding that both entities play complementary roles and are indispensable to one another. Duan Xuguo delineated the cognitive process governing the relationship between the government and the market into three phases: the stage of fiscal non-intervention grounded in general equilibrium theory, the stage of fiscal intervention rooted in disequilibrium theory, and the stage of fiscal coordination based on disequilibrium coordination theory [20]. According to Figure 1.3, Duan Xuguo posits that the theory of non-equilibrium coordination addresses the deficiencies of both equilibrium and non-equilibrium theories. It represents a scientific equilibrium

theory characterized by internal unity and coordination, wherein the allocation of financial resources is not isolated and independent but rather coordinated and interdependent with other factors. Higher education as a quasi-public good is not entirely non-exclusive; therefore, it can be partially supplied by the market. This allows the government to allocate its limited financial resources more effectively towards enhancing the quality of higher education while also fostering a broader array of educational pathways. Nonetheless, the allocation of higher education resources in the market will not be fully realized, and government provision of higher education products and services is important.

General equilibrium	→	small government, small finance	Non-intervention	→	big market
Macro disequilibrium theory	→	big government, big finance	Fiscal intervention	→	small market
Theory of unbalanced coordination	→	Government finance	Financial coordination	→	market

Coordinated regulatory mechanisms for fiscal and other instruments in the context of government-market contingencies

Figure 1.3 − Three stages of financial resource allocation

Source: Compiled by the author

Secondly, the government's significance in higher education resource allocation extends beyond its financial role in market coordination to encompass the preservation of equity and public order. The public significance of educational resources has expanded the government's responsibility in the allocation process. Government regulation of educational resources aims not only to coordinate and rectify market

allocation inequities but also to prevent disorderly competition from undermining public order. Consequently, regarding the supply content, the government primarily allocates resources for higher education in the form of equitable educational opportunities, foundational research funding, and higher education legislation, among others. Epple et al. examined the effects of higher education financial expenditures on students from low-income families in the United States. The researchers analyzed government assistance allocated to public colleges and universities by developing a model that illustrates student demand for higher education at both public and private institutions based on enrolment patterns. Their research indicates that an augmentation of federal assistance to public colleges and universities elevates attendance by 6% of the initial college demographic, primarily benefiting students from low-income backgrounds. Conversely, a reduction in federal aid markedly diminishes attendance among these disadvantaged students and concurrently boosts enrolment at prestigious private institutions. The equitable distribution of financial resources for higher education significantly enhances educational accessibility for students from impoverished backgrounds, and judicious government action can foster equality in educational opportunities across diverse groups.

How can the government effectively coordinate the distribution of resources for higher education? Ruan Li Quan and Hu Weitong assert that education policy and systems are the primary mechanisms through which the government regulates higher education resources, with the pursuit of fairness and effectiveness in education being the central focus during policy formulation [23]. Research by Romer, Rosenthal and Munley indicates that the allocation policy for educational financial resources in the United States is significantly influenced by referendums, with both the structure of state appropriations and referendums markedly impacting state education budget expenditures [24]. Furthermore, Corcoran et al. contended that the accountability system and judicial review of the budget are efficient mechanisms for the government to oversee the distribution of financial resources for education [25]. Chinese scholars have mostly proposed the government's coordinating role in the allocation of financial resources for education, focusing on budget management and performance

management. Xing Tiantian advocates for the development of a "performance + allocation" budget model to enhance the efficiency of financial resource allocation in education [26]; Li Yuxiang, Feng Guoguo and Zhang Rongxin recommend that educational finance policies should be tailored to local requirements, implement meticulous budget management, accurately ascertain the total education budget, optimize the budget structure at various levels, and establish performance accountability mechanisms, etc. [27].

Ultimately, universities themselves exert regulatory influence over the distribution of higher education resources, setting higher education apart from other educational stages with a notable degree of academic freedom. As the modern economy and society evolve, the government's role is continuously transforming, with an increasing number of countries transitioning toward a "professional government". Concurrently, the concepts of university autonomy and academic freedom have gained widespread acknowledgment, manifested in the decentralization of financial resource allocation for higher education, thereby granting colleges and universities greater operational freedom and increased autonomy [28]. Clark Cole observed that the diversity of objectives and the multiplicity of power centers, among other aspects, define contemporary higher education [29]. Each university possesses a distinct focal point for development, enabling varied decisions in the allocation of financial resources and the pursuit of divergent developmental trajectories. Furthermore, universities possess the autonomy to establish various systems based on their academic principles, including the selection of faculty, the development of fields and pedagogical methods [30]. In the context of the game process, universities, as the primary producers of higher education products, aim to acquire additional means of production (government financial support) by enhancing their performance. This is done to secure greater financial allocations through the assurance of academic excellence and the robust cultivation of talent [31].

In summary, among the tripartite forces influencing and determining the allocation of higher education resources, the government pays more attention to fairness and efficiency, focusing on balancing higher education resources among

regions and improving the efficiency of resource allocation through unified planning and centralised allocation; market force is the self-adjustment of private resources according to the change of market returns; academic power focuses on academic freedom in the process of higher education resource allocation; the government also seeks to satisfy the demand for equal distribution of resources in different fields, different levels and different regions as much as possible. Academic power in the process of higher education resource allocation focuses on the academic freedom to meet the demand that resources be distributed as equally as possible in different fields, different levels, different geographical colleges and universities and seeks a flexible system and financial support for key projects [32]. The three forces check and balance each other, influence each other and determine and promote the allocation of higher education resources in a continuous game, forming two modes of higher education resource allocation: the plan mode, the market mode, and the mixed mode of plan and market [33].

This study emphasizes the significance of interaction among equality, efficiency, and balance in resource allocation for higher education. Equity and efficiency are two critical factors in the distribution of educational resources. Certain scholars contend that, due to the quasi-public good nature of higher education, equity should be prioritized in resource allocation [34], whereas others assert that the allocation of higher education resources should emphasize the efficiency of the input resource mix [35, 36].

Equity is a necessary precondition for achieving a balanced allocation of resources, and efficiency is a sufficient basis for achieving a balanced allocation of resources. Only fairness, no efficiency of education resource allocation, is low-quality fair, and only efficiency without fairness of education resource allocation is also low-quality efficiency. Efficient and fair allocation of higher education resources is the goal of balanced development of higher education, but also the requirement of balanced allocation of higher education financial resources. Therefore, it is only by accurately grasping the connotation and relationship between the three that we can

better understand the internal mechanism and constraint mechanism of the balanced allocation of higher education financial resources.

Let us undertake a more detailed examination of the question of the interaction between fairness and equilibrium in the context of the management of state financial resources in higher education. Educational equity is an important part of social equity and an issue of great concern to the general public, and scholars have been studying educational equity for a long time and have been very fruitful. Plato's establishment of a complete education system, Aristotle's legislation guaranteeing the right to education for free citizens, and Confucius' "education for all" are the earliest expressions of educational equity. In the Enlightenment of the 17th and 18th centuries, a series of demands of thinkers in pursuit of the rule of law and equality gave birth to the concept of educational equity for the first time in the field of education [37], and the dual-track education system commonly practiced in the 18th and 19th centuries in the European countries has gradually expanded the situation of educational inequity. From the 20th century onward Western scholars gradually paid attention to and conducted many studies on educational equity.

Many scholars and institutions have defined the concept of educational equity from different perspectives, but its core elements are mainly centred on the fairness of educational opportunities and the guarantee of material resources. The United Nations Universal Declaration of Human Rights suggests that the content of educational equity should include equal rights to education, access to basic education, equality in technical and vocational education, and equal access to higher education based on merit; the Organisation for Economic Co-operation and Development (OECD) believes that a just education is independent of factors such as gender, economic status, and ethnicity and that all people should have access to basic education [38]. Rawls, based on the principle of justice, believes that all rights, including the right to education, should be equal and open and that gaps due to social and economic status can be filled through "compensatory education", i.e., to improve the situation of poor areas and people from poor backgrounds who have difficulties in receiving education, with a view to realizing educational equity. In 1964, Professor James Coleman of

Hopkins University in the United States conducted a large-scale survey in the field of education, and in 1966, he submitted the Report on Equal Opportunities in Education to the Congress. This famous report played an important role in promoting the development of the theory of equity in education. The report systematically elaborated the system of educational equity and proposed four components of educational equity: equal opportunity to receive basic education, equal opportunity to participate in educational advancement, equal outcome of education, and equal impact of education on life prospect opportunities [39]. The innovation of Coleman's theory of educational equity is that he not only focuses on the equity of educational starting points and educational inputs but also begins to include the equity of educational outcomes in the consideration of educational equity. Swedish educator Thorsten Husen's theory of equality in education, moreover, combines efficiency, fairness and self-realization and puts forward the theory of equality of starting point, equality of process and equality of substance in educational equity [40]. According to Husson, when considering starting point equity, efficiency and economic rationality should be taken into account, i.e., limited resources should be equally distributed to individuals through a reasonable and efficient education distribution system; process equity corresponds to treating every educated child in a fair and just manner; and substantive equity is to provide individualized education for each child based on his or her different character and talents, so as to achieve the same expected educational results.

Educational equity, as a prerequisite for a balanced allocation of higher education resources, has an impact on the balanced allocation of educational resources that is mainly reflected in the three aspects of starting point equity, process equity and substantive equity [6]. The starting point of the balanced allocation of higher education resources is the equality of access to education. The allocation of education resources should make every citizen, regardless of the status of the high and low, rich and poor families or geographical differences, enjoy equal access to higher education, which is expressed in the financial resources of the state scholarship policy. The process fairness of the balanced allocation of higher education resources is that the learning process can be treated equally and get corresponding resources, such as the balanced

education funding between regions, reasonable teacher strength, adequate research equipment and even the attention to each student in the teaching classroom. Substantive fairness in the allocation of higher education resources is reflected in the balanced results of the training of professionals and scientific research and innovation, while the development needs of the regions and the actual situation are not the same, which shows that the balanced allocation of higher education resources between regions is relative fairness, not absolute fairness.

Educational equity as the ideal pursuit of human society is absolute, but because it is subject to specific socio-economic and political factors in human society it is usually relative [41]. The realization of the goal of educational equity in all countries is objectively and inevitably subject to the influence of such factors as uneven economic and political development in the region, inconsistent endowment of cultural resources in groups and differences in the talents and abilities of the educated. Therefore, in order to better promote educational equity, it is necessary to coordinate the balance of educational resources and eliminate the influence of objective factors on educational equity.

Let us undertake a more detailed examination of the question of the interaction between efficiency and equilibrium in the context of the management of state financial resources in higher education. The core topic of concern in economic research is the allocation of scarce resources, so that limited resources are allocated through the rational allocation of the greatest possible utility, the concept of "efficiency". Therefore, the importance of efficiency in economics is self-evident. Simply put, efficiency is the ratio between the resources invested in a certain area and the results of the output. When the inputs are the same, the more the outputs the higher the efficiency; conversely, when the outputs are the same, the fewer the inputs, the higher the efficiency [42].

Efficiency is the essential characteristic of resource allocation. Samuelson [43] writes in his book Economics 2: "Economics studies how a society uses scarce resources in order to produce valuable goods and services and distributes them among different people". This statement contains two layers of logic: first, the object of study

is scarce social resources; second, through the allocation of these resources to be able to produce valuable goods or services, that is, the allocation of resources to be effective. To answer the question of "what kind of resource allocation is efficient" in the field of economics the "Pareto Optimality" (Pareto Efficiency) must be explained. The so-called "Pareto Optimality" is an ideal state of resource allocation, i.e., the existing state of resource allocation is the state that can make the utility of all people reach the optimum or maximize the state. In this state, if you want to make the utility of any person increase, it will inevitably reduce the utility of the other person, the kind of the "Pareto optimal" state no longer exists to improve the space and is the most efficient state pursued by the allocation of resources. However, in the reality of economic life, in most cases, we are unable to achieve the "Pareto optimal" and then need to adjust the allocation of resources in order to ensure that the efficiency of some people remains unchanged at the same time as improving the efficiency of other people to achieve the purpose of the overall efficiency, which is "Pareto" improvement [44].

The fundamental purpose of the allocation of resources is to maximize the utility of the output; efficiency and resource allocation are two aspects of economic research that are mutually dependent and inseparable, and the balanced allocation of higher education resources should naturally be studied with efficiency in mind [45]. The efficiency of the allocation of educational resources is mainly divided into two aspects: external efficiency and internal efficiency. External efficiency is a measure of the size of the resources return rate invested in education compared with the resources invested in other areas in the allocation of resources in society as a whole; internal efficiency refers to the study of how to maximize the efficiency of the allocation of resources in the field of education [46]. The efficiency of higher education financial expenditures mainly refers to the relationship between higher education financial inputs and higher education outputs and therefore belongs to the research part of internal efficiency in education. Many scholars have already explored the issue of measuring the efficiency of financial resource allocation in higher education and have come up with some feasible and effective efficiency evaluation methods, mainly in the two categories of educational production function and social benefit assessment [47]. No matter which

type of research method has proved that through the optimal allocation of existing financial resources for education can effectively improve the level of education [48]. Therefore, there is a real need to study the balanced allocation of financial resources for higher education.

Let us undertake a more detailed examination of the question of the interaction between equity and efficiency in the context of the management of state financial resources in higher education. Equity and efficiency are fundamental issues of universal concern in the development of human society, with the hope that access to resources will be equal and fair, while at the same time the allocation of resources will be efficient and not wasteful. Whether in philosophy, sociology, jurisprudence or economics and education, there is a rich discussion on equity and efficiency. The origin of equity is an ethical concept, belonging to the judgment of value; efficiency is an economic concept, emphasizing the comparison of inputs and outcomes, which are not logically contradictory but are often closely related in practice [41]. Jia Dan's study pointed out that when the relationship between equity and efficiency occurs, it is generally accompanied by two necessary conditions: one is the scarcity of the object of study, and the other is that the object of study has a common material interest for people [48]. Educational resources have both scarcity and the common interest of increasing the value of human capital of the audience, so it is necessary to explore the equity and efficiency of education.

The discussion on the relationship between fairness and efficiency is limited to three views: one is that fairness takes precedence over efficiency; the other is that efficiency takes precedence over fairness; and the third is that the two are regarded as different value systems and standards of judgement and are considered to be independent of each other, with no priority. Rawls believes that the most important value of a social system is fairness, so as long as a certain system violates the concept of fairness, no matter how efficient it is, it needs to be considered carefully, so fairness takes precedence over efficiency [49]. Western economists, on the other hand, believe that efficient production is the most important factor in promoting capital accumulation and that institutional compensation for equity on the basis of rapid

capital growth can achieve a balance between the two, so efficiency takes precedence over equity. Arthur Okun [50] pointed out in his book "Equality and Efficiency: The Big Choice" that "Equality and efficiency each have their own important value, and there is no absolute priority between them", so it is necessary to appropriately improve efficiency and equity or promote equity and efficiency when targeting different areas or to promote equity with efficiency, as appropriate, in different areas.

With regard to the development of equity and efficiency in education, scholars have two main views: one is that the two do not interfere with each other and develop independently, so that they can be treated separately; the other view is that the two promote each other or contradict each other and develop in a balanced manner, and that they should be considered in an integrated manner.

Some scholars argue that the pursuit and eventual realization of equity in education is an independent process, unrelated to efficiency, i.e., the two are independent of each other. Geoff et al. argue that the promotion of equity in education is about compensating for the unequal distribution of resources in education due to economic conditions and social status, etc., through the lens of equity [51].

Efficiency has nothing to do with it. Peng Zeping conducted an analysis on the relationship between education equity and efficiency, highlighting their independent values and the impact of various intrinsic factors. He concluded that there is no antagonistic relationship, and the advancement of one party does not necessarily hinder or boost the other, with only a slight correlation [52]. Yang Dongping discovered that during China's educational development process, education theories have disproportionately focused on balancing equity and efficiency from an economic standpoint, resulting in the general slogan "efficiency first, while taking equity into account" [53]. With the exception of the basic education stage, where equity and efficiency are synonymous, achieving equity in other education stages necessitates system construction, regardless of efficiency. Xu Xiuhong and Zhang Lei analyze the concepts and scope of education equity and efficiency, finding them to be virtual contradictions in the real education field. They conclude that the previous identification of the relationship between education equity and efficiency as mutually

reinforcing or exclusive is a misinterpretation, and they find no relationship between the two [54].

However, more scholars believe that education should balance equity and efficiency, that the two can sometimes be mutually exclusive and sometimes complementary, and that we can jointly achieve equity and efficiency through the regulation of specific policy instruments.

Hong qi et al. consider educational efficiency as the rate of contribution of education to individual and national development [55]. The criteria for educational efficiency are different from economic efficiency because education has its own unique principle of efficiency. The relationship between educational equity and educational efficiency is neither antagonistic nor progressive. Educational equity and educational efficiency are equally important educational goals, and modern educational development should adhere to the principle of giving equal importance to both educational equity and educational efficiency. The development of balancing equity and efficiency is flawed if it relies on either the government or the market alone and requires a hybrid mechanism led by the government with the market playing a supportive role, which is better able to promote both educational equity and educational efficiency than any single mechanism. In a study on education development in Ghana, the World Bank discovered that despite the government's significant efforts to enhance the quality and standard of education, the continuous expansion of the educational scale has significantly improved education equity, leading to a gross enrolment ratio of over 90% in Ghanaian primary schools. This suggests that enhancing education efficiency also enhances education equity [56]. In 2014, the World Bank conducted the Costa Rica Education funding project in Costa Rica, analyzing the dynamic equilibrium between education efficiency and equity. The results demonstrated that education funding significantly improved children's access to education and the rate of further education in rural areas. This suggests that expanding the scale of education can, to some extent, simultaneously improve both equity and efficiency of education [57].

The question of financial adequacy in higher education system should be considered in the context of the full expression of public values. As mentioned earlier, the concept of educational adequacy was developed on the basis of educational equity, which organically combines equity and efficiency to ensure the achievement of the set educational target outcomes and is a higher-stage form of equity. So, what is the goal of government allocation of financial resources for education? According to the nature of government organizations, it can be seen that the realization of the public value of education should be its basic goal.

Public value must inform the theoretical rationale and practical conduct of government, as its primary purpose is to oversee public affairs and deliver public services. Mark Moore defines public value in his book "Creating Public Value". Compared to the private sector, the public sector's proposed "private" value should produce "public value". The main way to explain public value is as a list of societal expectations about how the government should act. In other words, the government shouldn't just act to protect itself; it should also be constantly changing its functions and strategies to fit new situations and its understanding of public value, which creates more value that matches what the majority wants [174]. In contrast to the private sector, which evaluates value by comparing benefits and costs, determining public value requires assessing if the government's value outweighs or significantly outweighs the costs of liberty and consumption that the public bears when they entrust their trust to the government [175]. To achieve the public value of an optimal allocation of financial resources, the government must first meet public expectations comprehensively and then ensure that the costs of its activities are both reasonable and efficient. The existing governmental administrative framework features a more defined division of labor, necessitating that all tiers of government delineate their respective responsibilities, judiciously ascertain the extent of public goods provision at their level and enhance the maximization of public value.

The quasi-public product attribute of higher education has been recognized by the academic community, and the balanced allocation of financial resources for higher education includes the government's mission to realize its public value. U.S. public

universities have always adhered to the University of Virginia in 1819, when Thomas Jefferson put forward the "national function of the establishment of institutions must meet the public demand" point of view, adhere to serve the public interest and play a good higher education to maintain and improve the quality of citizens' life [176]. Bruce Johnstone, former Chancellor of the State University of New York, summarized the public values (public purposes) of higher education into three categories: preservation and transmission of culture; promotion of national economic growth; and realization of common aspirations [177].

With regard to understanding **how the government improves the allocation efficiency of higher education financial resources** by optimising the structure of higher education financial expenditure, on the one hand, from the point of view of higher education as a quasi-public product, the government can make up for the part of the market supplying the effectiveness and more able to give play to the public value of higher education; on the other hand, the system of fiscal decentralisation also has certain influence on the efficiency of the supply of public products, including higher education. Fiscal decentralisation also has a certain impact on the efficiency of public goods supply, including higher education.

The legitimacy of government allocation of financial resources for higher education is comprehensively explained by the theory of public goods. The concept of public goods was first expressed in Hume's "A Treatise of Human Nature" in 1895 [154], when he stated that services such as "draining the lawn", which do not conflict with the interests of others but are essential to society, are public goods. In 1919, the term "public goods" was formally introduced into the field of economics by Lindahl in his theory of "Lindahl's Equilibrium" [155], where he defined the principle of market equilibrium prices that distinguishes public goods from private goods. Samuelson defined public goods as the consumption of a product by any person that does not diminish the quantity or quality of the consumption of that product by others [156]. Subsequently, Buchanan expanded the scope of public goods in his book "Democratic Finance Theory", arguing that products provided collectively can be considered public goods and introducing the concept of "quasi-public goods" [157].

Public goods are evaluated chiefly by their two principal characteristics: they are non-rivalrous and non-exclusive in comparison to private commodities when individuals consume or utilize the commodity. Non-competitiveness occurs when the marginal cost or marginal congestion cost of a product is zero; specifically, each additional consumer does not elevate the supplier's marginal cost of provision nor influence the consumption of other consumers. Consequently, the product does not belong to the category of competitive goods, exemplified by national defence and diplomacy. Non-excludability denotes that once a commodity is made available, it cannot be restricted from communal use by others, or the expense of exclusion is prohibitively expensive, as exemplified by haze control and environmental protection. Moreover, public goods generate externalities, meaning that their provision yields a social return that may exceed or fall short of the private benefit [158]. We classify a non-competitive and non-exclusive product as a pure public good. Due to its inherent characteristics, it is virtually unfeasible for people to supply such commodities, necessitating government provision of pure public goods. Goods that are either solely non-competitive and not non-exclusive, solely non-exclusive and not non-competitive, or that fulfil both non-competitiveness and non-exclusiveness under specific conditions are termed quasi-public goods.

Scholars generally agree that education is not a purely public good, and Samuelson has pointed out that education can be exclusionary to a certain extent, because it has an element of variable returns, and there may be a situation in which the loss of other people's benefits leads to an increase in the benefits of a certain citizen; at the same time, education also has a certain degree of competitiveness [159]. For example, the selection of students by schools at the time of enrolment, where one student gains access to education at the expense of others; and the way in which classes are taught, which requires students to compete for the teacher's attention, where the quality of teaching inevitably declines as the number of students increases. Therefore, a more accurate definition of the attributes of education should be a quasi-public good. As a quasi-public good, higher education has both private and public properties. Firstly, the private benefits of higher education are more obvious, which are mainly

manifested in the competitive advantages and high income of the educated in their jobs. In addition, higher education has a certain positive externality, and its social impact is also more obvious. Higher education improves the level of social labour force, promotes social and economic growth and leads the development of the society through the cultivation of specialists, scientific research, etc.

If quasi-public goods are all provided by the government, they will lead to inefficient and chaotic use of resources because of their incomplete non-competitiveness and non-exclusivity, but if they are all provided by individuals, they will lead to unfair phenomena such as the concentration and monopolisation of resources. For the supply of higher education, limited government involvement is important, not only to compensate for the time lag in education, but also to correct the problem of market imperfections due to preferences or other reasons and to supply higher education resources more efficiently.

At present, China has established a financial expenditure method for education in which the central and local governments support key national and local institutions respectively, but there is still a need to further establish a reasonable cost-sharing mechanism to promote balanced, fair and effective inter-regional provision.

Regional differences in the allocation of financial resources for higher education is comprehensively explained by the theory of fiscal decentralization. The theory of fiscal decentralisation examines the division of fiscal relations between different levels of government, through which the central government delegates part of its fiscal autonomy to local governments, enabling them to allocate resources according to the socio-economic development of the region, thus achieving the goal of coordinated regional economic development. Fiscal decentralisation is a multidimensional concept that mainly includes revenue decentralisation, expenditure decentralisation, transfer payments and local debt.

The conventional theory of fiscal decentralization primarily focuses on the necessity and rationale for the presence of local governments. A prominent theory is the fiscal decentralization theory proposed by Tiebout in "The Pure Theory of Local Expenditure", published in 1956. This theory posits that the central government's

fiscal framework is static, and that the competitive differentiation among local governments can enhance the efficiency of public goods provision. Residents' propensity to "vote with their feet" incentivizes local governments to deliver public services that align more closely with Pareto efficiency [160]. This is because the "voting with feet" conduct of citizens might urge local governments to deliver public services that achieve Pareto efficiency more efficiently. Tiebout's theory has seven assumptions. Firstly, residents, as both voters and consumers of public goods, will select a community that aligns with their preferences due to their complete mobility; secondly, residents possess comprehensive knowledge regarding the fiscal dynamics of all communities and react accordingly to their disparities; thirdly, there exists a sufficient variety of differentiated communities for residents to select from; fourthly, there are no employment restrictions and residents derive their livelihoods from dividends; fifthly, there are no externalities associated with the public services rendered by communities; sixthly, all communities deliver public services that achieve Pareto efficiency; seventhly, each community has distinct optimal sizes determined by managers based on the preferences of the original residents; finally, communities that attain optimal size sustain stability, while those that do not must either attract or expel residents to minimize average costs. Nonetheless, the premises of the theory are excessively idealistic, and Tiebout himself contends that it serves merely as an operational consideration rather than a theoretical inquiry, applicable solely to the United States.

Subsequently, Musgrave, examining various governmental functions, emphasized the necessity of fiscal decentralization. He asserted that the central government primarily operates at a macro level, supplying adequate financial resources to facilitate the local government's focus on delivering public goods aligned with the preferences of its constituents. This arrangement is essential for the normal functioning of the country and ensures the efficient provision of public goods [161]. Oates' empirical research on decentralization theory offers a compelling demonstration. Research and analysis conducted in New Jersey, USA, indicate that local governments are more efficient in providing public goods, which in turn attracts

more residents, stimulates regional consumption, enhances regional value added and underscores the necessity of local government existence [162].

The second-generation theory of fiscal decentralization, emerging in the 1980s, diverges from traditional theory by incorporating contract theory. It posits that governmental behaviour should adhere to the rational actor model and examines the operational mechanisms of decentralization through the lens of officials' self-interest. In 1982, Olson, a renowned American economist, asserted in his book "The Rise and Fall of Nations: Economic Growth, Stagflation and Social Rigidity" that under the premise of rational economic agents, government officials will exploit taxes to maximize personal benefits, characterizing the government as a self-serving entity [163]. Consequently, the provision of public goods may be inefficient, although competition arising from decentralization can mitigate this inefficiency to some degree. Olson contends that the provision of public goods should be allocated among several governmental tiers based on the extent of distinct advantages, categorizing public goods into national, quasi-national and local public goods. National and quasi-national public goods cannot be supplied by local governments due to their inherent characteristics and associated costs; these products benefit inhabitants uniformly across the nation and are primarily provided by the central government. The provision of local public goods diminishes with distance and geographical limitations render it inappropriate for the central government to supply these goods. Consequently, residents in remote areas may receive benefits that do not correspond to the costs incurred. In contrast, local governments can enhance the efficiency of public goods delivery, thereby creating quasi-market effects in their provision. A study by Qian and Weingast revealed that political and economic incentives significantly influence the efficacy of decentralization and that an effective fiscal decentralization mechanism must thoroughly consider the alignment of incentives between government officials and residents [165]. The second-generation theory of fiscal decentralization posits that fiscal decentralization across all government levels enhances information acquisition efficiency, optimizes resource allocation, fosters equitable distribution, introduces competitive and innovative mechanisms, as well as facilitates fiscal oversight. It further

elaborates on the equilibrium mechanisms of fiscal decentralization in various domains, including public goods provision, inter-governmental competition and soft budget constraints.

An analytical strategy for fiscal decentralization between national and local governments is essential to distribute higher education resources more equitably and enhance the allocative efficiency of their distribution. Given the scarcity of resources, it is essential for providers to utilize current financial assets efficiently to deliver high-quality public services equitably to inhabitants across all regions. Educational resource allocation occurs at two primary levels: the higher level, which involves the distribution of resources across various regions and sectors, and the lower level, which pertains to the utilization of resources within a specific sector or unit, differentiating among various applications to optimize resource utility [166]. Fiscal decentralization primarily influences the efficacy of resource allocation in higher education through mechanisms like financial subsidies and transfer payments, aiming to attain equilibrium in education across various areas or sectors. Certain studies indicate that fiscal decentralization can enhance the efficiency of public goods provision; however, the effectiveness of decentralization is constrained by the financial capacity of local governments and the extent of transfer payments [167]. A different cohort of scientists posits that fiscal decentralization exerts little influence or a negligible negative effect on the efficacy of the provision of public goods related to livelihoods, such as education.

Enhancing the allocation of financial resources for higher education necessitates a clearer understanding of the impact of the fiscal decentralization system on the distribution of higher education resources among governments, thereby enabling the theory of fiscal decentralization to more effectively inform the equitable allocation of higher education resources across regions.

1.2. Regional equity, efficiency and adequacy of financial provision of higher education in China: problems and perspectives for budgetary management and analysis of methodological background

The theoretical framework of the management of state financial resources in the field of higher education in China in the context of balanced allocation of financial resources mainly analyses from the theoretical perspective: whether there is a convergent characteristic of the gap in financial expenditure for higher education between regions in China (equalization); why the allocation of financial resources for higher education is justified (public goods theory) and how to achieve effectiveness (fiscal decentralization); how to achieve the optimization of the balanced allocation of financial resources for higher education (fiscal sufficiency in education); and other issues.

The existence of a system of fiscal decentralisation makes different levels of government behave differently in terms of the objectives and modalities of financial resource allocation, which brings about a dynamic game of resource allocation between governments, thus affecting the efficiency of the allocation of financial resources.

As early as the end of the last century, Besley and Case [169] put forward the theory of "yardstick competition" in the field of finance, the theory that the residents of the jurisdiction will use their own limited information and other jurisdictions as a reference to judge the behaviour of the government of the jurisdiction or the performance of the yardstick, this decentralized system of downward accountability of the local government, stimulating the "competition between governments". This decentralized system of local government downward accountability stimulates inter-governmental competition, thus generating the "yardstick competition effect".

In China, there are notable disparities in the allocation of higher education resources among governmental entities. In contrast to the fiscal decentralisation observed in Western federal nations, China's fiscal decentralisation does not adhere to the notion of "downward responsibility" and possesses distinct characteristics, which

are primarily evident in the following three aspects: initially, decentralisation inside centralisation. Despite our nation attaining decentralised financial management between central and local governments, political authority remains centralised, as local officials are predominantly selected and appointed by higher government levels and are accountable to superiors rather than constituents. Secondly, China's decentralised financial system is defined by a "top-down" methodology, in which the central government devises decentralised rules, thereby granting itself preferential access to financial resources. Thirdly, China's household registration system and local community structures restrict population mobility, preventing individuals from exerting influence over and overseeing the distribution of local government resources through the mechanism of "voting with their feet". [170]. Li Tao and Zhou Ye'an assert that "yardstick competition" persists inside China's fiscal decentralisation framework [171]. The attributes of China's fiscal decentralisation system render the interaction between the central government and local governments more intimate and intricate, a dynamic that scholars metaphorically refer to as the "principal-agent" relationship. Local governments represent a modest portion of tax income, whereas the central government possesses greater financial resources, and its transfer payments to local governments provide a significant source of local revenue. The government of a specific region will not diminish the supply of public goods due to a "free riding" mentality, given the availability of comparable public product replacements in nearby regions, but will persist in maximising public expenditure. Furthermore, in the promotion system predicated on GDP as the evaluative criterion, local officials will prioritise investments in economic construction projects to secure greater financial resources and achieve notable political accomplishments, thereby neglecting investments in education, healthcare and other social welfare initiatives for a certain duration [172]. Consequently, based on the economic standard assessment, local governments will persist in optimising public expenditure. The local government's incentive to distribute financial resources for education based on the economic standard assessment is minimal.

In recent years, the share of educational expenditure within the public financial outlay of local governments has exhibited a consistent annual increase. Due to China's transition into a new normal phase of economic development, there are heightened demands for high-quality economic and social advancement. Consequently, the orientation of financial expenditures and the promotion criteria for officials must prioritise social and livelihood transformations. To align with national development trends, local governments have increasingly redirected their financial expenditures towards critical public service sectors such as education, science and technology and healthcare. Secondly, as local governments increasingly recognise the significance of talent in fostering economic development, they are not only implementing preferential policies to attract talent but also emphasising the cultivation of local talent and higher education. This is evident in the competition for talent among colleges and universities. Local governments are increasingly assuming an active role in the distribution of financial resources for higher education.

Currently, higher education in China is governed by a collaboration between the central government and local authorities. The central government primarily finances the expenditures of universities directly under its jurisdiction, while local governments are responsible for the financial expenditures of local universities; furthermore, the central government equitably subsidises local higher education through grants and awards. The research conducted by Li Zhenyu and Wang Jun indicated that local government expenditure constitutes 70% of the financial outlay for higher education, thereby assuming primary responsibility for such expenditures [173]. Higher education generates external benefits, including local talent pools and intellectual resources; however, the expenditure criteria and funding mechanisms for local higher education are primarily established by the local education department in collaboration with other agencies. This results in a significant reliance on local economic development and central transfer payments, causing disparities in the allocation of financial resources for higher education nationwide. The efficacy of the distribution of national higher education financial expenditures requires enhancement.

In conclusion, pure fiscal decentralisation and transfer payments do not inherently empower local governments to efficiently allocate educational financial resources; thus, an improved fiscal decentralisation framework and expenditure structure must be established to optimise the equitable distribution of higher education funding across regions.

The question of whether the financial resources allocated to higher education in China are sufficient and optimally distributed is a priority that requires urgent attention. Although the fiscal decentralisation system has a certain incentive effect on the behaviour of local governments to increase investment in higher education, and the level of China's higher education financial expenditure has been increasing year by year, the problem of unbalanced and uncoordinated regional development has never been solved perfectly. In recent years, more and more scholars have begun to pay attention to the study of financial sufficiency in education, and financial sufficiency provides new optimisation ideas for the balanced allocation of higher education financial resources.

The question of financial adequacy in China's higher education system should be considered in the context of the full expression of public values. From the perspective of historical development, the public value of higher education in China has shifted from "elite education", which fosters key talents to lead economic development, to "popular education", which improves the overall quality of the population. At the beginning of the reform and opening up, China's higher education shouldered the important task of boosting the economy and promoting the process of socialist modernisation, and the Decision on the Reform of the Educational System promulgated in 1985 stated clearly for the first time that the main task of China's higher education was to cultivate high-level specialists and to develop science, technology and culture, and to this end, the construction of a number of key colleges and universities and shortage of disciplines was the core of the allocation of financial resources for higher education at that time [178]. In recent years, with the expansion of the scale of China's higher education and the maturity of the talent market, the concept of "employment first" has gradually become the goal of colleges and universities,

resulting in the allocation of higher education resources in favour of subjects with good employment prospects and advantageous regional location of the school. Scholars hold a different view, believing that the concept of "employment first" over-emphasises the importance of professional knowledge and is a kind of career-orientated talent cultivation, while the ultimate goal of education is to promote the all-round development of human beings and to become a person who identifies with the times and the society before becoming a certain kind of person and engaging in a certain occupation [179]. Therefore, higher education resources should focus more on a balanced allocation among disciplines and regions and provide adequate education for all regions, thereby improving the quality of the country's overall population and creating public value.

Budgetary guidance ensures adequate financial expenditure on higher education. Guaranteeing the adequacy of higher education to efficiently create public value is the goal of the government's balanced allocation of higher education resources. First of all, let us see how the idea of "educational adequacy" came to be. Thus, while "adequacy" stresses the need to reach certain educational outcomes based on certain educational goals, the most important part of "achieving educational adequacy" is the issue of "educational inputs", and the government's job is to make sure that enough money is spent on education.

The government uses fiscal expenditure as a key tool to fulfil its functions of distributing social goods and regulating economic activities, and the fiscal budget's constraints dictate the scale and structure of its expenditures. Furthermore, the budget serves as a government program that sets price criteria, guiding the use of available resources to achieve public value.

In his book "The Lack of a Theory of the Budget", Key asks: "How is it decided to allocate X dollars to A rather than to B, and on what basis is the decision made?". This question exquisitely reveals the essence of a budget, which is an economic form of resource allocation to achieve a specific goal [180]. Sorenson and Goldsmith propose that educational budgets allocate resources by considering the vision and planning for educational development [181], as illustrated in Figure 1.4.
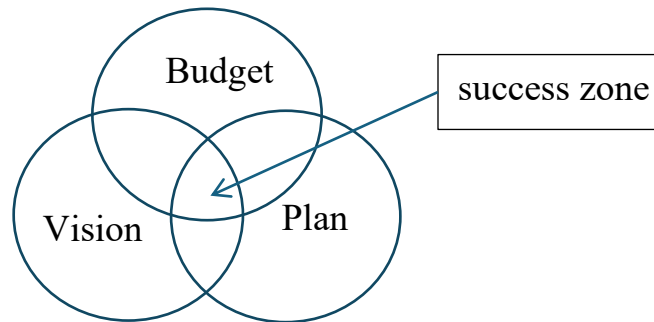
Figure 1.4 − Education budget model based on vision and planning

Source: Compiled by the author

The objective of resource allocation to education is to achieve public value, which embodies the vision of the educational budget. In the context of higher education in China, this entails delivering "mass education" to improve the general quality of the populace. The objective of the planning domain is to systematically allocate higher education resources, furnish sufficient financial support for higher education and guarantee a balanced distribution of efficiency and equity. Although a universally applicable education budget model does not exist, an effective budget should at minimum achieve the previously stated vision and planning objectives. It must also adjust to changes and advancements, guaranteeing sufficient financial security for the appropriate distribution of higher education resources.

The "budget vision planning" system for educational adequacy provides a comprehensive overview of the goal-oriented production process in higher education. This study seeks to identify the ideal framework for the equitable distribution of financial resources in higher education, informed by the three-tiered structure of "budget-vision-planning". This will be accomplished by analysing the discrepancies between the existing distribution of financial resources in higher education and the envisioned framework.

The primary discourse concerning the distribution of higher education resources in China centres on governmental processes. The distribution of resources for higher education in China has predominantly been governed by the government, with central and local government funding playing a crucial role in this sector. From

1949 to 1985, China's higher education system operated under a fully planned model, with the government financing all aspects, including institutional operations and student living expenses. Nonetheless, the proposed model exhibits issue of uniformity, integrity and inefficiency associated with a "one-size-fits-all" allocation approach. Consequently, by the late 1980s, China commenced a gradual exploration of integrating market forces and private capital into higher education, implementing a series of incentives and enhancement policies to invigorate enthusiasm and adaptability in resource allocation for this sector. The market's spontaneous direction facilitates the allocation of higher education resources to areas that yield the most utility, hence enhancing the efficiency of resource distribution in higher education. While the market approach enhances the efficiency of higher education resource allocation and revitalises existing educational resources, it is also myopic and utilitarian, leading to resource concentration, significant inequities and exacerbated geographical disparities. Consequently, both the plan model and the market model possess distinct advantages and disadvantages, necessitating a balanced selection to optimise equality and efficiency in resource distribution.

Currently, China employs a hybrid model of planning and market mechanisms, characterised by government-led investment, comprehensive planning and equitable resource distribution, while simultaneously incorporating market-driven competition. This approach aims to enhance the efficiency of higher education resource allocation through the diversification of educational resources, varied investment channels, and the standardisation of investment practices.

In examining the correlation between education and economic development in China over the last twenty years, Hossain discovered that previous educational policies have concentrated on enhancing educational efficiency, which has led to the marginalisation of the impoverished in the allocation of educational resources. Consequently, these individuals have not reaped the benefits of economic growth but have instead faced increased barriers to accessing services. Therefore, the Government should prioritise the advancement of educational equity in future policy formulation and focus on delivering efficient educational services [58]. Flatter's "The French

Shared Contribution Scheme" exemplifies how various higher education financing methods and governmental support can significantly benefit disadvantaged families, including the impoverished, the injured and the ill, thereby enhancing the equity of higher education [59]. Williams contends that educational equity gains significance when education is regarded as a public service; but, when its economic externalities are taken into account, educational efficiency has greater importance [60].

Currently, experts in China's higher education research predominantly assert that enhancing the effectiveness of higher education should be prioritised alongside advancing its equity. In the 1990s, Tan Songhua underscored the significance of the principle of "prioritising efficiency while considering equity" in economics, asserting its relevance to educational equity. He noted that achieving efficiency and equity in education depends on a specific socio-economic context. Furthermore, influenced by educational policy, he advocated that China's education system should prioritise ensuring equity at the basic education level while simultaneously promoting the provision of higher-quality education for select individuals, grounded in equity [61]. Simultaneously, influenced by educational policy, China's education system should prioritise ensuring equity in basic education while promoting the provision of superior quality higher education for select individuals. Consequently, the advancement of higher education in China has consistently prioritised the enhancement of educational effectiveness. Chen Dejing asserts that the justice and efficiency of higher education must be harmonised despite their inherent contradictions. Unity signifies that the two entities are interdependent and foundational to one another, while an equitable educational environment establishes a robust value framework and system for enhancing efficiency; optimal resource allocation fosters greater productivity and yields extensive social resources, thereby advancing educational equity [62]. The contradiction between the two is evident in the scarcity of resources, necessitating the expansion of educational access to ensure equitable enjoyment of higher education resources, while simultaneously enhancing the quality and substance of higher education to improve its efficiency. This requires substantial investment in education, highlighting the conflict between the pursuit of equity and the limited availability of

resources. Furthermore, according to the general principle of efficiency, newly allocated resources tend to augment existing high-quality higher education, thereby exacerbating inequities within the system. From the standpoint of education policy evaluation, Shi Huoxue examined the reasons for the persistent emphasis on educational efficiency in higher education policies and proposed that future developments should harmonise individual and social values in education, while addressing the requirements of the value environment, thereby considering both educational equity and efficiency in policy formulation [63]. Hu Yanrong's research indicates that China's financial expenditure on higher education exhibits inequities characterised by irrational allocation, an imperfect cost-sharing framework and uneven resource distribution. In terms of efficiency, it reveals inefficient utilisation of educational resources, an illogical funding structure, and significant waste of research resources. Moving forward, it is essential to enhance financial investment in higher education, judiciously distribute financial authority and expenditure responsibilities among various government levels, and allocate financial resources for higher education in a rational manner [64]. In the future, we must persist in augmenting financial investment in higher education, judiciously apportion financial authority and expenditure responsibilities among various levels of government, effectively allocate higher education resources, and enhance the efficiency of higher education. Seaman and Cui Yuping assert that attaining educational efficiency is the paramount objective of enhancing educational equity, indicating that the two concepts are not antagonistic but rather mutually reinforcing [65].

Let us undertake a more detailed examination of the question of the factors affecting the balanced allocation of financial resources for higher education between regions. The allocation of China's higher education resources varies greatly between regions, and there is an objective problem of unbalanced resource allocation. For a considerable amount of time, factors such as geography, history, culture, economic status, and other factors have contributed to the relative advantage of the eastern region of China, both in terms of the number of colleges and universities and the allocation of higher education resources. To balance the development of higher education

between regions, our government has fostered a number of national key colleges and universities in the western region and increased the financial investment of the central government in higher education in the west, which to a certain extent has alleviated the problem of uneven allocation of higher education resources [66]. Since 1998, China's higher education enrolment expansion has significantly increased overall financial investment in higher education, and the proportion of budgeted higher education funding has also increased, indicating a gradual strengthening of the government's attention to higher education [37]. Although the scale of China's higher education funding has increased year by year, the problems of uneven and insufficient funding for higher education between regions remain unsolved. Sorting out the reasons for the unbalanced allocation of higher education resources between regions will help promote the coordinated development of higher education in the area.

Based on a review of existing literature, scholars believe that the main factors affecting the balanced allocation of higher education resources among regions are the level of regional economic development, historical and cultural factors, political factors, regional factor endowment (geographic environment factors), social factors, and other factors, as shown in Figure 1.5.
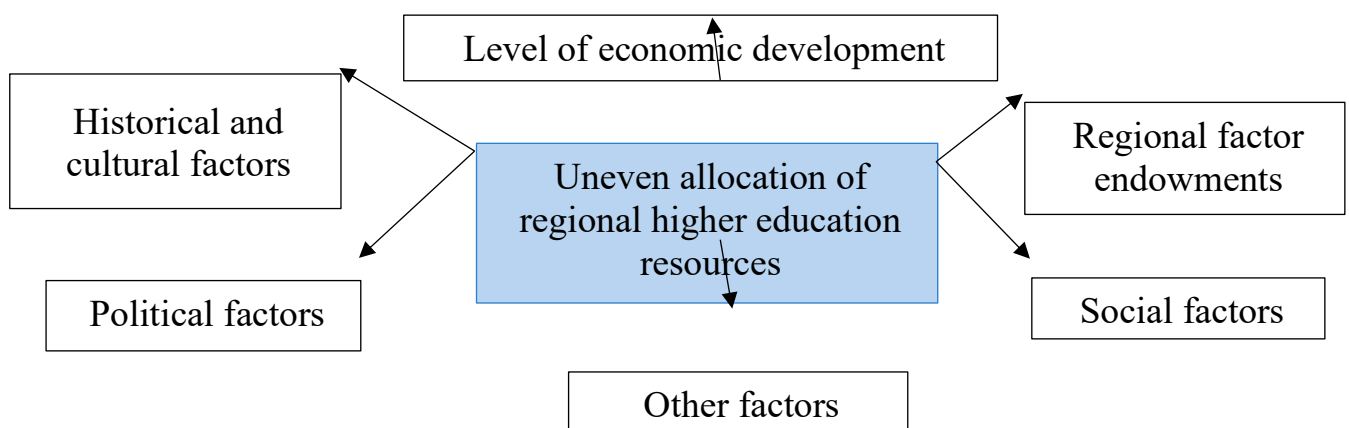

Figure 1.5 − Main reasons affecting the balanced allocation of higher education resources between regions

Source: Compiled by the author

The level of economic development is an important factor in the unbalanced allocation of educational resources in China. As early as 1998, Michael pointed out in his research that education and the economy are interacting with each other and that economic development significantly affects the supply of educational resources in the region, thus causing an imbalance in the distribution of educational resources between regions [67]. Gao Junhui arrived at a similar conclusion in his statistical analysis of the distribution of higher education resources across Chinese regions, concluding that economic factors significantly contribute to the significant disparity in higher education resources between the east and west [68]. Xiong Zhiwei and Hu Qian's study concluded that the unequal distribution of high-quality higher education resources between regions is primarily due to the regional and differentiated development of China's economy. They suggested that sharing educational resources could alleviate this imbalance, using Jiangxi Province as an example [69]. Sang Jinlong posits that the balanced development of higher education serves as an endogenous factor in the region's balanced development. He further argues that a benign interaction exists between the laws, changes in the region's development and the external social environment. This implies that the allocation of resources for higher education should align with the local economy and society's development, while simultaneously fostering the advancement of the local economy and society. Generally, since modern times, the economic development of China's south-eastern region began earlier. Its infrastructure, industrial structure and other supporting facilities, which can further promote the development of higher education, are superior to those in the central and western regions. Consequently, the imbalance in resource allocation for higher education between the east and west tends to persist.

Historical and cultural factors are also very important in the unbalanced allocation of educational resources in Chine. The development of education has a certain degree of continuity, since ancient times there has been a trend of succession, higher education also has the influence of cultural precipitation. From the 19th century, China's higher education budding period, talent training and higher education construction of the centre will be more concentrated in Beijing, Shanghai, Nanjing and

other political and economic centres in the southeast region, while the central and western regions gradually lagged behind due to the distance from the coast because of their location inland. The development of these regions straggled not only economically, but also ideologically, as they had a certain gap in the local government on higher education. Local governments do not pay enough attention to higher education, resulting in the gap in access to higher education resources [71].

Political factors are also very important in the unbalanced allocation of educational resources in China. Political ideas and strategies not only determine the pattern of social development but also profoundly affect the allocation of higher education resources. During the initial stages of reform and opening up, China prioritized the development of the southeast, emphasizing the opening up of strategic areas to enhance the industrial structure's adjustment and upgrading and to boost the region's economic, scientific and technological strength [72]. However, as China's economic and social development has entered a new normal period, the development gap between the eastern and western regions has been increasing, and the problem of uncoordinated regional development has become a key obstacle restricting China's sustainable economic and social development, and the introduction of relevant policies to vigorously support the development of higher education in central and western regions from the national level has become the main theme of the higher education planning in the past three decades. Liu Xiaofeng and Xie Yan's study on the development of higher education in the Tibet region confirms the influence of political factors on the balanced allocation of regional higher education resources. This allocation is guided by national activities to support Tibet, the "Belt and Road" initiative and other policies, resulting in the recent leapfrog development of higher education in the Tibet region [73].

The unbalanced allocation of educational resources in China is significantly influenced by geo-environmental factors. The geographical location of different regions and the environment are the basis for their survival and development. Different regional factor endowment will create different regional characteristics, as Weber has pointed out in his book "Industrial Location Theory" [74]. Geographic environment

and spatial layout, as well as other human social development and resource allocation have an important impact on the way. In China, the densely populated central and western regions are characterized by inconvenient traffic and relatively weak infrastructure construction, which directly impacts the equitable distribution of higher education resources. The study by Ma Zhong et al. analyzed how regional factor endowment affected the distribution of higher education funds and discovered that regional factor endowment indirectly led to a growing imbalance in the distribution of higher education funds [75]. This shows that regional factor endowments do have an impact on the balanced allocation of higher education resources, but with "Western Development", "The Rise of Central China", "Northeast Revitalization" and other favourable national policy trends, the central and western regions are in a better position in terms of resource allocation. However, national policies such as "Western Development", "Rise of Central China" and "Northeast Revitalization" are gradually improving the disadvantageous position of the central and western regions in resource allocation.

Social factors play a significant role in the uneven distribution of educational resources in China. Education and social development are mutually reinforcing and constraining relationships. Social factors primarily impact the uneven distribution of higher education resources through two aspects: social stratification and the demand for education. On the one hand, as the economic gap between China's eastern and western regions widens, the disparity between the affluent and the poor widens, as well as the pace of urbanisation accelerates, the demand for higher education in the southeast region naturally outpaces that of the central and western regions. As a result, the market assumes a more interest-oriented role, leading to a tilt in the allocation of higher education resources toward the southeast region. On the other hand, the south-eastern region's rapid development due to modernization and society also increases the demand for high-tech, high-quality talent. On the other hand, the rapid development of the south-eastern region due to modernisation and society has increased the demand for high-tech, high-quality talents, which in turn has boosted the development and growth of higher education to cultivate such talents [68]. Miao

Wenyan believes that the reasons for the imbalance in the allocation of higher education financial resources are broad and complex, involving political, economic, and social factors. He believes that the establishment of reasonable guidelines for the allocation of higher education financial resources is a fundamental solution to reduce the differences in regional resource allocation [76].

In addition to the five main categories mentioned above, the population base, cultural atmosphere and other factors also contribute to the uneven distribution of higher education resources between regions, albeit to a certain extent. Under the combined influence of these factors, China has established an unbalanced status quo where the allocation of higher education resources is more concentrated in the south-eastern region and more scarce in the central and western regions. Financial expenditures are always the main source of higher education resources; therefore, it is of great significance to further explore the balanced allocation of higher education financial resources to optimize the structure of China's higher education resource allocation [31].

Figure 1.6 summarizes the relevant theories and research on the distribution of financial resources for higher education.

Theoretical Studies on Balanced Allocation of Financial Resources for Higher Education

The Theory of Economic Convergence

Facts and Logic of Economic Convergence

Equation of Economic Convergence

Three Assumptions Behind Economic Convergence

Historical Research and Current Status of Economic Convergence

Convergence Logic of Financial Expenditure

Relationship Between Financial Expenditure and Economic Development

Institutional Convergence and Economic Development

Classification of Economic Convergence

σ-Convergence

β-Convergence

Club Convergence

Time-Series Convergence

Impact of the Efficiency of Financial Resource Allocation in Higher Education

Public Goods Theory and Fiscal Decentralization

Definition and Characteristics of Public Goods

Education as a Quasi-Public Good

Theory of Fiscal Decentralization

Necessity and Rationality of Fiscal Decentralization

Multidimensional Concept of Fiscal Decentralization

Optimization of Financial Resource Allocation for Higher Education

Expression of Financial Adequacy in Education

Realization of Public Value

Budget-Guided Financial Adequacy

Balanced Allocation of Higher Education Financial Resources

Goals of Financial Resource Allocation

Relationship Between Financial Budget and Education Planning

Research Trends in Higher Education Resource Allocation

Fundamental Research on Higher Education Resource Allocation

Foreign Research Trends

Domestic Research Trends

Main Game in Higher Education Resource Allocation

Roles of Government, Market, and Universities

Government's Role in Resource Allocation

Connotation of Higher Education Resource Allocation

Relationship Between Equity, Efficiency, and Balance
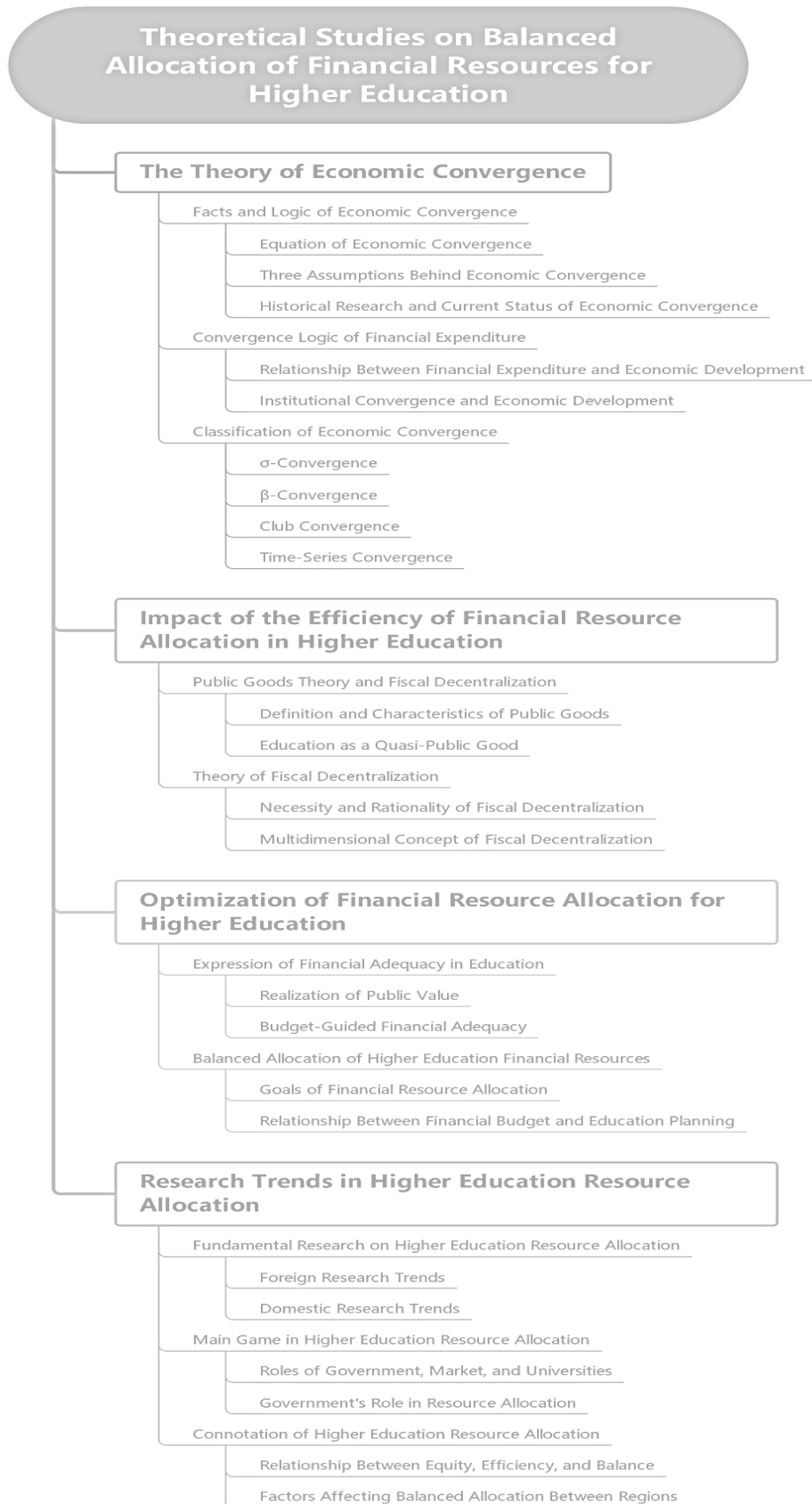
Factors Affecting Balanced Allocation Between Regions

Figure 1.6 − Main theories and research on the management of state financial resources in higher education

Source: Compiled by the author

1.3. Resource allocation in the context of the management of state financial resources in higher education: a comparison of the experiences of China, Japan, the United Kingdom and the United States

Given the crucial importance of higher education in economic development, both established and developing Western nations have allocated a larger proportion of their resources to enhance higher education and its efficient distribution. Despite substantial disparities in the foundational structures and financial systems of various countries, along with distinct methodologies for resource allocation, there are nonetheless shared principles and commonalities that regulate the distribution of higher education resources internationally. We may derive numerous ideas for maximising the equitable distribution of higher education resources in each country by leveraging the pertinent experiences of other nations. This section will analyse the current practices of many nations in the distribution of higher education resources, aiming to offer pertinent experiences and references for optimising the equitable allocation of such resources in each nation.

The higher education system in China distributes resources according to official economic policy. Since the reform and opening, China's economic development has shifted from rapid expansion to a steady deceleration; from 2012 to 2019, the growth rate of China's gross domestic product (GDP) declined from 7.9 percent to 6.1 percent. Economic development has transitioned from a high growth rate of approximately 10 percent to a new phase characterised by medium- to high-speed growth, which is expected to gradually stabilise at around 6 percent. Concerning this recent aspect of China's economic development, General Secretary Xi Jinping articulated the significant remark that China's economic growth had reached a "new normal" in 2014. In the current era of economic evolution, the traditional, resource-intensive development model is obsolete and will be supplanted by sustainable development, propelled by advancements in industrial structure, productivity enhancement, and technological innovation. The evolution of the economic framework is hastening, with the development of new industrialisation, information technology, urbanisation and

agricultural modernisation progressing concurrently. Despite a deceleration in economic growth during this phase, the quality of economic development has consistently enhanced. Scientific and technological advancements, along with managerial innovation and enhancements in workforce quality, are increasingly vital drivers of economic development.

The "new normal" presents novel difficulties and opportunities. The carrying capacity of the ecological environment approaches its upper limit, rendering ecological protection imperative. Concurrently, the demand for pristine ecological products, such as clear skies, clean water and unpolluted soil, is escalating. Traditional sectors, including machinery and manufacturing, are nearing saturation, while emergent industries, such as next-generation information technology, advanced materials and high-end manufacturing, are proliferating. The advancement of science and technology, coupled with a deceleration in economic growth, has resulted in a decline in traditional job opportunities, intensifying employment pressures. Conversely, the demand for positions in new industries is rising, necessitating the bridging of the talent gap in these sectors. The demand for employment in emerging industries has increased significantly, although the talent deficit in these sectors persists. To capitalise on these new prospects, we must guarantee enough talent protection and secure sufficient developmental reserves for the onset of the new normal economic era.

"The impetus for innovation necessitates innovative talent". The cultivation of new talents is essential for the holistic establishment of a moderately successful society and the eventual achievement of robust socialist modernisation. Higher education, as an essential mechanism for developing fresh and high-calibre people, significantly influences our nation's future growth and strategy. General Secretary Xi Jinping has consistently addressed the strategy of enhancing national strength through talent in his speeches, underscoring the necessity for higher education to fully leverage its significant advantages in talent convergence, intellectual vitality and disciplinary comprehensiveness. In October 2018, the Ministry of Education published the Opinions on Accelerating the Construction of High-Level Undergraduate Education

and Comprehensively Improving Talent Cultivation Capability, detailing specific recommendations for institutions of higher education to enhance talent development, reform teaching and research systems and strengthen science and technology. The Innovation Demonstration and Leading Role has delineated certain standards, providing direction and facilitating the development of China's higher education system to cultivate new talent. The successful attainment of significant strategic objectives, such as socialist modernisation, hinges on the development of inventive talent and the equitable advancement of the higher education system. Consequently, prioritising the advancement of China's higher education and examining its equilibrium is of paramount concern at this juncture.

The university, as a manifestation of contemporary civilization, emerged relatively late in China's recent history, marked by poverty and vulnerability, which, along with recurrent social upheavals and political transformations, resulted in numerous alterations in the distribution of higher education. Nonetheless, irrespective of the timeframe, the distribution of higher education resources in China inherently follows the principle of regional equilibrium

During the late Qing Dynasty, the initial establishment of universities in China was spearheaded by reformers from the foreign affairs party and reformists, resulting in the creation of Beiyang Public School, Nanyang Public School, and Peking University Hall. Regarding distribution patterns, Beiyang Public School and Peking University Hall are positioned in Tianjin and Beijing in the north, whilst Nanyang Public School is located in Shanghai in the south. The equitable distribution of higher education resources between the north and south during this period aims to develop globally connected talents in diverse regions. However, due to the war-affected living conditions and rapid societal changes, which also ensure a degree of institutional continuity, if a particular area is hindered by environmental factors from maintaining school operations, it is possible to transfer to another institution, allowing teachers and students to continue their education. For example, near the close of the 19th century, the Beiyang Public School in Tianjin was temporarily moved to Shanghai because of the Boxer Rebellion.

During the era of the Beiyang Warlords and the Republic of China, the distribution of higher education resources was rather equitable. This era represented the "golden age" of university education development in China, which was characterized by the establishment of numerous national universities across various regions, including National Zhejiang University, National Central University, National Tsinghua University, National Wuhan University, National Sun Yat-sen University, and National North-western University. Additionally, several esteemed institutions were founded by democratic and patriotic individuals, such as private Nankai University, Fudan University, Xiamen University, Soochow University and Jinling University, alongside with the foreign church-affiliated institutions like Yenching University and St. John's University. Democratic nationalists established notable institutions like Nankai University, Fudan University, Xiamen University, Soochow University and Jinling University, while foreign churches erected Yenching University, St. John's University and Tongji University. Notwithstanding the expansion of universities during this era and the rise of private education in developed areas such as the southeast, the allocation of national institutions remained rather uniform across the eastern, southern, western and central regions.

In the initial phases of New China's foundation, the nation encountered a deficiency of skilled personnel for communist construction. The inadequate and uneven distribution of higher education resources impeded the comprehensive recovery and advancement of the national economy. To enhance the scale and quality of higher education in China and to stimulate national development, the Ministry of Education implemented a comprehensive restructuring of faculties and departments in higher education institutions in 1952, guided by the principle of "prioritising the cultivation of talent and educators for industrial development, establishing specialised colleges and reorganising and fortifying comprehensive universities". Subsequently, a succession of reforms has been implemented to standardise the structure of higher education throughout various regions of the country. In early 1955, to equilibrate the development of higher education and bolster social and economic progress in the western region, the primary campus of Jiaotong University was relocated to Xi'an,

resulting in the formation of Shanghai Jiaotong University and Xi'an Jiaotong University. To further enhance higher education in the western region and facilitate its development, Lanzhou University was established as a national key comprehensive university in 1953, followed by the merger with Nankai University in 1965, which included specialisations in nuclear physics and radiochemistry. In 1965, Nankai University's nuclear physics and radiochemistry programs were integrated into its modern physics department, thereby enhancing Lanzhou University's physics disciplines. In 1969, the University of Science and Technology of China relocated from Beijing to Hefei, Anhui Province, which significantly facilitated the transformation and upgrading of the industrial structure in the central region, contributing to its economic and social development. This exemplified the equitable distribution of higher education resources. In the early 1990s, to bolster the robustness of local higher education and attract talent, the country initiated a series of mergers among colleges and universities, exemplified by "the new Jilin University", "the new Peking University", "the new Wuhan University" and "the new Sichuan University". The new Jilin University, the new Peking University, the new Wuhan University, the new Sichuan University and the new Xi'an Jiaotong University were among others. The equitable distribution of these colleges and universities around the nation enhances the talent cultivation system in each region and fosters local economic development. In recent years, the extensive development of key universities, such as the "211 Project" and the "Comprehensive Strength Enhancement Project for Universities in Central and Western China", has provided higher education resources in the central and western regions with opportunities for advancement. However, historical legacies and economic disparities continue to result in a predominance of high-level institutions in the eastern regions. Despite the predominance of prestigious educational institutions in the eastern region of the country, attributable to historical legacy and economic advancement, the principle of equitable distribution of higher education resources has consistently been upheld, with all regions striving to enhance their own higher education standards.

In conclusion, from a historical standpoint, the equitable distribution of higher education resources across regions is both a strategic national decision and a pursuit for enhanced and constructive synergy between education and economic development at the regional level.

In the span of over 40 years after the reinstatement of the college entrance examination, China's higher education system has experienced substantial transformation. The quantity of conventional higher education institutions rose from 404 in 1977 to 2,688 in 2019, while the number of college graduates escalated from 16,500 in 1978 to 753,308,087 in 2018. The gross enrolment rate for universities has attained 48.1%, nearing the objective of achieving a 50% gross enrolment rate at the universalisation phase. Moreover, in this new phase of China's economic advancement, the present state of higher education, which draws talent from varied backgrounds, is essential for China's scientific and technical innovation, as well as its prospective economic and social progress.

While the general advancement of higher education in China is commendable, the disparity in progress among regions remains pronounced. Consequently, the future trajectory of higher education development should prioritize enhancing quality and attaining greater regional equilibrium than the rapid expansion of overall capacity. This dissertation analyses the current state of higher education in China regarding resource allocation, revealing varying degrees of disparity among provinces concerning the number of institutions, faculty strength, output and average per student public budget funding, among other factors.

From the standpoint of investment in educational resources, there exists a significant disparity among China's regions regarding the quantity of higher education institutions and the quality of educators. Figure 1.7 illustrates that in 2019, the distribution of ordinary colleges and universities, institutions directly under central departments, and "211" universities across China's 31 provinces (municipalities) is markedly uneven. Notably, the high-quality educational resources of institutions directly under central departments and "211" universities are predominantly concentrated in the more economically developed eastern regions. In Figure 1.7,

I compiled the number of colleges and universities alongside the number of teachers in each region. It was determined that the ratio of full-time teachers to colleges and universities in Beijing serves as the benchmark, and most regions exhibit a lower ratio, indicating an insufficient number of full-time teachers, with pronounced disparities among regions. Conversely, Shandong and Henan demonstrate a higher ratio of full-time teachers to colleges and universities, suggesting a more adequate supply of teachers; however, the qualification level of these full-time teachers falls below the standard. The academic qualifications of full-time educators are inadequate, as illustrated in Figure 1.8.
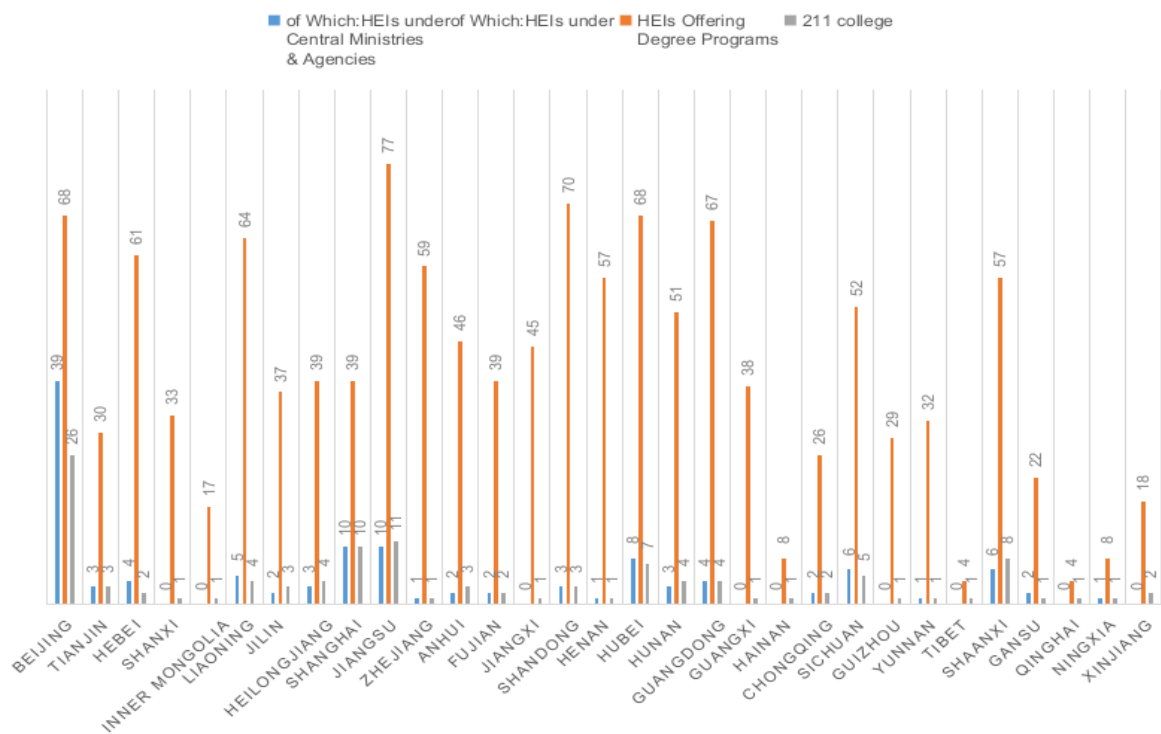

Figure 1.7 − Number of general higher education institutions in China, 2019

Source: Education statistics on the official website of the Ministry of Education of China

Figure 1.8 − Number of Teachers in General Higher Education vs. Number of Colleges and Universities in China, 2019

Source: Education statistics on the official website of the Ministry of Education of China

Figure 1.9 − Academic qualifications of full-time teachers in general colleges and universities in China, 2019

Source: Education statistics on the official website of the Ministry of Education of China

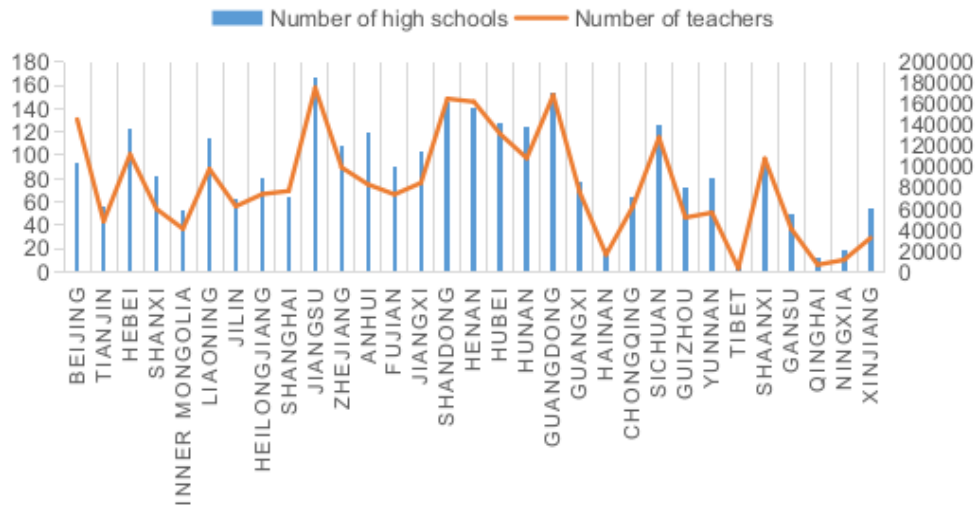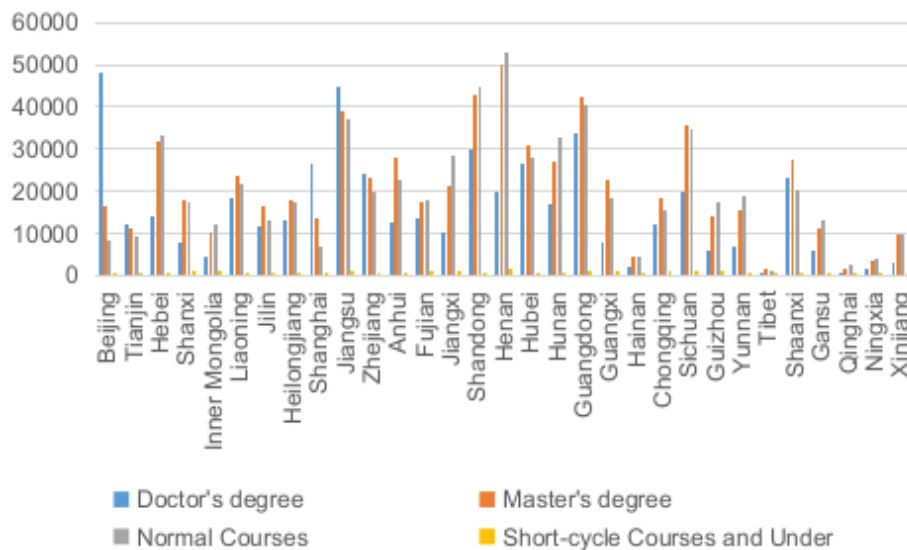Figure 1.9 illustrates the academic credentials of full-time educators in general colleges and universities across different regions. Full-time educators possessing doctoral degrees are predominantly located in economically and socially advanced

areas such as Beijing, Shanghai and Guangdong. Conversely, in provinces with a higher concentration of general colleges and universities, such as Shandong and Henan, the academic qualifications of full-time teachers are typically lower, with bachelor's degrees being the predominant qualification. In the western region, the academic qualifications of full-time teachers are generally inferior, with the proportion of those holding doctoral degrees falling below 20 percent in most areas. In most locations, the percentage of full-time teachers possessing PhD degrees is below 20%, while in Shaanxi Province, where the overall educational attainment of full-time teachers is comparatively elevated, this percentage is under one-third.

There exists a significant disparity in expenditure on higher education across different regions. Investment in education is a critical determinant of educational quality. Figure 1.10 depicts the regional financing for higher education and its impact on total educational spending in 2018. The expenditure on higher education exhibits significant regional disparities, with Beijing and Guangdong leading substantially, whereas the western region remains comparatively low. Furthermore, the ratio of higher education expenditure to total educational expenditure differs across provinces, with Beijing having the highest proportion at 36.75 percent and Xinjiang the lowest at merely 8.52 percent.
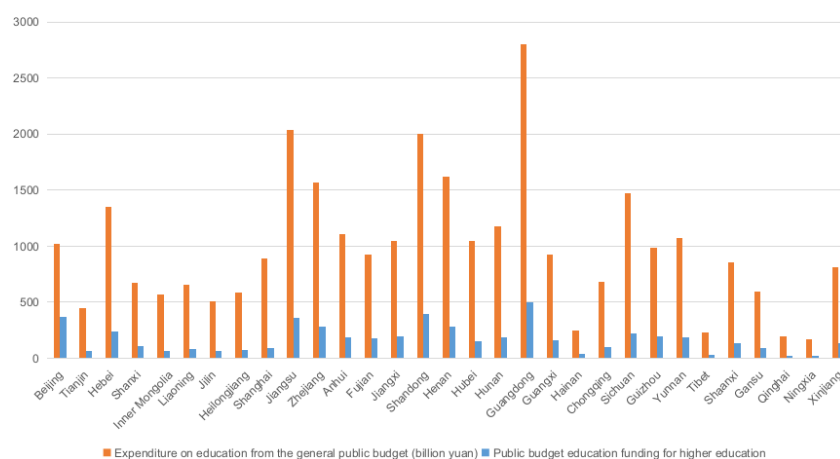

Figure 1.10 − Expenditure on higher education and its share of total education expenditure by region in China, 2018

Source: Statistical Bulletin on the Implementation of National Education Expenditure in 2018

The universality of higher education, in contrast to basic education, indicates that equalising its resource distribution does not necessitate complete equivalence. The disparities in per capita spending for higher education among areas, as depicted in Figures 1-11, provide a clearer representation of the inequity in the distribution of higher education resources among regions. Figure 1-5 illustrates that Beijing, Shanghai, and Guangdong, owing to their advanced economic development, receive substantially greater financial support compared to most regions in the country, resulting in a higher average per capita public budget allocation for higher education. Conversely, western regions such as Tibet, Ningxia and Qinghai benefit from significant national policy preferential treatment, leading to their average per capita public budget funding for higher education also ranking among the highest nationally. The western regions, including Tibet, Ningxia, and Qinghai, receive preferential treatment from national policy, resulting in a high amount of public budget support per student for higher education, among the highest in the nation. In various locations, the per capita public budget allocation for higher education is often low, especially in Shandong and Henan provinces. Notwithstanding the abundance of colleges and universities, these regions exhibit the lowest per capita public budget allocations for higher education, which is evidently unjustifiable.
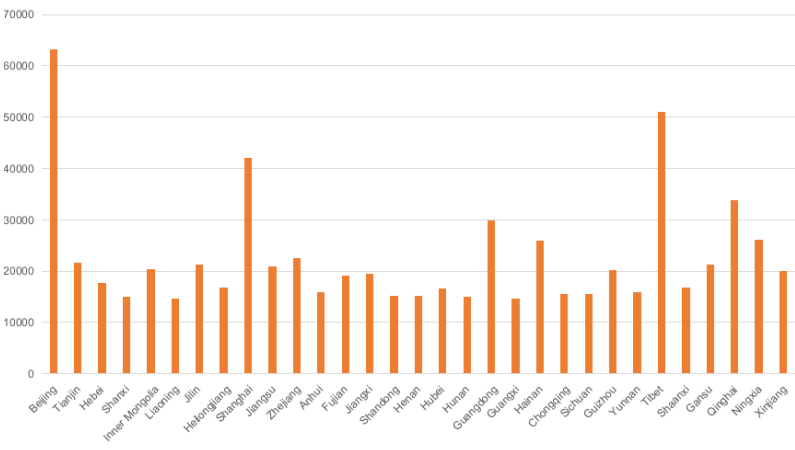

Figure 1.11 − General public budget per student expenditure on higher education by region in China, 2018

Source: Statistical Bulletin on the Implementation of National Education Expenditure in 2018

The distribution of higher education resources across regions in China will inevitably differ due to factors such as uneven regional economic and political development, inconsistent cultural resource endowment, and variations in the talents and abilities of educated individuals. In the contemporary phase of China's economic advancement, higher education is pivotal in fostering the sustainable development of local economies through the pursuit of balanced regional growth.

The equitable distribution of resources for higher education is a fundamental aspect of coordinated regional development in China. Considering the present circumstances of China's economic and social development, the 18th Party Congress proposed five new development principles to leverage the advantages of this new era: innovation, coordination, sustainability, openness and inclusivity. Neither innovation nor coordination can be realised without the support and advancement of regional higher education.

A robust educational foundation and the development of high-calibre talent are vital for attaining creative progress and successfully converting the "demographic dividend" into the "talent dividend" is pivotal in promoting the advancement of an inventive nation. Experience has demonstrated that innovation necessitates creative abilities, while sustainable development demands a consistent influx of talent. Higher education, as a significant social endeavour for the development of skilled professionals across diverse fields, supplies a substantial workforce for various industries, promotes talent mobility across regions and serves as the foundation for the cultivation and preservation of high-quality regional talent. Concurrently, higher education functions as the primary arena for scientific inquiry and creative endeavours, thus promoting the direct implementation of scientific and technological advancements. The advancement of higher education is intricately linked to a region's innovation ability and economic development, significantly influencing the degree of innovation and sustainable growth within the regional economy.

The judicious distribution of interregional components, such as higher education resources, is a crucial aspect of coordinated regional growth. The new development paradigm emphasizes the coordinated advancement of urban and rural areas, regions,

economies and societies. The coordinated development of higher education resources largely pertains to collaborative advancements among areas. This indicates that, through a thorough and equitable strategy, it is essential to prioritize equilibrium among regions, maintain parity and provide support for underperforming areas and connections. This method establishes a framework for balanced development and consequently augments developmental strength. Research indicates that, except the four primary first-tier cities of Beijing, Shanghai, Guangzhou, and Shenzhen, the geographical placement of higher education institutions significantly influences students' employment choices [1]. Consequently, an equitable allocation of higher education resources across regions might, to some degree, affect the equitable distribution of talent throughout those regions, thereby fostering coordinated and sustainable socio-economic growth in each area.

Currently, China's higher education resources demonstrate considerable inter-regional differences that are inconsistent with the need for coordinated development. To strengthen a resilient higher education system in the new socialist era, it is imperative to tackle the disparity in regional allocation of higher education resources and promote the coordinated advancement of higher education across regions. This will guarantee an adequate impetus for scientific and technical innovation and synchronized socio-economic development.

Financial expenditures are a crucial factor for equitable regional distribution of higher education resources in China. To align higher education with the demands of the contemporary era and develop high-calibre talent for China's reform, opening up and socialist modernisation, it is essential to vigorously advance higher education reform and consistently enhance educational quality. The Ministry of Education and other departments indicated in the 2018 notice of the Guiding Opinions on Accelerating the Construction of "Double First-Class" Higher Education Institutions that higher education must prioritise reform-driven and connotative development, enhance regional coordination, optimise the arrangement of disciplines, establish a coordinated and sustainable disciplinary system and create a high-level talent cultivation framework. Reform and development are inextricably linked to the

provision of material resources; current investments in higher education primarily derive from government, societal and individual contributions. As a quasi-public good, the resource input for higher education predominantly relies on government financial expenditures. Table 1.1 illustrates the primary sources of higher education funding in China from 2013 to 2017, together with their respective quantities.

Table 1.1 − Sources of funding for education in China's general higher education institutions, 2013-2017 Unit

Vintages	Total funding for higher education	State financial resources for education		Of which: public finance for education	Organisers' inputs in private schools	Social contribution	Business income (including tuition fees)	Other education funds
		Sum of money	Percentage					
2017	10947.0	6798.9	62.2%	5631.0	38.0	46.4	3436.3	627.4
2016	9973.4	6198.8	62.1%	5194.3	47.3	47.2	3168.1	512.0
2015	9364.1	5841.1	62.4 %	4828.3	28.1	48.1	3012.0	434.8
2014	8510	5144.9	60.4%	4270.2	19.2	40.4	2886.2	419.3
2013	7975.7	4796.9	60.1%	4419.4	34.0	43.3	2687.2	414.3

Source: China Education Statistical Yearbook

The table indicates that China's national financial expenditure on education constitutes over 60 percent of the total funding for general higher education institutions, with both the amount and proportion exhibiting an upward trend. Higher education is a crucial factor in fostering regional innovation and sustainable development, with financial investment serving as a primary source of funding that significantly influences the advancement and reform of regional higher education. Government-directed financial investment in higher education functions as a strategic approach to resource allocation, potentially rectifying the inequitable distribution of resources by the market. The market allocation of resources functions as a mechanism to modify prices according to the supply and demand connection, thus attaining an effective distribution of resources. The market's allocation of higher education resources, while improving supply efficiency, will result in the concentration of high-quality educational resources in economically developed regions characterized by open policies and a high rate of technological advancement. This will exacerbate the disparity, causing strong institutions to become more robust while weaker ones

deteriorate further. This inequitable circumstance is expected to lead to a substantial depletion of higher education resources in economically disadvantaged and resource-scarce areas, including the central and western regions of China. This circumstance impedes higher education's capacity to effectively fulfil its function by advancing social fairness and facilitating regional economic development. Consequently, the allocation of higher education resources via financial plans seeks to implement a holistic planning process from a macro perspective, guaranteeing an equitable and efficient distribution of these resources across diverse locations. The financial investment in higher education directly indicates the policy trends in national resource allocation for higher education. The central government has consistently prioritized the advancement of higher education in the central and western regions, issuing policies such as the "Central and Western Higher Education Revitalization Plan (2012–2020)" and "Several Opinions on Revitalizing Higher Education in Central and Western China in the New Era". These policies emphasize the necessity of enhancing financial support for institutions in these areas and encourage the alignment of higher education initiatives with regional development strategies like "One Belt, One Road" and "One Road". These policies mandate the enhancement of financial support for universities in central and western China and advocate for higher education to proactively engage with the "Belt and Road" initiative and other regional development strategies, thereby establishing a higher education construction system aligned with the strategic framework of central and western China. Consequently, the Ministry of Finance, the Ministry of Education and other agencies have released the "Notice on Reforming and Improving the Budgetary Allocation System of the Central Universities" and the "Notice on Issuing Measures for Supporting the Reform and Development Funds of Local Universities", among others. These documents explicitly mandate that financial allocations for higher education should favour the central and western regions with regard to basic expenditures, project expenditures and the per capita student allocation coefficient, thereby facilitating the reform of local higher education and enhancing support for local development. The financial investment in higher education substantially affects the equitable allocation of educational resources

among various locations. Consequently, it is rational, practical and imperative to explore methods for optimizing this resource distribution.

The literature has predominantly concentrated on three facets of the equilibrium in China's higher education financial expenditures: firstly, assessing the current status of interregional financial distribution; secondly, contrasting domestic and international methodologies for allocating higher education financial resources; and thirdly, analyzing China's strategies for enhancing the regional allocation of higher education resources. Nevertheless, there is insufficient robust research on the developmental trend of the disparity in expenditure on higher education among regions and the actual amounts disbursed and no singular methodology exists for its measurement. The measurement approach is too subjective, rendering the research findings of limited utility for policymakers seeking equitable distribution of higher education funding across areas.

Resource allocation in the context of management of state financial resources in higher education in the United States

Currently, higher education in the United States has achieved a level of adequate institutional coordination, organization and balanced advancement. This steady condition is intrinsically connected to the distribution of resources within the core of the relationship. Examine the resource allocation practices in higher education in the United States, as they may offer significant insights for China's own resource allocation in higher education, especially with relationship coordination and the management of beneficial experiences.

The United States is a federal nation characterized by a decentralized political and financial structure, in which both federal and state governments possess distinct responsibilities. The federal government is primarily responsible for overseeing significant macro accounts related to national development, while state and municipal governments primarily handle local matters.

The national system has shaped a resource allocation model in U.S. higher education that is characterized by institutional autonomy, decentralization and national involvement. Higher education in the United States is primarily funded by government

appropriations, tuition money, endowment income and other social service income, with government appropriations being the principal funding source for public universities. Data from the National Centre for Education Statistics indicates that in 1999 government appropriations constituted 62% of overall funding for higher education in the United States, with contributions from federal, state and municipal governments being the most substantial. Subsequently, in post-1999 period the level of U.S. government financial support for colleges and universities progressively diminished. As of 2015, government support constituted merely 38.14% of the financial resources for U.S. public colleges and universities, with a market-driven cost compensation system increasingly prevailing in the allocation of higher education resources in the United States.

Marketization is the primary method by which the United States governs most economic and social issues. In higher education, the government undertakes greater responsibilities in indirect regulation and macro-decision-making, providing financial assistance through student financial aid, research money and institutional funding.

There is a prevailing agreement in American society that higher education is financed through market-based mechanisms. While higher education is typically considered a quasi-public good, it is indisputable that individual students get significant personal advantages from access to it, enabling them to ascend in their careers. Consequently, students in the United States are anticipated to shoulder the predominant financial burden of higher education, particularly due to the progressive reduction in government funding in recent years, the rapid escalation of tuition fees in U.S. higher education, the statistic indicating that over half of U.S. college students are in debt and the reality that U.S. higher education ranks among the costliest globally.

Nonetheless, the market-driven distribution of higher education resources does not imply the total exclusion of government involvement. The government has consistently regulated the allocation of higher education resources among various groups and regions through legislative assurances, funding distributions and scholarship programs to ensure equity in higher education. Additionally, the United States has employed educational performance budget reporting across multiple

continents, distributing funds to colleges and universities based on their performance metrics.

The current distribution of resources for higher education in the United States reflects a dynamic interplay among governmental pressures, market influences and academic institutions (Figure 1.12).
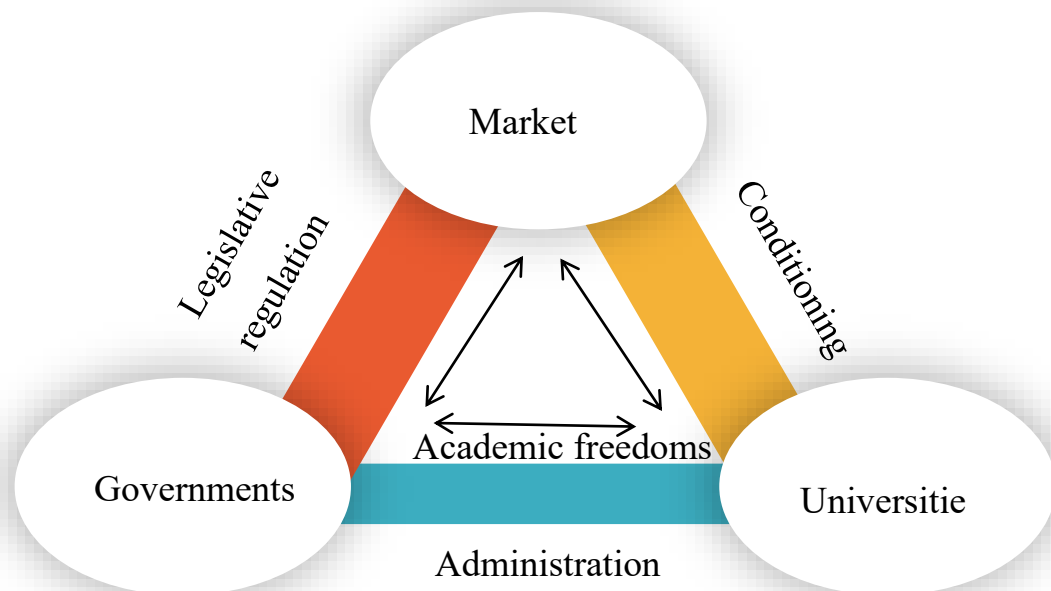
Figure 1.12 − The Balance of Government, Markets, and Colleges and Universities in the Allocation of Resources to U.S. Higher Education

Source: Compiled by the author

In this equitable arrangement, the government primarily wields the authority to legislate and oversee higher education. The federal government impacts higher education in the United States via law and funding, whereas local governments oversee higher education administratively through entities such as the Council on Higher Education. These departments devise local higher education funding allocation policies, oversee the progress of colleges and universities within the state and regulate the interaction between the government and these institutions. The government's involvement in the distribution of higher education resources largely seeks to improve educational quality at institutions through macro-regulation and oversight without engaging in specific operational issues with schools. In terms of academic freedom

and university autonomy, educational institutions are independent. This is because the academic autonomy of colleges and universities and the administrative authority of the government cannot exist together. This gives these institutions a lot of freedom in how they run their businesses.

The market is essential in the distribution of higher education resources, and institutions of higher learning possess significant autonomy. Colleges and universities in the United States will be governed by the limitations of the consumer market for higher education and the labour market regarding operational scale, curriculum design and the establishment of educational objectives; concurrently, the advancement of higher education has heightened awareness of its contribution to economic development, prompting increased market investment in this sector.

The United States' higher education funding system, driven by market principles and involving collaboration between the government and institutions, has established a multifaceted finance framework for higher education. Simultaneously, it has provided colleges and universities with various educational objectives and roles, facilitating their advancement to a level where resource allocation is more sufficient and distribution is more equitable.

Resource allocation in the context of management of state financial resources in higher education in the United Kingdom

In contrast to the mature market-oriented resource allocation system for higher education in the United States, the government assumes a more significant role in resource distribution for higher education in the United Kingdom. However, in recent years, the United Kingdom has also commenced the exploration of market-based reforms in resource allocation for higher education. Integrating its pertinent reform history can offer valuable insights for enhancing the allocation mechanism of higher education resources in China.

The advancement of higher education in the United Kingdom commenced earlier; nevertheless, it was only from the 19th century that the government progressively engaged in the distribution of resources for higher education. Since that time, financial allocations have consistently held a more significant role in the distribution of

resources for higher education in the United Kingdom, allowing students to access higher education at no cost for an extended duration.

The market-oriented reform of higher education in the United Kingdom commenced in the 1980s. During this period, the UK underwent a phase of economic inflation and swift expansion of higher education institutions. Amidst this pressure, the UK government commenced a steady reduction in financing for higher education and began contemplating reforms to the resource allocation system. Margaret Thatcher's adoption of various social reform initiatives resulted in a 15% reduction in financial financing for higher education in the United Kingdom from 1981 to 1984 [203]. The subsequent evolution of higher education in the United Kingdom during the 1990s specifically advocated for a decrease in public funding for higher education institutions. Subsequently, the UK government has enacted and released the White Paper "Higher Education: Meeting the New Challenges" and the Further and Higher Education Act, which explicitly convey the intention to promote self-financing among higher education institutions through several avenues. In the early 1990s, the implementation of the Student Finance Loan system and the termination of the living expenses funding growth adjustment compelled higher education institutions to explore more market-oriented fundraising strategies while simultaneously enhancing the efficiency of financial resource utilisation. In 1998, the time of free access to higher education for students came to an end, and colleges began charging national students £1,000 per year in tuition fees; the maximum tuition fee ceiling has climbed fast throughout the 21st century, reaching a maximum charge of £9,250/year in 2016. Due to escalating fiscal demands on the UK government and the rapid implementation of market-oriented changes in higher education resource allocation, a growing portion of higher education expenditures has been transferred to the private sector.

The financial distribution of British colleges and universities is executed via intermediary institutions, which have undergone significant transformations in their role in the allocation of higher education resources. In the early 20th century, the British financial sector established a University Grants Committee (UGC). Colleges and universities present a financial plan to the committee every five years. Every five

years, the committee presents a financial plan to the government for the distribution of higher education financing, following a comprehensive evaluation and formulation of a rational financial resource allocation strategy. In 1987, due to reductions in higher education financing, the University Grants Committee was restructured as the University Financing Council (UFC). In 1992, it was renamed the Higher Education Funding Council (HEFC) along with other committees. Consequently, the UK government incorporated performance appraisal criteria into the funding framework for higher education and established the Quality Assurance Agency for Higher Education (QAA), tasked with the comprehensive assessment and oversight of higher education quality in the UK, emphasising educational standards and the availability of teaching resources. In 2018, the UK Office of Research & Innovation (UKRI) and the Office for Students (OFS) were reinstated to oversee the distribution of research money for higher education and to regulate the provision of financial resources to higher education, respectively.

Currently, the British Government not only directs the distribution of higher education resources through financial allocations but also promotes universities to independently generate funds via multiple avenues, including student tuition fees, philanthropic contributions and revenue from external research collaborations, facilitated by legal guidance and economic regulation. The government-directed, market-oriented higher education resource allocation system in the United Kingdom is progressively undergoing enhancement.

After years of reform and development, the distribution of higher education resources in the United Kingdom has started to shift towards a marketization tendency. Nonetheless, the cornerstone of this allocation continues to be the government's fiscal provisions. The current allocation system of higher education resources in the United Kingdom is essentially characterised by the following aspects:

Initially, the diversification of fundraising channels. Unlike prior financial distributions, revenue from higher education tuition fees in the United Kingdom has consistently risen in recent years. This expansion has coincided with a rise in private contributions and alternative funding sources, chiefly through government grants and

private financing. Government funding mostly consists of educational money, research grants and additional financial resources, whereas private funding sources include tuition revenue, philanthropic contributions and revenues from collaborative research efforts. Figure 1.13 illustrates the composition of its higher education funding sources.

The government distributes a segment of educational funding according to performance evaluations, student and faculty counts and the scale of higher education institutions, among other criteria. Organisations like the Higher Education Funds Council distribute research funds according to the research calibre and requirements of higher education institutions. They evaluate the research teams and the status of the tertiary institutions prior to distributing cash via direct grants or research project submissions. Non-conventional funding, excluded from education and research financing, including project grants, higher education development funds and temporary funding. One source of private funding for higher education is revenue from external cooperative research, which is primarily derived from the provision of research services by higher education institutions to social entities, organizations and enterprises or from the execution of research projects.
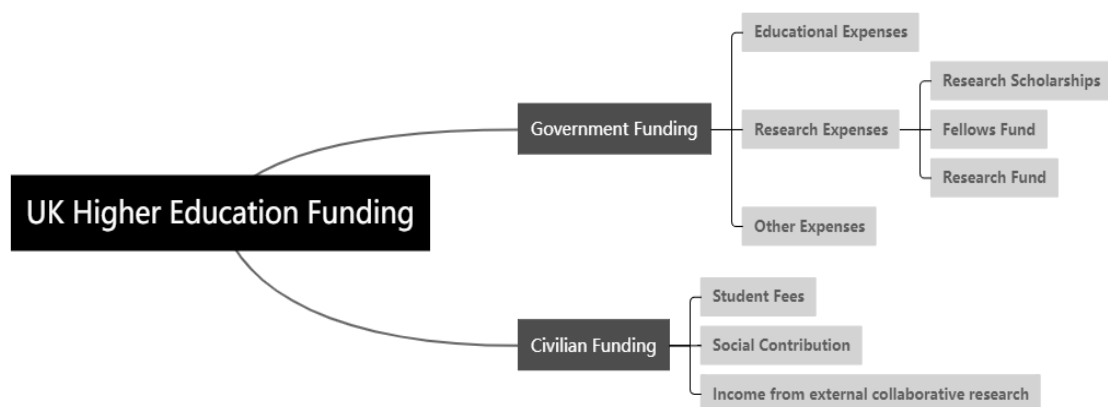

Figure 1.13 − Structure of sources of funding for higher education in the UK
Source: Compiled by the author

Multichannel fundraising not only alleviates the state's financial obligations but also correctly represents the dynamics of higher education cost burdens, facilitating a more equitable and judicious distribution of higher education resources.

Secondly, the educational quality is exceptionally effective. To enhance the efficacy of government funding for higher education, the British Government has recently implemented a performance evaluation system for the distribution of financial resources in this sector. The Quality Assurance Agency for Higher Education (QAA) establishes and assesses the quality of colleges and universities according to its quality and assessment criteria. It also assesses and evaluates the quality of the institutions, especially the calibre of their scientific research. The evaluation results provide the foundational reference for the subsequent phase of the financing committee's decision-making process. This strategy will not only systematically allocate and optimize financial resources but also necessitate that universities focus on the quality of their teaching and research, ensuring that the highest performers excel and the lowest performers falter, thus attaining a standardized high-quality education.

Thirdly, I seek to promote the conversion of research findings. Due to the decrease in budgetary allocations for higher education in the United Kingdom, an increasing number of British universities are investigating the possibility of securing educational finance through external collaboration. Colleges and universities can collaborate with enterprises to execute scientific and technological projects, thereby securing research funding and management costs. Simultaneously, they can offer knowledge services to society, generating economic benefits through the dissemination of research findings, personnel training services, or the sale of enhanced equipment or technology shares. In pursuing funding through external collaboration, universities facilitate the integration of "industry, academia and research" while advancing the societal application of research outcomes.

The government has consistently played a proactive role in directing and controlling the distribution of higher education resources in the United Kingdom. The government has established non-governmental public welfare organisations to oversee the distribution of financial resources for higher education, effectively exercising its

macro-regulatory function in resource allocation and directing market funds to advance the growth of higher education. These experiences and methods provide significant insights for the reform of resource allocation marketing in higher education in the United Kingdom.

Resource allocation in the context of management of state financial resources in higher education in Japan

Both internationally and within Asia, Japan maintains a superior standard of higher education, with its universities and the calibre of its scientific research ranking among the highest. Analyzing the current condition of resource allocation in Japan's higher education system can allow to extract valuable lessons from its successful practices to promote the advancement of higher education. This will benefit Japan and China as they massify higher education.

The government predominantly finances national and public universities, whereas the School Education Law explicitly delineates the designated financial sources for each type of higher education institution. Japan has developed a comprehensive, multi-tiered and diverse framework for higher education.

The national government predominantly finances national universities, which constitute around one-fifth of all higher education institutions in Japan. During the 20th century's education reform, the Japanese government implemented a policy of "one university for each prefecture" to optimize the distribution of higher education and promote equitable regional development, thereby establishing uniform national universities across the nation. Japan's national universities not only excel in certain academic domains but also collaborate closely with localities to foster regional development. The central government primarily provides the substantial financial support that national universities require, administering it through a specialised accounting system for national institutions integrated into the national budget. The government exerts substantial and authoritative control over the distribution of resources for this facet of higher education.

Approximately 5% of Japanese higher education institutions are public universities, funded mostly by local governments and administered via the local self-

government accounting framework. The responsibility of local governments to finance public universities within their regions results in differences in resources among these institutions, reflecting varying degrees of economic development and contributing to uneven progress. Consequently, the government has instituted a framework of state financial subsidies and a municipal tax payment system to furnish financial support to public schools. The national treasury directly subsidizes local government finances through the national financial subsidy system, which fosters the advancement of local higher education. Simultaneously, the local tax payment system designates a fraction of local taxes to finance public universities. The government plays a crucial role in equilibrating the advancement of higher education among regions, irrespective of the type of support.

A significant number of private universities in Japan have substantially contributed to the advancement of higher education. The school corporations predominantly finance these universities via tuition fees, monies generated by their representatives, endowment income, operational revenue and national financial subsidies, with tuition fees constituting the most substantial financing source. Financial subsidies predominantly assist teaching initiatives, research institutions and apparatus at private universities. The government provides funding to private universities via long-term, low-interest loans and tax benefits.

Japan's framework for allocating higher education resources includes a specialised accounting system for state-funded national institutions, a public university funding model that receives support from local governments and national financial subsidies, as well as a private university funding structure that receives financial assistance. Table 1.2 illustrates the precise condition of its higher education resource allocation system. The government directs the allocation of higher education resources through appropriations, effectively implementing the national higher education development strategy within this varied structure.

Table 1.2 − Status of the Resource Allocation System for Higher Education in Japan

Type of school	Main body of funding	Sources of funding	Mode of appropriation
National university	Central Finance	State financial allocations for educational programmes, infrastructure and scientific research	Special accounting system for State schools
Public university	Local finance	Local financial burden, with support from the national treasury	Accounting system for local self-governments, system of State financial assistance and system of local tax payments
Private university	School Legal Entity	Tuition fees, funds raised by legal representatives, endowment income, school operating income and State financial assistance	Grants for education services and research facilities and equipment

Source: Compiled by the author

The advancement of higher education in Japan emphasizes governmental oversight, market regulation and the establishment of a more comprehensive framework for the allocation of higher educational resources. The following aspects demonstrate the significant relevance of Japan's higher education financial resource allocation in enhancing the distribution of financial resources in China's higher education.

We must strategically position the allocation of financial resources. Despite the lower share of national and public universities in Japan's higher education system compared to private institutions, the government can nevertheless influence the allocation of higher education resources through its investments and power. Since the 1990s, Japan has prioritized internationalization in higher education development, designating 30 research universities around the country to receive focused financial assistance to enhance their research capabilities to a superior international standard. They obtain specialized financial support to improve their research circumstances and attain superior international status. A crucial aspect of internationalization, liberalization and diversity in higher education in Japan is the strategic deployment of financial resources and the emphasis on finance's guiding role in its advancement.

Secondly, it constitutes an exemplary educational assessment system. Over the years of reform and development, Japan has developed a relatively complete system for monitoring the quality of higher education, with the government, schools, third-party organizations, society and many other parties jointly supervising this system. The government regulates and administers the functions of colleges and universities by creating competitive project funds and distributing resources according to the results of their quality evaluations. Japanese colleges and universities prioritize self-assessment of teaching and learning quality by establishing dedicated evaluation organizations on campus that routinely generate assessment results encompassing various dimensions, including instructional content, equipment and facilities and the campus environment. The Ministry of Education, Culture, Sports, Science and Technology has accredited evaluation agencies that can assess the operational quality of colleges and universities; the effective system of third-party evaluation agencies has promoted the internationalization of Japanese higher education.

Thirdly, the creation of a competition mechanism is appropriate. Japan's higher education system exhibits significant marketization through the implementation of competitive mechanisms that effectively mobilize private funding and robustly sustain private universities. Conversely, Japan categorizes its higher education budget expenditures as quantitative and skewed allocations. The quantitative allocations provide essential expenditures for basic education, while the skewed allocations channel higher education resources to the most effective sectors, enhancing the quality of higher education amid competition. In contrast, Japan categorizes its financial investment in higher education into two types: rationed funding and subsidized money.

Despite Japan's more marketable resource allocation for higher education compared to China, its effective quality assessment mechanisms and prudent government guidance are nevertheless commendable and worthy of emulation.

Following the synthesis of the comparative analysis, the author provides Table 1.3, which delineates their criteria for evaluating the patterns of resource allocation to higher education in China, the United States, the United Kingdom and Japan.

Table 1.3 − Comparative Analysis of Higher Education Resource Allocation Models in China, the United States, the United Kingdom and Japan

Criteria for Comparison	China	United States	United Kingdom	Japan
Government Role	Strong central planning with regional balance efforts	Decentralized with significant state and local government roles	Central government funding with increasing market influence	Central and local government support with a special accounting system for national universities
Market Influence	Growing, with some tuition fees and social contributions	High, with significant reliance on tuition and private funding	Increasing, with tuition fees and market-based mechanisms	Moderate, with government subsidies and private initiatives
University Autonomy	Limited, with government control over key decisions	High, with institutions having significant decision-making power	Moderate, with some autonomy within government frameworks	Relatively high, especially in private universities
Tuition and Fees	Controlled and relatively low, with some exceptions	High, with significant variation between institutions	Moderate to high, with a trend towards increasing fees	Generally high, reflecting the cost of private education
Public Funding	Dominant, with a focus on balancing regional development	Significant, but decreasing as market mechanisms increase	Still primary, but with efforts to increase efficiency and performance	Substantial, especially for national and public universities
Private Sector Involvement	Limited, but growing through partnerships and donations	Extensive, with a significant role in resource allocation	Increasing, with encouragement for alternative funding sources	Considerable, particularly in private universities
Access and Equity	Efforts to balance access across regions and social groups	Mixed, with concerns about accessibility due to high costs	Striving for equity through various funding mechanisms	Generally high, with a focus on equal opportunity
Quality Assurance	Government-led assessments and standards	Diverse, with a mix of internal and external evaluations	Government and independent bodies regulate quality	Comprehensive, with a focus on international standards
Research and Development	Supported by government, with a push for innovation	Market and government-funded, with a strong emphasis on innovation	Government and industry partnerships for research	Robust, with significant government and private sector support
Internationalisation	Government-driven efforts to increase global engagement	High, with a global outlook and significant international students	Increasing, with a focus on attracting international talent	Strategic, with a goal to internationalise higher education

Source: Compiled by the author

The Chinese model is defined by robust governmental planning and an emphasis on equitable regional development. The market's influence is increasing; nonetheless, the government continues to maintain a predominant role in financing and ensuring quality.

The U.S. model is characterized by a market-driven approach, substantial academic autonomy and considerable private sector participation. Within a varied and competitive higher education environment, research and development receive significant attention.

The UK model has been evolving toward increased market-oriented changes while preserving substantial governmental involvement in financing. The emphasis is on performance and quality assurance to guarantee efficient resource allocation.

Japan's model harmonizes governmental financing with market dynamics, especially in private colleges. A comprehensive system for monitoring and evaluating higher education standards accompanies a robust focus on quality assurance and internationalisation.

Conclusion of the chapter 1

1. Theoretical Foundations and Global Comparisons: Chapter 1 presents a theoretical framework for comprehending management of state financial resources in higher education, with particular emphasis on regional equality, efficiency and the sufficiency of financial resources. It stresses the relevance of financial resource allocation in higher education as a strategy to relieve gaps in resource availability and support holistic sector progress. This chapter does a comparative analysis of China's methodology alongside those of international peers, including the United States, the United Kingdom and Japan, highlighting unique methods of resource allocation and their effects on regional equilibrium and educational quality.

2. Global Trends in Higher Education Resource Allocation: The chapter highlights a notable rise in academic focus on higher education resource allocation in recent decades, underscoring the increasing significance of this matter amid swift

economic advancement and the shift into the information technology age. The examination of global trends indicates a transition towards a more strategic and equal distribution of resources, acknowledging the crucial importance of higher education in national development and scientific advancement.

3. China's Advancements and Obstacles in Resource Allocation: Although commencing later than other countries, China's initiatives to equilibrate the allocation of higher education resources are consistent with the nation's core policy goals. The chapter highlights the progressive rise in scholarly writing regarding resource allocation in higher education in China, signifying an increasing emphasis on the significance of financial resources in the sector. Nonetheless, it recognises the ongoing difficulties in attaining an equitable allocation of resources and the considerable inequalities among regions.

4. The chapter examines the interaction between governmental and market pressures in the distribution of higher education resources, emphasising the necessity for a balanced strategy that utilises the advantages of both sectors. It emphasises the historical shift from limited government involvement to increased governmental engagement in reaction to economic crises and the developing comprehension of the synergistic functions of government and market.

5. Equity and Efficiency in Resource distribution: A primary focus of the chapter is the equilibrium between equity and efficiency in the distribution of resources within higher education. It contends that equity is an essential prerequisite for equitable resource distribution, but efficiency constitutes a sufficient foundation for that equilibrium. The chapter argues that comprehending the nuances and interconnections between equality and efficiency is essential for a deeper knowledge of the underlying mechanisms and limitations of balanced allocation.

6. Public Value and Educational Adequacy: The chapter introduces the concept of educational adequacy as a higher-stage version of equity, combining both equity and efficiency to ensure the achievement of educational goals. The text examines the government's responsibility in actualising the public value of education via fiscal

investments, highlighting the necessity to fulfil public expectations while maintaining appropriate and efficient expenditures.

7. Fiscal Decentralisation and Its Impact: This chapter examines the theory of fiscal decentralisation and its effects on the distribution of higher education resources, specifically within the framework of China's distinctive fiscal architecture. It underscores the dynamic interaction between central and local governments in resource distribution and the impact of decentralisation on regional inequalities in higher education financing.

8. International Experiences and Lessons: This chapter conducts a comparative examination of higher education resource allocation models in China, the United States, the United Kingdom and Japan, extracting insights for the optimisation of resource distribution. It delineates the merits and shortcomings of each model, encompassing the robust central planning in China, the market-oriented strategy in the United States, the performance-based funding in the United Kingdom and the harmonious integration of governmental and market forces in Japan.

9. Strategic Recommendations for China: This chapter conclude with strategic recommendations for China to rectify the imbalances in the allocation of higher education resources. It recommends that China maintain its emphasis on the progression of higher education, concentrating on quality improvement and regional balance while drawing insights from global practices to optimise its fiscal policies and resource distribution plans.

10. The path forward: The chapter underscores the necessity for ongoing research and policy formulation to guarantee that the distribution of higher education resources in China is equitable, efficient and congruent with the nation's socio-economic goals. A nuanced strategy is required that considers the intricate interaction of government policy, market dynamics and educational requirements in the quest for equitable regional development and national advancement.

The primary findings of this chapter were published by the author in the following works: [237-240].

CHAPTER 2: REGIONAL DIFFERENCES, CONVERGENCE AND EFFICIENCY IN THE ALLOCATION OF FINANCIAL RESOURCES FOR HIGHER EDUCATION IN CHINA: FINDINGS FOR THE MANAGEMENT OF STATE FINANCIAL RESOURCES IN HIGHER EDUCATION

2.1 A consideration of the regional differences and convergence in the allocation of state financial resources in higher education management in China

A primary objective for attaining a balanced distribution of educational resources is equity. The current study about the equity of educational resources predominantly encompasses metrics like as variance, standard deviation, coefficient of variation, Tel index and Gini coefficient. The Gini coefficient is the most prevalent and direct indicator, facilitating uncomplicated assessment. Furthermore, by examining the disparity in financial resource allocation across regions, specifically the convergence of financial expenditures, one can intuitively and comprehensively grasp the trend of equitable distribution of financial resources for higher education in China. This chapter will examine the geographical disparities and convergence of financial expenditures in higher education in China, utilising the Gini coefficient and convergence research methodology.

Trends in the equalisation of financial expenditure on higher education: the theory of economic convergence. Neoclassical economics underpins the theory of economic convergence. This theory examines the factors that contribute to economic development, leading to convergent growth when the marginal production of capital declines. Convergence, originally a mathematical concept, refers to a function or sequence that approaches a specific value infinitely closely. In economics, it serves to depict varying levels of economic development, highlighting the initially low economic indicators of underdeveloped regions. I expect these regions to experience higher growth rates compared to more developed areas, which will gradually reduce economic disparities until they converge towards a common value. This trend can manifest as unidirectional, bidirectional or as a catching-up phenomenon. The

examination of development economics has consistently emphasized reducing the economic disparity between regions with differing levels of economic advancement, generally termed "economic convergence". The following equation articulates the concept of economic convergence more intuitively:

$$\lim_{t \to \infty} \frac{y_p(t)}{y_r(t)} = 1 \tag{2.1}$$

where y. is the per capita output of regions with higher levels of economic development and y. is the per capita output of regions with lower levels of economic development.

The equation has three basic assumptions behind it, making it economically meaningful:

(1) $y_r(0) > y_p(0) \geq 0$ and there is always $y_r(t) > y_p(t)$ for $t < \infty$. That is, regions with low levels of economic development also have low per capita output and are always in a state of catching up with regions with high levels of economic development.

(2) $y_r > 0$. The economic growth rate of a region with a high level of economic development is positive and is not due to convergence caused by its growth rate changing from positive to negative.

(3) Considering that it is impossible to obtain data for an infinite time span, $t \to \infty$ here only represents a longer economic period and the actual measurement usually obtains economic growth data for a longer period of time.

In the 20th century, economists extensively researched economic convergence, noting that initially poorer regions exhibit lower per capita output levels compared to wealthier regions and are consistently in a state of catch-up. When economic convergence occurs, the per capita output growth rate in poorer areas surpasses that of wealthier areas. The concept of economic convergence is applicable to the economic development relationships between different countries and can also be utilised to analyse economic development disparities within regions of a single country. The notion of economic convergence pertains to the correlation between the economic

development of various countries and the economic development of distinct regions within a country [139].

In 1928, Ramsey [140] discovered that the growth rate of per capita income across various regions was inversely correlated with the level of per capita income. He posited that in a closed economy with uniform preferences, economically disadvantaged regions would experience a more rapid growth rate, facilitating convergence with economically advanced regions. The logical reasoning in economics can be elucidated by Solow's neoclassical economic growth model. Solow's economic growth model posits that the growth rate of capital per capita is inversely related to the initial capital stock per capita, attributable to diminishing marginal returns. Regions with low capital stock experience minimal depreciation and a high natural rate of return, prompting a capital influx to these areas. This dynamic results in an increase in per capita output and reduces the economic disparity between impoverished and developed regions [141]. The conclusion regarding economic convergence is not limited to any specific economic attribute, thereby representing a form of absolute convergence. Conditional convergence occurs when it is acknowledged that the economy will approach a distinct steady state if parameters change between countries, such as variations in steady-state capital per capita due to disparities in the savings rate.

Kaldor delineated six characteristic facts regarding economic growth in relation to convergence: (1) the long-term growth rate of per capita output remains fundamentally stable; (2) the growth rate of capital aligns closely with the growth rate of output; (3) the level of per capita capital experiences a relatively stable growth rate over the long term; (4) the rate of return on capital remains consistently stable in the long run; (5) the ratio of labour remuneration to material compensation for labour and material capital as a fraction of national income has exhibited broad stability; (6) there is a significant disparity in the per capita output growth rates among various countries. Neoclassical economics validated these observations, leading to the conclusion of economic convergence between impoverished and affluent places [142]. Subsequently, Kuznets analysed the growth trajectories of multiple economies from the mid-19th

century to the mid-20th century and discovered substantial disparities in per capita output growth rates among countries. He noted that due to the varying levels of economic development at the onset of this period, even when the per capita output growth rates of impoverished and affluent nations were identical, their per capita output levels diverged, resulting in an exacerbation of the gap [143]. There is no economic convergence within the specified period. However, this does not imply that economic convergence is an unattainable illusion. In his book "200 Years Review of the World Economy", Maddison provides detailed and precise statistics on the economic development trends of the 19th and 20th centuries. Although the global economy has not exhibited overall economic convergence, there have been distinct instances of regional economic convergence within specific temporal and spatial contexts, notably between 1950 and 1990, where per capita output in Western Europe, Southern Europe and the United States demonstrated a clear upward trajectory [144]. Between 1950 and 1990, the disparity between Western and Southern Europe and the United States significantly diminished; concurrently, the economies of the Asian region exhibited a robust trend of convergence with the United States, as the per capita output ratio declined from 11:1 in 1950 to 4:1 in 1992.

The phenomenon of economic convergence also exists within the country. Barro measured the economic convergence of each region in the United States during the period of 1880–1990 and in Japan during the period of 1930–1990 and found that there was a tendency toward absolute convergence. Some scholars in China have also analysed the economic convergence of the eastern, central and western regions and found that there is a local convergence [85].

Therefore, the existence of economic convergence is conditional rather than unconditional. The famous Wagner's Law in the field of fiscal research reflects the close relationship between a country's scale and structure of fiscal expenditure and its level of economic development. Numerous scholars have confirmed that a country's fiscal expenditure follows the same development trend as its economic growth [146-148]. Higher education financial expenditure falls under the category of public financial expenditure and its development law exhibits a similar trend to the law of

regional economic growth. Additionally, there is a phenomenon of economic convergence, which is more prevalent under specific conditions of convergence.

Convergence logic of financial expenditure on higher education. Convergence of higher education financial expenditure, on the one hand, is based on the close relationship between financial expenditure and the level of economic development, with the convergence of economic growth brought about by the convergence of higher education financial expenditure; on the other hand, higher education financial expenditure is also a public system. There have been a number of empirical studies that proved the relationship between the system and the economic development and economic convergence will be accompanied by the system convergence of the effect meaning at the same time.

Economic development often leads to changes in institutions, resulting in an accompanying trend of institutional convergence. Kaufmann and Kraay [149] made a system of indicators to measure a country's institutional effectiveness. These indicators included civil liberties, political stability, government effectiveness, regulatory quality, rule of law levels and corruption control. They then plotted the relationship between these indicators of institutional effectiveness and GDP per capita for 195 countries from 1996 to 2000. They found out that higher economic levels tend to correspond to higher levels of institutional convergence. By constructing a system of indicators to measure a country's institutional effectiveness, including civil liberties, political stability, government effectiveness, regulatory quality, rule of law and corruption control, I plotted the relationship between institutional effectiveness indicators and GDP per capita for 195 countries between 1996 and 2000 and obtained the result that higher economic levels tend to correspond to higher levels of institutional effectiveness, thus arguing that there is economic convergence along with institutional convergence. There is also factual evidence of institutional convergence. As for today's increasingly globalised economy, Coase et al. [150] highlight that national divisions are increasingly focusing on differences in institutional arrangements and that variations in economic growth across countries also stem from these differences. Maddison's statistics also show that Western European countries

with similar institutional structures have better economic convergence with their derivative countries. An important aspect of promoting economic development is to attract foreign investment. In order to create a better environment for foreign investment, developing countries will improve their own investment environment through the optimisation of the system, which in turn accelerates the convergence of the system while achieving a higher rate of economic growth. Higher education financial expenditure as the government supply of higher education products in the form of monetary expression, reflecting a country's attention to higher education and the development of strength, is the financial institutional arrangements for higher education. There is a tendency for interregional fiscal expenditure on higher education to converge, both from the perspective of economic development and from the perspective of institutional convergence.

Reducing the inter-regional higher education resource input gap is one of the requirements for the balanced allocation of inter-regional higher education financial resources. The previous description of the inter-regional higher education financial resource input gap usually focuses on the use of cross-sectional data, while the economic convergence coincidentally provides a way of description from the time trend to study the development gap between the country or the region. It also shows whether the gap is narrowed and how. The higher education financial expenditure of the convergence makes it clearer whether there is a trend of convergence between regions in China and whether the balanced allocation of financial resources has improved.

Classification of economic convergence. Current research has delineated five principal forms of convergence: σ-convergence, β-convergence, club-convergence, γ-convergence and time-series convergence, with the first three being more prevalent in economic studies.

σ-convergence is the gradual decrease in the gap between economies over time. Since the standard deviation can indicate the magnitude of dispersion of a set of data, an economy is considered to be σ-convergent if its standard deviation generally decreases over time, i.e., roughly $\sigma_{i+1} < 0$. Measures of σ-convergence generally

include the standard deviation, the coefficient of variation, the Gini coefficient and the Terrell index.

Beta convergence can be categorised as absolute beta convergence and conditional beta convergence. Absolute β-convergence is a more rigorous concept, positing that all economies sharing identical fundamental characteristics, such as population growth rate, savings rate and rate of technological advancement, can converge to the same steady-state equilibrium irrespective of their initial conditions. Furthermore, it asserts that economies further from the steady state will experience accelerated growth, while those nearer will exhibit slower growth rates. The growth trajectory and rate of absolute β-convergence are solely contingent upon its beginning economic status. The fundamental factors such as population growth rate, savings rate and technological progress rate vary among economies. Conditional β-convergence posits that these differing factors influence the growth trajectories of each economy, leading them to converge towards distinct steady states.

Club convergence arises from the concept of conditional β-convergence, wherein economies sharing identical initial conditions and analogous structural traits would see their economic growth converge towards respective steady states over the long term [151]. There is internal convergence inside both the economically disadvantaged group and the economically advanced group; nevertheless, there is neither convergence nor divergence between the two, which can be encapsulated as "convergence within the group, no convergence between the groups" [152].

The primary techniques for assessing β-convergence and club convergence include model regression, geographic econometrics, income distribution analysis, time series analysis and Markov chain approaches, with model regression and spatial econometrics currently being employed more frequently. American economists Barro and Xavier initially proposed the calculation equation for economic convergence and validated both absolute β-convergence and conditional β-convergence among individuals in the region. However, the cross-sectional data they employed exhibited issues such as biased estimation, prompting subsequent scholars to utilise panel data for convergence studies, yielding valid results [145]. This paper will utilise the

economic convergence model proposed by Bernard and Jones [153] to analyse the convergence trend of financial expenditures in China's higher education.

Trends in research on interregional allocation of financial resources for higher education. As mentioned earlier, financial expenditure is an important source of higher education resource input in China, and the research on higher education financial resource allocation and financial system is also one of the main contents of higher education resource allocation. In order to further understand the research direction of domestic higher education financial resource allocation, this dissertation will first use the keyword co-occurrence analysis method to collate and analyse the relevant literature search results on CNKI.net. Keywords are the most central and intuitive summary of a piece of literature. The keyword co-occurrence analysis is carried out through the statistics of the vocabulary pairs or noun phrases in a piece of literature between two common occurrences. The analysis of the literature in the subject matter of the words interrelated to each other, allows to arrive at the entry point of the relevant research. In this dissertation, the keyword co-occurrence analysis is carried out on the literature in the past ten years searched in the Knowledge Network with the keyword "allocation of financial resources for higher education" and the results are shown in Figs. 2.1:
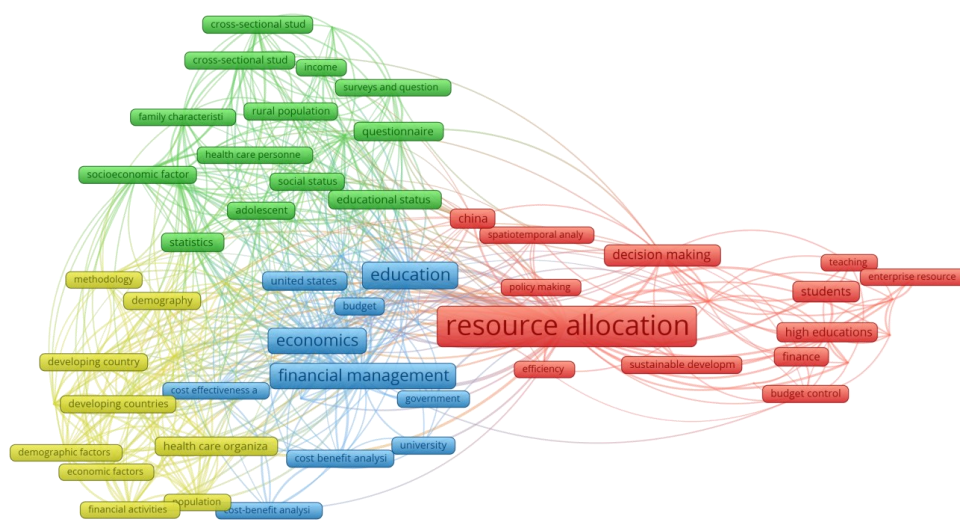

Figure 2.1 − Network diagram of co-occurrence analysis of keywords in studies related to financial resource allocation in higher education in China

Source: Compiled by the author based on the results of a search on the CNKI

The two words connected by a line in the picture signify their co-occurrence in the same literary work, and the greater is the circumference of the surrounding nodes around the keyword, the higher is the word's frequency in the literature. The aforementioned data illustrates that pertinent research about the allocation of financial resources for higher education in China mostly concentrates on balanced development, financial expenditure, financial input and financial decentralisation.

The balanced development of political resource allocation is the research theme of this dissertation; higher education financial expenditure is the starting point; and fiscal decentralization is the theoretical basis for guaranteeing the fairness and efficiency of higher education financial allocation. In the related research on higher education financial expenditure, some scholars have begun to focus on convergence and sufficiency, and this dissertation will also base its investigations on these findings.

Interregional differences in financial resource allocation for higher education and convergence the report of the 18th CPC National Congress points out that it is necessary to "vigorously promote fairness in education and gradually narrow the gap between schools, urban and rural areas, and regions". At the same time, it stresses the need to "vigorously promote fairness in education and rationalise the allocation of educational resources". Promoting the solution to the problem of excessive disparity in financial expenditure on higher education between regions is an important measure to promote equity in higher education and the balanced allocation of its financial resources [77]. Gu Xueliang [78] summarised the state of balanced allocation of higher education resources among regions as the balance of the four aspects of higher education scale, efficiency, quality and structure, as well as the balance among subjects. Chang Wenlei [79] further emphasized that interregional higher education balance manifests not only in the macro aspect of scale balance, but also in the micro aspect of major and discipline balance. Whether it's the balance of higher education in the macro or micro aspects, reducing the gap between inter-regional financial expenditure on higher education is necessary to promote its realisation [80].

However, numerous scholars' research indicates that the current allocation of financial resources for higher education in China remains unbalanced, with a notable

trend of a higher proportion of expenditures in the east and less in the west [10, 71, 81].

By examining the current state of the development gap in higher education financial expenditures across regions in China, I can identify and analyse the factors that impede the equitable distribution of these resources, and subsequently offer suggestions and opinions aimed at narrowing this gap and achieving a more balanced allocation of resources. When researching the regional gap in the allocation of financial resources for higher education, domestic scholars typically utilize inequality indexes like the Gini coefficient, the Terrell index and other methods to examine the inter- and intra-regional imbalances between the East, Central and West regions. Using the Gini coefficient, Zhu Meijuan [82] analysed the allocation of higher education resources in China's provinces and found that the imbalance in the overall investment of education resources between provinces in China is increasing year by year. Zhang Wei [83] found that China's financial investment in higher education was "high in the east, low in the west and collapsing in the middle", and the interprovincial Gini coefficient was always hovering around 0.4, which indicated that the interprovincial higher education funding imbalance was obvious.

Yang Wen and Wang Haimin [84] used the Theil index to explore the distribution of three-level education financial resources in China's eastern, central and western regions, and found that the degree of difference in higher education financial resources in the eastern region is much higher than that in the central and western regions. They also found out that differences within the region contribute more to the overall differences than differences between regions, which indicates that while paying attention to the balanced distribution of higher education resources between provinces, it is equally necessary to pay attention to the balanced distribution of higher education resources within neighbouring regions.

Qu Wenjian [6] employed the principle of game theory to investigate a balanced resource allocation method that balances the interests of both subjects and objects in the allocation of higher education resources, with a focus on equity and efficiency. The study's findings indicate that while the allocation of higher education resources

in Beijing and Shanghai is relatively efficient, the allocation efficiency in Tibet, Inner Mongolia, Gansu and Xinjiang is relatively ineffective. Therefore, the government, as the key player in this process, should uphold the principles of science and reasonableness, optimize the local industrial structure conditions and natural resource advantages in each place and enhance fair competition and incentive and constraint mechanisms. Dai Shengli [8] and his team employed principal component analysis to examine the allocation of higher education resources in nine provinces and two cities along the Yangtze River. They discovered significant regional variations in the capacity to allocate these resources and the clustering effect of these resources has exacerbated the disparity in higher education resources in the region. They suggest enhancing the collaboration among higher education institutions in the region to establish a sustainable mechanism of synergistic development.

Liu Yuanyuan [13] employed the Gini coefficient method and the entropy power method to investigate the distribution of educational resources among China's centrally directly affiliated institutions. The findings indicate that the central and western regions continue to face disadvantages in terms of the number of centrally affiliated institutions and the resources they receive. Furthermore, the differences in geographic areas and physical capitals significantly contribute to the uneven distribution of educational resources. Similarly, Gao Jianlin [9] explored the balanced allocation of higher education resources from the perspective of ecological balance. His study points out that China's higher education has developed rapidly during the past 20 years, but the scale and resource allocation of higher education among provinces are very uneven and the gap between developed and poor regions is on the trend of expanding. Therefore, colleges and universities in each region should find their own "ecological position" and implement the ecological allocation of higher education resources, which is the premise and foundation for guaranteeing equity in higher education.

However, both the inequity index methods, such as the Gini coefficient and Terrell index, and the measurement methods of financial resource allocation in higher education, such as principal component analysis, are limited to using cross-sectional

data for point-in-time analysis. They are unable to clarify the continuous reduction of the gap in financial expenditure in higher education and the trend of balanced financial resource allocation in China. Scholars have gradually begun to favour the use of the concept of economic convergence to describe the trend of the inter-regional financial expenditure gap in higher education.

The American economists Barro and Xavier first discovered and proposed economic convergence, an important component of neoclassical growth theory, which holds that a country's real per capita income converges to the steady-state equilibrium value of economic growth. [85] Barro and Xavier introduced the concepts of σ-convergence and β-convergence, i.e., the reduction of the income gap and the "catching up" of poorer regions to richer ones over time. Thereafter, Mankiw et al. [86] further proposed absolute and conditional convergence.

Nowadays, as research on theories related to economic convergence continues to deepen, the theory has not only been limited to explaining the trend of economic growth but has been widely applied to other fields of socio-economics, such as economics and finance. Huo Ke and Ding Wei [87] conducted a study on the relationship between transfer payment systems and regional economic convergence, concluding that these systems have no effect on regional economic convergence. Wang Xiaoping [88] studied the convergence of local fiscal revenues in China and found that there is σ-convergence, absolute β-convergence and conditional β-convergence in inter-regional fiscal revenues. Chen Guozhu and Wang Chengyong [89] explored the regional differences and convergence of the tourism economy in Sichuan and found that the tourism economy in Sichuan is σ-convergent in general but there is a trend of local σ-divergence in the eastern part of Sichuan.

In the field of education and human capital, Smith and Sab [90] selected indicators such as enrolment rates and teacher-student ratios at various education stages in multiple countries as the object of study. They used the three-stage least squares method to investigate the convergence of human capital in education and concluded that there is conditional convergence. Stamatkis and Petrakis [91] assessed the convergence of enrolment rates in OECD countries and found that intra-country

human capital is σ convergent. Stamatkis and Petrakis [91] assessed the convergence of human capital within countries and found that there is convergence within countries, but not cross-country convergence. Afzal [92] examined the convergence of regional education and welfare in Pakistan and concluded that there has been significant beta convergence in literacy rates over the last fifty years, along with an increase in gender parity in enrolment and in the level of accommodation.

Gu [93] analyzed the convergence of China's local vocational education development and explored the role of neighbourhood structure in this process. The use of convergence analysis in the field of education is gradually increasing, and scholars in China have already launched relevant studies. Fan Jida [94] explored the convergence of the gap between urban and rural compulsory education in China using compulsory education funding and teacher strength as indicators and provided suggestions for the rational division of the government's compulsory education authority and the improvement of the transfer payment system. Li Kai and Luo Dan [95] also studied the convergence of compulsory education in China and found out that per capita education expenditure, regional per capita GDP and per capita education resources are important factors affecting the convergence of compulsory education and that there is no club convergence in compulsory education in the east, middle and the west.

For higher education research, Xia Yan and Cui Yuping [96] explored the economic convergence and spatial dependence of per capita higher education funding in China using panel data on per capita higher education utility expenditures in 31 provinces and cities during the decade 2001-2010. They pointed out that there is no a-convergence trend in Chinese higher education spending, and that there is a significant absolute β-convergence in higher education spending in the western region. Their study also shows that economic growth has a stable promotion effect on the convergence of regional higher education expenditure, therefore, the level of economic development and the scale of higher education in the central and western regions should be increased appropriately. Tang, Yipeng & Zhou, Lei [10] explores the impact of central-local relations and economic development on the equilibrium of

higher education from the perspective of economic convergence, using panel data on higher education financial expenditures in each province from 2006 to 2016. The study's results indicate a trend of absolute convergence in China's higher education budgetary funding, with a significant conditional convergence observed after accounting for central financial expenditure, per capita GDP and per capita disposable income. This suggests that central financial expenditure and economic development significantly influence the equilibrium of higher education. The research by Zhou Yuanxiang et al. [97] was the first to use spatial measurement theory in a convergence study of basic education financial investment. It also looked into why China's basic education financial investment hasn't grown evenly across regions.

Generally, the main methods used to study the imbalance in the allocation of higher education resources in the existing literature include the Gini coefficient method, the Terrell index method, the comparative analysis method, the principal component analysis method and the game theory. Research on the convergence of higher education is limited, primarily focusing on the convergence of interregional higher education budgetary funding, while the research on the convergence of intra-regional higher education resources is relatively weak. An in-depth study of provincial and regional differences in higher education financial funding and its convergence can aid in understanding the challenges in the development process of higher education and the robustness of the trend's characteristics. This, in turn, can guide policy recommendations aimed at promoting the balanced development of higher education.

Research methodology. The Gini coefficient and its decomposition. The Gini coefficient is commonly employed to assess income distribution inequality among the inhabitants of a country or region, so quantifying the disparity between the affluent and the impoverished and illustrating the equity of social resource allocation. Currently, the Gini coefficient is extensively employed as a metric for assessing inequality across diverse domains, including consumption, health resources and water resources, with an increasing number of scholars utilising it to evaluate educational inequality.

The Gini coefficient, established by Italian economist Gini, was first conceived as an abstract measure to quantify the dispersion of values of a random variable, independent of numerical units. The most straightforward and often utilised measure of the Gini coefficient is derived from the Lorenz curve. The Lorenz curve, developed by the renowned statistician Lorenz, represents the distribution of a population across varying income levels, arranged from lowest to highest. Each segment of the cumulative population percentage is aligned with the corresponding income percentage, resulting in a continuous curve connecting these points. Economics serves to intuitively assess the extent of wealth inequality. This is seen in Figure 2.2.
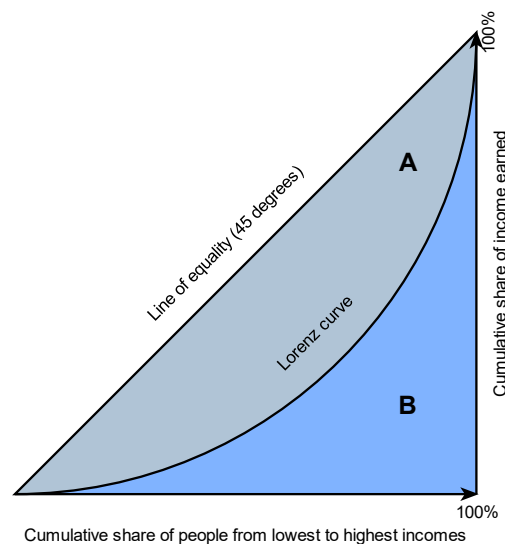
Figure 2.2 − Lorentz Curve Diagram

Source: compiled by author

It is clearer and more intuitive to judge the size of the Gini coefficient using this curve. The area between the absolute equality curve and the Lorentz curve is A, and the area to the lower right of the Lorentz curve is B. The ratio of the areas calculated by A/(A+B) is the size of the Gini coefficient, which ranges from 0 to 1. The smaller the Gini coefficient is, the smaller is the disparity in the distribution of income in the region, and vice versa, the larger is the disparity in the distribution of income in the region.

More scholars have studied the specific calculation method of the Gini coefficient. Chen Xiru [182] proposed point estimation and interval estimation of the Gini coefficient, a calculation method that is free from the restriction of data grouping. However, this method is unable to depict the size of the error. Most scholars have used grouped data to estimate the Gini coefficient between urban and rural areas or between regions in China, such as Wang Zuxiang [183] and Chen Changbing [184]. Duan Jinghui and Chen Jianbao [185] used the distribution function method to calculate the Gini coefficient by estimating the probability density function of the indicator and combining it with the Lorenz curve. Many scholars, including Mookherjee and Shorrocks [186], Lambert and Aronson [187], Dagum [188] and Hong Xingjian [189], have decomposed the Gini coefficient and measured the degree of inequality within and between groups of different decomposed objects, as well as their contribution to the overall inequality. Dagum's proposed Gini coefficient decomposition method integrates the issues from previous Gini coefficient measurement and decomposition methods, calculates intra-group, inter-group and cross terms, and has found widespread application in measuring regional economic disparity, regional food safety risk disparity and regional agricultural level disparity, among other areas [190]. The method not only analyzes the degree of inequality by region, but also considers the issue of overlapping sample distributions when dividing subgroups, making it more suitable for exploring the inequality situation between regions.

This dissertation will assess the disparity in the allocation of financial resources for higher education among 31 provinces (municipalities) in China. The author aims to compute the Gini coefficient by utilising the financial expenditures on higher education in each province (municipality), based on the variables identified in prior work for assessing financial resources in higher education. Simultaneously, Dagum's Gini coefficient measurement and decomposition method is employed to assess the disparity in the distribution of higher education financial resources across regions in China, categorised into four subregions: eastern, central, western and north-eastern. The Gini coefficient is computed for both the overall and subregional levels. The formula for the overall Gini coefficient (G) is given below:

$$G = \frac{1}{2N^2\overline{Y}_1} \sum_{j=1}^{k} \sum_{h=1}^{k} \sum_{s=1}^{n_j} \sum_{s=1}^{n_h} |y_{jit} - y_{hrt}| \tag{2.2}$$

In this formula, G is the overall Gini coefficient value to be calculated, i.e. the Gini coefficient of China's higher education financial expenditure; N(n) represents the number of economies or the number of units of the measurement object, N is the total number, and n is the number in the region, i.e. N is the total number of general higher education students in the whole country, and n represents the number of students in general higher education in the region; j(h) is the different subgroups of the division, i.e. the east, the centre, the west or the northeast region; k is the number of sample regions. As this dissertation points out four regions, so the number of regions is 4; i(r) is the number of students in the sample region; Y(y) is the amount of per capita higher education financial expenditure, i.e., Y is the national average per capita higher education financial expenditure, and y is the average per capita higher education financial expenditure in the sub-region. Thus, y_{jit} (y_{hrt}) denotes the amount of per-student higher education financial expenditure in region j(h) at time t, n_j (n_h) denotes the number of provinces (municipalities) within region j(h), and $\overline{Y}_t$ is the average value of per-student higher education financial expenditure in the whole country, which is calculated as follows:

$$\overline{Y}_i = \frac{1}{N} \sum_{i=1}^{k} \sum_{i=1}^{n_j} y_{jit} \tag{2.3}$$

The formula for the Gini coefficient is calculated separately for each region on a two-by-two basis, exhausting all possibilities of "inequality". Dagum's decomposition of the Gini coefficient further decomposes the overall Gini coefficient (G) into three components: within-group disparities (G_w), net contribution of between-group disparities (G_{nb}), and the contribution of hypervariable density between groups (G_t). The hyper-variance density contribution is a measure of the contribution of the cross terms between subgroups to the effect of the overall Gini coefficient, which arises from the decomposition of the overall Gini coefficient.

Mookherjee and Shorrocks [186] have argued that the cross terms are embarrassing variables that are not amenable to precise interpretation, but the studies of Shorrocks [191] and Silber [192] have shown that the cross terms are not amenable to precise interpretation. The cross terms have practical economic significance, describing the degree of class clustering in the income arrangement of individuals in a group. When intergroup crossover is absent, the contribution of the hyper-variance density has a value of 0. Thus it then follows that $G = G_w + G_{nb} + G_t$.

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

$$G_w = \sum_{j=1}^{k} G_{jj} \, p_j s_j \qquad (2.4)$$

where G_{jj} denotes the Gini coefficient within region j, calculated as follows:

$$G_{jj} = \frac{\frac{1}{2\overline{y_j}} \sum_{i=1}^{n_j} \sum_{r=1}^{n_j} |y_{ji} - y_{jr}|}{n_j^2} \qquad (2.5)$$

where p_j is the share of students in region j, i.e. the number of students in general higher education in region j as a proportion of the number of students in general higher education in the country, $p_j = n_j / N$ and $\sum p_j = 1$; s_j is the share of financial expenditure on higher education in region j, $s_j = p_j \overline{y}_j \overline{Y}$ and $\sum s_j = 1$.

$$D_{jh} = \frac{d_{jh} - p_{jh}}{d_{jh} + p_{jh}} \qquad (2.6)$$

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

$$G_{nb} = \sum_{j=2}^{k} \sum_{h=1}^{j-1} G_{jh} \left(p_j s_h + p_h s_j \right) D_{jh} \qquad (2.7)$$

$$G_{nb} = \sum_{j=2}^{k} \sum_{h=1}^{j-1} G_{jh} \left(p_j s_h + p_h s_j \right) \left(1 - D_{jh} \right) \qquad (2.8)$$

where G is the inter-regional Gini coefficient for j-h, calculated as follows:

$$G_{jh} = \frac{\sum_{i=1}^{n_j} \sum_{r=1}^{n_h} |y_{ji} - y_{hr}|}{n_j n_h (\overline{y_j} + \overline{y_h})} \tag{2.9}$$

where D_{jh} is the relative impact of fiscal spending on higher education between regions j-h; d_{jh} represents the difference in fiscal spending on higher education between regions j-h, i.e., the summed weighted average of all y_{ji} - y_{hr} > 0 in both regions. d_{jh} and d_{jh} are defined by the following equations, respectively:

$$d_{jh} = \int_0^\infty d F_j(y) \int_0^y (y - x) \, dF_h(x) \tag{2.10}$$

where F_j (F_h) is the cumulative density distribution function for region j(h); p_{jh} is the hypervariable first-order distance, expressed as the mathematical expectation of the sum of all y_{ji} -y_{hr} >0 for both regions j-h, calculated as follows:

$$p_{jh} = \int_0^\infty d F_h(y) \int_0^y (y - x) \, dF_j(x) \tag{2.11}$$

According to the theory of convergence described in the previous section, it can be seen that there are three convergence assumptions in classical economics: σ-convergence, β-convergence and club convergence, while club convergence is the convergence among some individuals with the same or similar underlying characteristics, which is actually a special kind of β-convergence. σ-convergence is mainly measured by the standard deviation, the coefficient of variation, the Gini coefficient and the Terrell index, whereas this dissertation mainly focuses on the standard deviation and the coefficient of variation being analysed.

Beta convergence is measured by choosing a model based on the ideas of Bernard and Jones [153], and absolute beta convergence is modelled as follows:

$$(\ln y_{iT} - \ln y_{i0})/T = \alpha + \beta \ln y_{i0} + \varepsilon \tag{2.12}$$

In the above equation, y_{iT} and y_{i0} denote the data values of the ith cell in the reporting period and the initial period, respectively, which in this dissertation is the per capita higher education general public budget funding in the ith province (city). T

denotes the time span, α and β are the parameters to be estimated, and ε is the stochastic error term. Based on the relationship between β and 0, I can determine whether there is absolute β convergence for the observation, and there is absolute β convergence when β<0. In addition, the speed of convergence λ and the time of convergence t can be calculated from the estimated value of β as follows:

$$\beta = -\left(1 - e^{-\lambda T}\right)/T \tag{2.13}$$

$$\tau = \ln(2)/\lambda \tag{2.14}$$

The test model for absolute β-convergence is actually a regression of cross-sectional data, and its regression results are highly sensitive to the time horizon T [193]. Short-term fluctuations or singular values within a specific time period may impact it. Therefore, this dissertation conducts a validation in estimating the absolute β-convergence by region and time period, and the results will be shown in the findings below.

To find out China's conditional β convergence status, Xia Yan and Cui Yuping [96] looked at China's higher education resources across provinces in 2014 and used cross-section data on per capita higher education utility funding from 2001 to 2010. They also looked at the level of economic development, the level of higher education development in each province, and the level of government financial efforts as explanatory variables. They used the standard OLS and ML regression methods. However, the cross-sectional data volume is small, the estimation accuracy is not high, and the regression results do not accurately reflect the long-term convergence trend of higher education funding. Instead, they only represent the growth trend from 2001 to 2010. At the same time, the use of this method can only get whether there is a trend of conditional β convergence in the data within this period of time. In addition to the three explanatory variables used, there are also problems such as the possibility that there may be other omitted variables that have an impact on the convergence of higher education funding.

Therefore, this dissertation selects the panel data of per capita higher education general public budget funding from 2007 to 2018 to study the conditional β-convergence, which extends the data scope and basis of the study. In terms of research methodology, this dissertation employs the panel data two-way fixed effects model, previously used by Miller and Upadhyay [194] in their study of the conditional convergence of full factors of production, to estimate the conditional convergence of general public budget funding for higher education. The two-way fixed effects estimation method not only controls for time and cross-section effects, but also considers the fact that different individuals have different steady state values, i.e., different provinces have different convergence tendencies, leading to a more accurate estimation of convergence. In addition, the two-way fixed effects model is able to avoid the endogeneity problem arising from omitted variables. The specific regression model is formulated as follows:

$$\ln(y_{it}/y_{i,t-1}) = \alpha + \beta \ln y_{i,t-1} + \varepsilon_{it} \tag{2.15}$$

The formulae for convergence time and convergence rate are as follows:

$$\beta = -\left(1 - e^{-\lambda T}\right) \tag{2.16}$$

$$\tau = \ln(2)/\lambda \tag{2.17}$$

Data sources and sample analysis. This part primarily analyses China's provincial (municipal) higher education financial expenditures, denoted as exp in billions of yuan, and the per capita higher education general public budget funding, indicated as Di in ten thousand yuan, to investigate the Gini coefficient and the convergence of financial resource allocation for higher education. The data for this study is sourced from the official website of the Ministry of Education and the China Education Statistical Yearbook from prior years. Table 2.1 presents the particulars.

Table 2.1 − Data Descriptive Statistics

exp	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Mean	34.65	44.04	49.71	60.86	89.41	116.07	112.14	118.66	136.76	145.07	169.9	180.61
Standard deviation	30.31	35.62	40.73	46.73	58.58	69.78	70.12	78.74	86.94	91.91	112.21	120.94
Maximum value	123.92	142.78	174.67	202.82	259.1	281.57	285.25	353.97	370.25	386.11	514.69	587.01
Minimum value	2.91	3.76	3.58	4.92	7.97	8.4	8.36	7.09	11.29	11.7	14.69	18.25
D_i	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Mean	0.62	0.75	0.79	0.96	1.4	1.65	1.56	1.56	1.83	1.87	2.16	2.26
Standard deviation	0.38	0.43	0.5	0.59	0.8	0.73	0.75	0.87	0.96	0.86	1.09	1.12
Maximum value	2.14	2.44	2.98	3.45	4.41	4.76	4.76	5.85	6.13	5.57	6.66	6.33
Minimum value	0.29	0.37	0.42	0.43	0.76	1.1	1.01	1.11	1.11	1.22	1.37	1.46

Source: compiled by author

The data presented in the table indicates that financial expenditure on higher education and per capita general public budget funding for higher education in each province (city) have significantly increased from 2007 to 2018. Although the absolute value disparity between the maximum and minimum has widened, the relative gap has shown a degree of contraction. The subsequent results of the study will further evaluate the unique regional disparities and convergence of financial resources in higher education.

This dissertation will assess the Gini coefficient and its decomposition, σ-convergence, absolute β-convergence and conditional β-convergence of financial expenditures in higher education across China and its sub-regions, aiming to investigate the disparities, convergence trends, and potential convergence pathways for financial expenditures in China's higher education sector.

Analysis of regional disparities in financial expenditure on higher education. The disparate distribution of higher education resources across regions necessitates a clear illustration of the variations in financial resource allocation over the past decade. To achieve this, the spatial distribution of higher education financial expenditures

across China's 31 provinces (municipalities) for the years 2007 and 2018 was depicted using ARCGIS software, as illustrated in Figures 2.3 and 2.4, respectively.

Figure 2.3 − Spatial Distribution of Financial Expenditure on Higher Education in China, 2007

Source: compiled by author

From Figures 2.2 and 2.3, it can be clearly seen that the spatial distribution of China's higher education financial expenditures showed similar aggregation regions in 2007 and 2017, with a significant overall east-high and west-low trend. The eastern coastal region maintains a high total financial expenditure on higher education, especially in Guangdong Province, Beijing Municipality, Shandong Province and Jiangsu Province; while the western region consistently exhibits a low value of aggregation (Inner Mongolia Autonomous Region (IMAR), Ningxia Hui Autonomous Region (NAR), Gansu Province (GSP), Xinjiang Uygur Autonomous Region (XUAR), Tibet Autonomous Region (TAR) and Hainan Province (HNP)). The north-eastern region is also a "depression" in higher education financial expenditures, and the financial expenditures on higher education in Heilongjiang and Liaoning provinces declined by one level from 2007 to 2017, suggesting that the gap between the north-eastern region and the rest of the country has widened further. Sichuan Province,

Yunnan Province, Guizhou Province, Chongqing Municipality, Jiangxi Province and Anhui Province have all risen in rank, indicating that the gap between the financial expenditure on higher education in these regions and other regions has a tendency to narrow, reflecting that the national policy support for higher education in the central and western regions has begun to bear fruit. It is worth noting that I can also see that China's financial expenditure on higher education is clearly distributed around the "Hu Huanyong line".
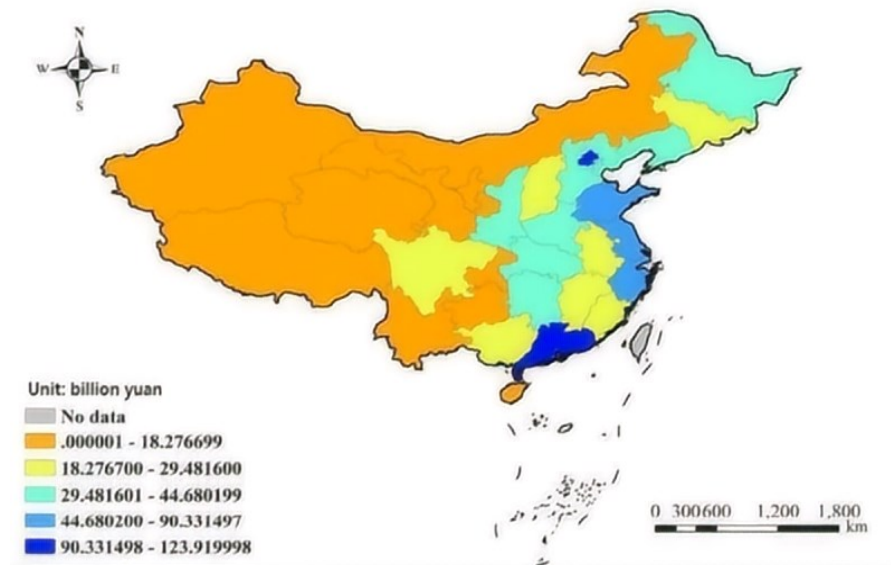

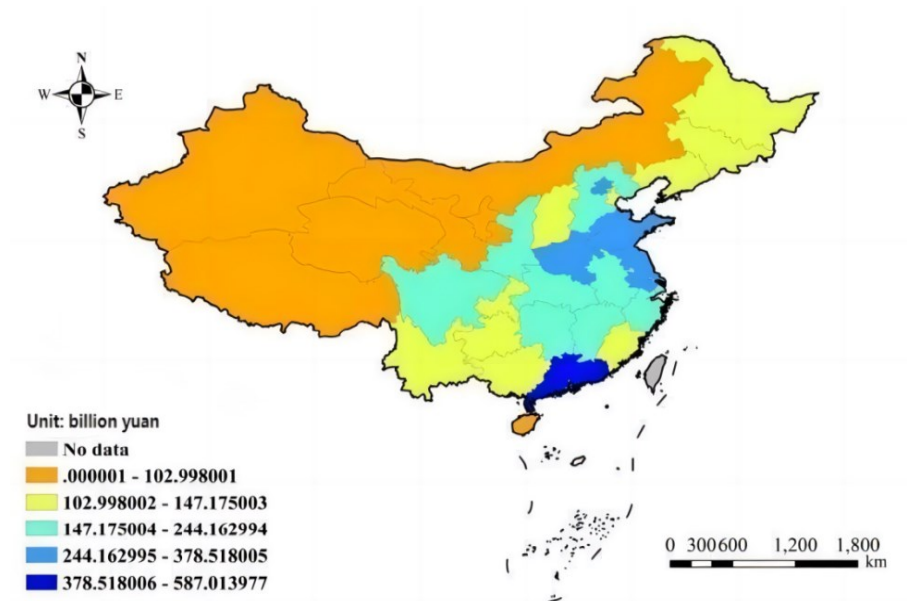Figure 2.4 – Spatial Distribution of Financial Expenditure on Higher Education in China, 2018

Source: compiled by author

This dissertation employs Dagum's Gini coefficient and its decomposition method to estimate the Gini coefficient of China's higher education financial expenditures from 2007 to 2018, categorised by regions: east, central, west and northeast, with results presented in Table 2.2.

Table 2.2 – Regional Gini coefficients and their decompositions 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

Note: Data from the Ministry of Education's official website on education statistics, Statistics on the Implementation of Education Expenditure over the Years, and China Education Statistical Yearbook

The results in the table are characterised by the following points:

(1) In the timeframe examined in this dissertation, i.e., the 12-year period from 2007–2018, the level of the Gini coefficient of higher education financial expenditures nationwide has shown a fluctuating and decreasing trend, and although there was a small increase after it fell to the lowest level of 0.1838 in 2014, the overall decreasing trend is more obvious, from 0.2721 to 0.2183. China's higher education sector spans nearly twelve years. Figure 2.5 provides a more intuitive view of the status and overall trend of the financial expenditure gap. This indicates a gradual narrowing of the overall financial expenditure gap on higher education in China, highlighting the need for

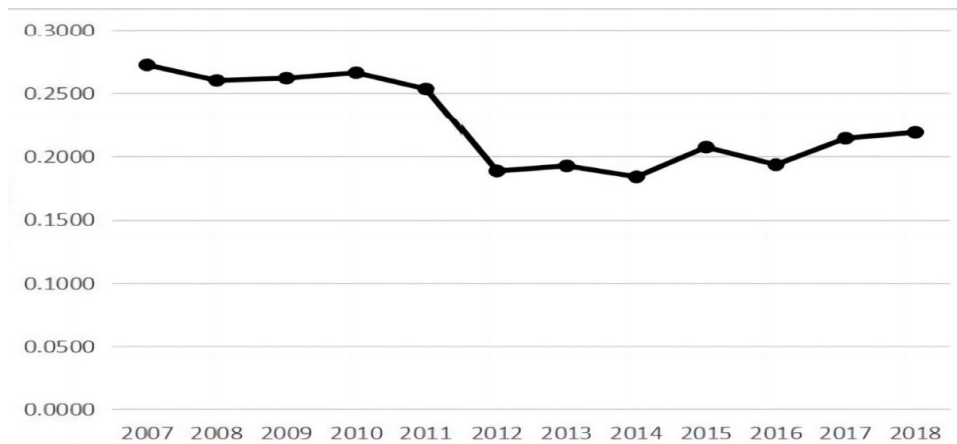further effective measures to promote a balanced allocation of financial resources for higher education.

Figure 2.5 – Evolutionary trend of regional disparities in financial expenditure on higher education in China as a whole

Source: compiled by author

(2) When I delineate the eastern, central, western and north-eastern regions, the intra-regional disparities in financial expenditures for higher education clearly show that the eastern region has the most pronounced disparities among provinces (cities). The Gini coefficients have consistently surpassed 0.2 over the twelve-year study period, peaking at 0.3212 in 2011, signifying a markedly uneven distribution of higher education financial expenditures within the eastern region. The allocation of financial resources for higher education in the eastern region is markedly uneven. Nonetheless, the eastern region exhibits the most pronounced decline in the intra-regional Gini coefficient among the four regions, as illustrated in Figures 2.6.

The western region exhibits a significant disparity in higher education financial expenditures among its provinces (municipalities), with the intra-regional gap initially decreasing before subsequently increasing. The Gini coefficient reached its nadir in 2014 at merely 0.1096; however, this year marked a turning point, as the intra-regional Gini coefficient in the western region began to ascend thereafter. The Gini coefficient increased, reaching 0.2080 in 2018, up from 0.1873 in 2007. In comparison to the eastern and western regions, the intra-regional disparity in higher education financial

expenditure in the central and north-eastern regions is markedly smaller. The Gini coefficient in the central region consistently remained below 0.1 across all years, whereas the north-eastern region exhibited a fluctuating upward trend in its intra-regional gap in higher education financial expenditure. This signifies a notable reduction in financial expenditure on higher education in the north-eastern region, necessitating our attention and worry.

Figure 2.6 – Evolutionary trends of regional disparities in financial expenditures on higher education within each region of the country

Source: compiled by author

(3) According to the inter-regional Gini coefficient situation, the eastern region, compared to the other three higher education regions, exhibits a significantly larger financial expenditure gap. This discrepancy can be attributed to the eastern region's higher level of economic development, the concentration of higher education institutions, and other factors. These findings align with existing literature, indicating that China's financial resources for higher education are more evident in the uneven allocation of the situation. However, it's important to note that the largest disparity in financial expenditure on higher education occurs not between the eastern and western regions, but rather between the eastern and central regions. In this dissertation's 12-year study, the Gini coefficient between the eastern and central regions consistently exceeds the gap between other regions. In 2012, the Gini coefficient between the two

regions reached a value of 0.2202, which was higher than that of the eastern and western regions. Moreover, the Gini coefficient consistently exceeds the value of 0.2 in each year. And the Gini coefficient has always remained above 0.2 in all years. Figures 2.7 illustrate the trend of change.

The gap between the western region and both the central and north-eastern regions is slightly larger than that between the central and north-eastern regions, which may be mainly due to the fact that the financial policy support given by the state to colleges and universities in the west is stronger compared to the other two regions. Thus, the number of colleges and universities directly under the Ministry of Education (12) in the western region is more than that in the central region (10) and in the north-eastern region (5), respectively, and the number of college and university students in the western region is also smaller, so the western region has relatively more resources in higher education than the central and north-eastern regions. The western region receives comparatively more resources for higher education than the central and north-eastern regions. In addition, the trend of the Gini coefficient shows that the financial expenditures on higher education in the western and central regions have narrowed, while the gap between the western and north-eastern regions has a tendency to widen in a non-significant way.
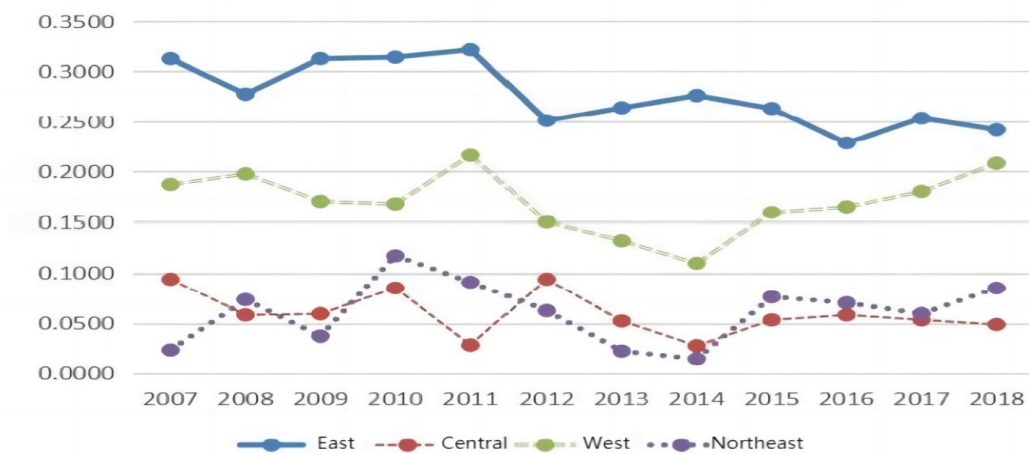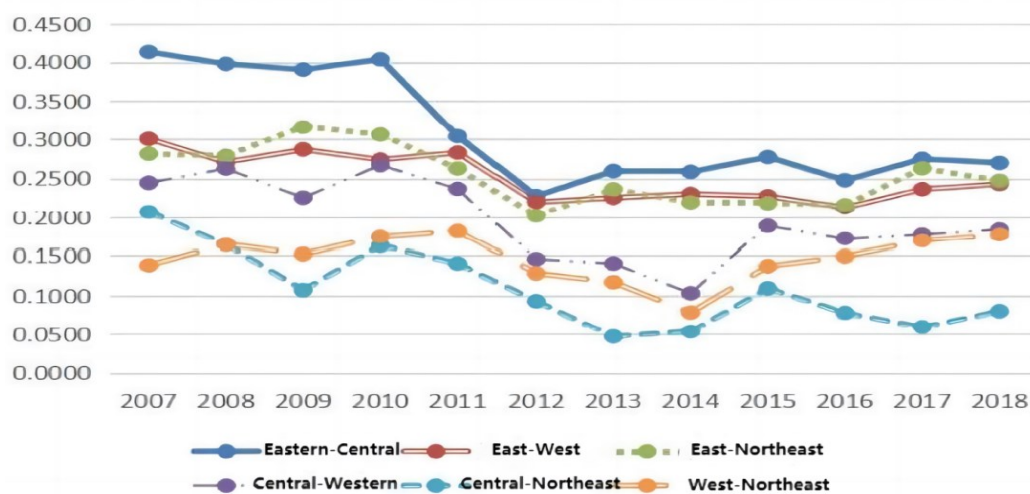

Figure 2.7 – Evolutionary trends in the gap in financial expenditure on higher education between the regions of the country

Source: compiled by author

The smallest gap among regions is between the central and north-eastern regions, with the Gini coefficient less than 0.2 and the smallest among other regions in all years except 2007, when it was higher than that between the western and north-eastern regions. At the same time, the fastest reduction in the gap between regions was also between the central and north-eastern regions, with the Gini coefficient falling from 0.2073 in 2007 to 0.0802 in 2018, a reduction of nearly 62 per cent.

(4) When considering the contribution of various disparities to the overall Gini coefficient of China's higher education financial expenditures, interregional disparities have consistently been the most significant, often surpassing 40%. However, in recent years, this contribution rate has decreased, dropping from 48.6% in 2007 to 38.06% in 2018. The hypervariable density contribution rate follows, showing a direction of change opposite to the interregional contribution rate. It has been gradually increasing, reaching 34.66% in 2018, suggesting a growing seriousness in the cross-over of higher education financial expenditures between regions. Finally, there is the contribution rate of intra-regional disparity, which has not changed much during the study period and has always remained within the range of 27%–31%.

In short, China's inter-regional financial expenditure on higher education still has some gaps. As for the east, central, west and northeast of China, the inter-regional gap is dominated by the gap between the eastern region and the other regions, which is relatively large. To achieve the balanced development of inter-regional allocation of financial resources for higher education, we still need further efforts.

Convergence results for σ. This dissertation examines the σ-convergence of China's higher education financial expenditures, mainly in the form of standard deviation and coefficient of variation, to explore the horizontal trend of higher education financial expenditures over time. I select the data from the average general public budget expenditure on higher education in each province of China, which I derived from the China Education Statistical Yearbook of previous years. Figures 2.8 display the calculation results.
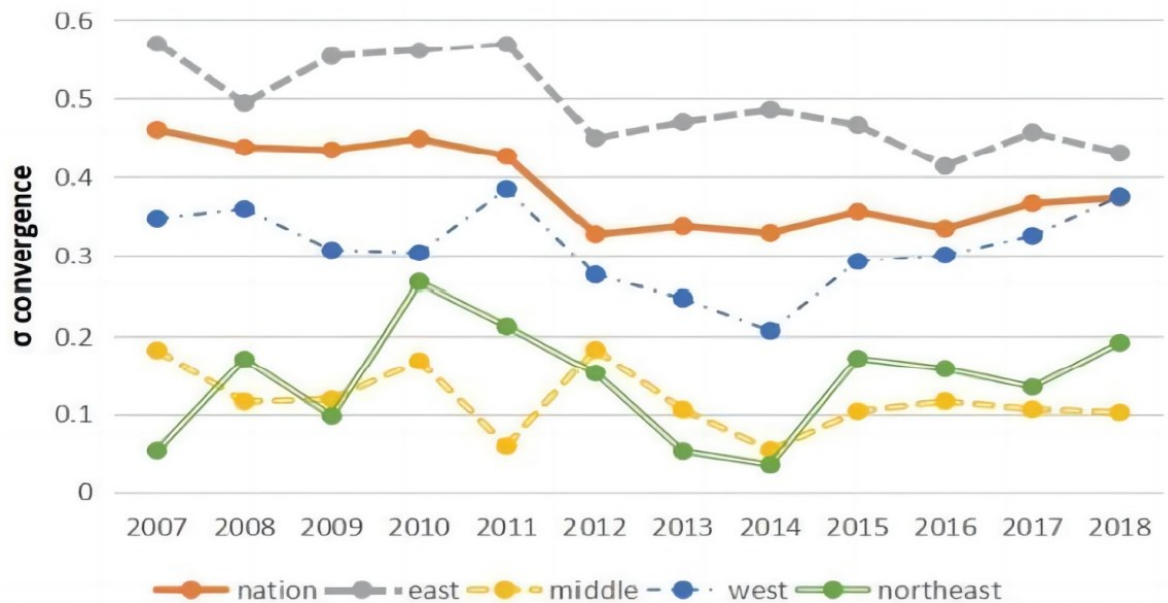
Figure 2.8 – Convergence test for national and sub-regional per capita general public budget funding for higher education σ

Source: compiled by author

As can be seen from the figure, the Chinese higher education per capita general public budget funding has had small oscillations over the past decade or so but has generally shown a downward trend, exhibiting σ-convergence characteristics, and the σ-value of the Chinese higher education per capita general public budget funding has decreased from 0.460 in 2007 to 0.373 in 2018. The σ-convergence test of sub-regions reveals that only the eastern region exhibited a more stable σ-convergence trend from 2007 to 2018. Only the eastern region's per capita general public budget expenditure exhibits a more stable convergence trend, rising from an initial value of 0.569 to 0.431 in 2018. Meanwhile, the central region displays a "M" type oscillation. With the exception of 2008–2010, 2011–2012 and 2014–2016, there is a slight dispersion trend, while the remaining years demonstrate a convergence trend. Except for 2008–2010, 2011–2012 and 2014–2016, which had a small divergent. With the exception of the years 2008–2010, 2011–2012, and 2014–2016, which exhibited a slight divergence trend, the remaining years demonstrated a convergence trend. The value of the per capita public budget funding for higher education in the central region decreased from 0.182 in 2007 to 0.101 in 2018, indicating an overall trend of convergence. Meanwhile,

the western and north-eastern regions demonstrated a more pronounced convergence trend during the 2010–2014 period, reaching their lowest values of 0.206 and 0.036 respectively in 2014, before beginning an oscillating upward trend, indicating the presence of divergence in these two regions in recent years. It only shows a more consistent σ convergence trend in the national and eastern regions, while the σ values in other regions only shrink somewhat over time and show a more consistent expansion trend in recent years. Therefore, there is a more significant σ-convergence of general public budget funding per student in higher education at the national level and in the eastern region, while there is no significant σ-convergence in the central, western, and north-eastern regions.

The coefficient of variation can show more accurately the degree of distributional dispersion of the data than the standard deviation, which is based on the average amount of money the government spends each year on higher education per student. Therefore, this dissertation further analyses the σ-convergence trend of the coefficient of variation of the general public budget funding for higher education per student, as shown in Figure 2.9.
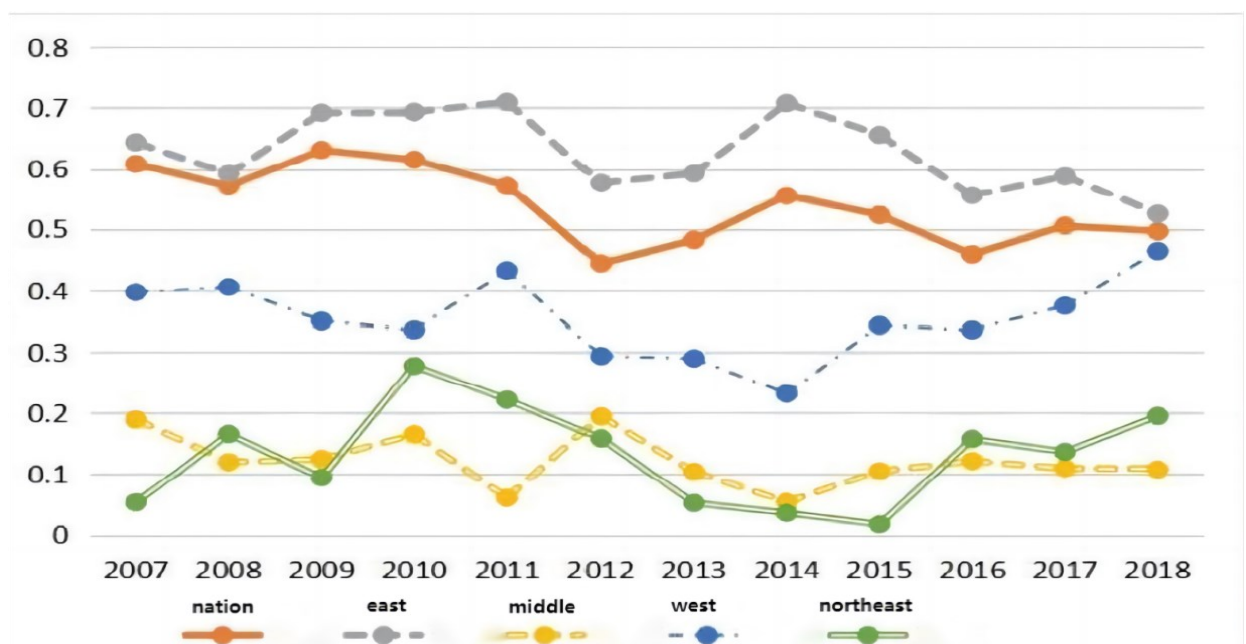

Figure 2.9 – Coefficient of Variation of General Public Budget Expenditure per Student in Higher Education at the National and Sub-Regional Levels

Source: compiled by author

From the above figure, it can be seen that the convergence trend performance of China's higher education per capita general public budget expenditure in the national scope and sub-region in the convergence of the trend are presented with the standard deviation of roughly the same characteristics of the time change, which still indicates that the national scope and the eastern region as a whole have a σ-convergence trend, and there is no σ-convergence trend in the other regions with the continuity of σ-convergence trend.

Absolute β-convergence checks to see if the steady-state equilibrium level of higher education spending in each region is the same. This checks to see if there is a "catching-up effect" between or within regions or between provinces. Table 2.3 displays the test results.

As mentioned earlier, in order to avoid the randomness and mutability of the cross-section data, this dissertation divides the data during the period 2007–2018 into several periods of different time lengths and conducts a comprehensive test of absolute β-convergence in the whole country and subregions during each period. The specific time periods are divided as follows: firstly, the continuous time of the whole period of 2007–2018 is used as the test period (T=12); secondly, the whole period is divided into four time periods, i.e., three years as one period (T=6), and the average of every three years is used as the amount of higher education financial expenditures in each time period for the estimation of the convergence; thirdly, 2012 is used as the dividing point to estimate the convergence of the financial expenditures of higher education in the period of 2007–2011 (T=5) and 2012–2018 (T=7) for convergence.

According to the test results in Table 2.3, the absolute convergence estimates for the four time periods nationwide are -0.026, -0.078, -0.043, and -0.018, respectively. With the exception of the time period 2012–2018 (T=7), which is significant at the 10% level, the significance of the other three time periods is at the 1% level, indicating a negative correlation between the growth rate of China's higher education expenditure and its initial level. This indicates that the growth rate of China's financial expenditure on higher education has a negative correlation with its level at the beginning of the period, i.e., there is a "catching-up effect" between regions with a

lower level of per capita general public budget funding for higher education at the beginning of the period and regions with a higher level of expenditure at the beginning of the period.

Secondly, when I conduct the absolute convergence test in the national time period, I find that the convergence rate in the three time periods is 10.5%, 4.8%, and 1.9%, respectively. The half-life cycle t is 6.590 years, 14.317 years, and 36.028 years, respectively. The half-life cycle in the full time range is 22.242 years, suggesting that it takes approximately 22 years to reduce the per-student funding gap between regions with higher per-student public budget funding for tertiary education and those with lower per-student budget funding.

Table 2.3 – Absolute β Convergence Tests for Financial Expenditure on Higher Education at the National and Subregional Levels

	2007-2018 (T=12)				2007-2018 (T=6)			
	β	R²	λ	τ	β	R²	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]		
Northeast	-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	R²	λ	τ	β	R²	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]		
Northeast	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.

This means that it takes roughly 22 years to halve the gap between regions with higher and lower per capita general public budget funding for higher education. This also means that the convergence speed of the general public budget funding for higher education per capita in China to the steady-state equilibrium point varies in different time periods, but all of them gradually converge to the same steady-state equilibrium; furthermore, according to the theory of new economic growth, the convergence of higher education financial expenditures comes from the convergence of the economy and the convergence of the system, which means that with the development of the social and economic development of China and the improvement and unification of the tax collection and management system and transfer system, the financial expenditures for higher education nationwide will be reduced by half in about 22 years. It shows that with China's social and economic development and the improvement and unification of the tax collection, administration, and transfer payment systems, the gap between financial expenditures on higher education nationwide is gradually narrowing and tending to equalize.

Given the distinct differences in the geographic distribution and regional characteristics of economic and social development in the eastern, western and north-eastern regions of China, this dissertation aims to confirm whether the per capita general public budget funding for tertiary education in these regions exhibits a similar convergence to the national level. To achieve this, I will utilize Equation (4.1) to conduct an absolute convergence test in sub-regions. The results show that the Eastern and Central regions have significant β-convergence in both continuous time and most subperiod estimates. The eastern region only lacks convergence from 2007 to 2018, and its continuous time convergence rate of 3.4% surpasses the national continuous time convergence rate. It is worth noting that the central region has a trend of β-convergence over all time periods. Its rate of convergence is not stable in continuous time, but it is much higher than the nationwide rate of convergence in all other segmented studies. This suggests that β-convergence has become more noticeable in localised time and that the region has started to experience a "catch-up effect" in higher education spending compared to the more advanced areas in recent years. The western

region is only in the period 2007–2018 (T=6); there is a more significant trend of β-convergence, while the Northeast region shows a trend of β-convergence only in consecutive time periods, and neither region has a trend of β-convergence in other time periods, suggesting that β-convergence is not obvious or a suitable path of β-convergence has not yet been found in the two regions.

Conditional β-convergence is β-convergence after controlling for factors such as time and omitted variables using two-way fixed effects, and convergence in real-world situations is generally conditional, and absolute β-the convergence is not as accurate as conditional β-convergence in describing the status of convergence between regions. Therefore, this dissertation will divide 2007–2018 into 4 cycles for the conditional convergence test, using 3 years as a cycle. The table below displays the regression results.

Table 2.4 – Conditional β-convergence test for national and sub-regional financial expenditure on higher education

	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***
	(0.007)	(0.012)	(0.018)	(0.012)	(0.021)
R²	0.980	0.984	0.976	0.977	0.984
λ	---	---	---	---	---
τ	---	---	---	---	---

Note: Standard deviations in parentheses, ***, ** and * indicate significance at the 10 per cent, 5 per cent and 1 per cent significance levels, respectively.

Table 2.4 reveals that the conditional estimates for the entire country and its sub-regions are all less than 0 and statistically significant at the 1% level, demonstrating a trend of conditional convergence. However, measuring the convergence speed across the entire country and all regions is unfeasible, suggesting that the country's financial expenditure on higher education is currently experiencing rapid growth and lacks maturity. Consequently, there is no suitable path for convergence, necessitating further exploration and improvement of China's financial expenditure on higher education in the future.

The above research yields comprehensive results, indicating a general trend of convergence in Chinese higher education financial expenditures. While the western and north-eastern regions do not exhibit more obvious absolute convergence, they do exhibit significant conditional convergence. Both absolute and conditional convergence are more evident in the eastern and central regions. All regions lack a stable convergence rate and time and have yet to find a suitable convergence path for themselves.

2.2 Evaluating the effectiveness of state financial expenditures in the context of improving the management of higher education in China

The balanced allocation of financial resources for higher education is not an absolute equal allocation but rather an equalisation that takes efficiency into account. As the findings of the previous chapter show, the gap in financial expenditure on higher education between regions in China has been gradually narrowing in recent years, but has the efficiency of its expenditure increased or decreased? This is exactly what this chapter intends to study. Only after comprehensively grasping the current situation of the allocation of financial resources for higher education in China can we further explore the optimal way of balanced allocation of financial resources for higher education.

Analysis of the Efficiency in the Allocation of Financial Resources in Higher Education. To allocate limited educational resources more rationally, the allocation efficiency of higher education financial resources is a crucial area of research. Scholars in this specific field primarily focus on financial inputs, specifically higher education resource inputs, and utilize methods such as data envelopment analysis and stochastic frontier surfaces to investigate the efficiency of higher education resource allocation and the factors that influence this efficiency.

The most widely used model is the Data Envelopment Analysis (DEA) model, which uses linear programming techniques to assess the efficiency of decision-making units. This model does not require knowledge of the specific form of the production

frontier surface or the construction of the production function. It is easy to use and flexible, making it one of the most commonly used methods for analyzing the efficiency of non-parametric frontiers. For the first time, Charnes, Cooper and Rhoder [98] proposed an ordinary linear programming model, known as Data Envelopment Analysis (DEA), to measure the efficiency of participating units. The principle of the use of DEA is based on a number of decision-making units (DMUs, i.e., DMUs) that have input and output data. The decision-making unit, or DMU, is formed by the production possibility set of the production effective frontier surface, measured by the distance between the decision-making unit and the production frontier surface. This distance is used to assess the reasonableness of the input and output, thereby obtaining a judgement on the technical efficiency. During this period, Charnes, Cooper and Rhoder established the CCR model, the fundamental model of DEA, to evaluate the relative effectiveness of each decision unit, or the overall efficiency. Subsequently, in 1984, Banker, Charles and Cooper [98] further enhanced the CCR model by modifying the assumption of constant returns to scale to variable returns to scale. This led to the creation of the BCC model, which is capable of evaluating both technical and scale efficiency. After years of in-depth research on the basis of the previous two DEA models, nearly dozens of DEA models and combinations of DEA models and other models have been produced in the study of efficiency and its influencing factors. One such model is the super-efficiency DEA model proposed by Andersen and Petersen [100], which is based on the principles of CCR and BCC by taking relaxation into account. This is achieved by incorporating slack into the principles of CCR and BCC. In the field of education finance, the super-efficiency DEA model and the DEA-Tobit model are the most widely used models.

DEA measures both the efficiency of resource allocation between regions and the efficiency of resource allocation across decision-making units. In order to guide the optimal allocation of educational resources, Sinunay-Stern et al. [101] used DEA analysis to construct a model that evaluated the relative efficiency of the operation of educational resources in 21 colleges of Ben-Gurino University. Soteriou et al. [102] used DEA-CCR, DEA-BCC and unconstrained CCR models to measure the efficiency

of selected high school schools in Cyprus and proposed corresponding improvements for inefficient or ineffective schools. At the same time, their study found that schools in rural areas are less efficient and have smaller gaps in educational efficiency compared to those in urban areas. However, the results demonstrated that environmental influences cannot account for differences in school inefficiency. Therefore, any corrective measures should aim to change the internal environment rather than the external environment. Using Dutch higher education institutions as an example, Salerno [103] estimated the efficiency of students' education costs through DEA analysis and traditional efficiency analysis methods, concluding that DEA analysis yields more effective results.

Toth [104] employed DEA to examine the efficiency of the higher education system in Hungary and other European countries. He also investigated the influence of the state and private sector's contribution, as well as socio-economic factors like GDP per capita and parental education, on the efficiency of the higher education system. Ying Xin and Cong Dong used a combination of balanced scorecards (BSC), factor analysis (DRF), and DEA analysis to construct a higher education performance assessment indicator system, which they used to assess the relative efficiency of 15 universities of science and technology. The higher education performance assessment indicator system fixes the error in judging effectiveness that comes from DEA analysis because of the link between input and output data. It can also rate the performance of higher education in a more scientific and fair way. Sav [105] used a two-stage DEA analysis to assess the performance of U.S. public institutions of higher education during the period 2003–2014. They estimated the effects of reduced state funding, state funding and Pell grants on efficiency during the period, and their findings indicated that reversing state legislative decisions and increasing state funding would enhance the efficiency of higher education.

Numerous scholars in China have utilized DEA analysis to investigate the efficiency of higher education in the country. Their findings indicate that the efficiency of higher education in China is generally at a medium level, with most regions lacking DEA effectiveness. Xu Jianzhong and Li Youbin [106] used Heilongjiang province as

an example and used the DEA–CCR model to study the efficiency of higher education resource integration. The results show that, compared to 1995–1999, the efficiency of higher education resource integration in Heilongjiang during 2000–2005 has improved. This improvement can be attributed to the merger of colleges and universities, the expansion of enrolment and the promotion of higher education resource integration. Therefore, it is important to continue increasing investment in higher education while also strengthening government guidance and rational resource allocation. Investing in higher education while simultaneously bolstering government guidance and rational resource allocation is crucial.

Scientists Xu Jian and Wang Xuhui [107] used DEA–CCR analysis and projection analysis to look into the efficiency of higher education and its causes in 31 provinces in China. The study's results showed that most of the provinces and regions in China do not have DEA effective situations. One big reason for this is that resources are not invested in higher education and are being wasted very badly. To fix this problem, it is important to improve the management of education funds and staff. important measures. Kang Jianying and Zhang Hui [108] used DEA analysis to look at how well China's 31 provinces spent their compulsory education funds. The study found that China's central and western regions were more efficient with their education spending than the eastern regions. There was also more variation in how well the funds were spent across regions. Finally, China's education spending efficiency of the provinces of education funds changed based on the number of school-age children and the direction of those changes. Therefore, on the one hand, we should continue to increase the investment in education in the central and western regions, and on the other hand, we should do a good job of scientific population forecasting and reasonable education investment planning in order to improve the efficiency of the use of education funds. Hu Min and Lu Zhenjia [109] used a basic DEA model to analyze the expenditure efficiency of education finance in Guangdong Province from 2000 to 2007. They used the gross enrolment rate of students in each grade from preschool to higher education and the per capita budgeted expenditure on education as the output and input data, respectively. The results showed that the total expenditure

efficiency of Guangdong Province's education finance was low, and the effect of promoting the improvement of the gross enrolment rate of education was not obvious. Although the gross enrolment rate has not significantly improved, there has been a gradual positive trend.

Gao Yuqiang et al. [110] figured out how efficient regional spending on education was by looking at the longer Cobb Douglas production function, DEA analysis, and the Malmquist productivity index to look at the effect of economic growth and the space of China's interprovincial spending on education. The findings contradict Kang Jianying and Zhang Hui's conclusions, which indicate a decrease in the overall efficiency of China's provincial fiscal education expenditures from the east to the west, as well as a decrease in the pure technical and scale efficiency in the western region. They suggest strengthening the management of education expenditures to enhance their efficiency. Zhang Bisheng [111] conducted a dynamic analysis of China's higher education efficiency using panel data from each province from 2000 to 2016, utilizing the game cross efficiency DEA model and the global Malmquist index method. The study revealed a V-shaped development trend in the efficiency of China's higher education, a recent improvement in the overall average efficiency and a primarily technological advancement in the eastern region. Technological progress primarily drives the improvement in education efficiency in the eastern region, while efficiency improvement primarily drives the improvement in the western region. Therefore, we must not only maintain the current balance of higher education across Chinese regions, but also strive to enhance the efficiency of higher education in accordance with local conditions. Chang Siliang and Wu Bing [112] conducted an evaluation and analysis of the efficiency of postgraduate education in postgraduate training colleges and universities in the Hunan region. They found that the efficiency of postgraduate education is generally at a medium level and the main causes of non-DEA are the low utilisation rate of education funds and poor management. Therefore, they recommend focusing more on managing the quality of education resource input and establishing a scientific and reasonable resource-sharing system for colleges and universities in the province to enhance the rate of resource

utilization. Establishing a scientific and reasonable resource-sharing system for colleges in the province should improve the utilisation rate of educational resources.

Along with these, the most common ways to check how useful educational resources are stochastic frontier analysis (SFA), expert evaluation, hierarchical analysis (AHP), fuzzy comprehensive evaluation and combing statistical evaluation. Johnes [113] used DEA analysis and SFA analysis, respectively, to explore the efficiency of resource consolidation in UK higher education institutions. He found that the technical efficiency of higher education in the UK was declining by an average of 5% per annum, and he also analyzed the strengths and weaknesses of the two approaches in the study of educational efficiency issues. Johnes says that both SFA analysis and DEA analysis can figure out the limits of production. The differences are that the limits in SFA analysis are parametric, while the limits in DEA analysis are non-parametric segmented linear boundaries that wrap around the data. SFA necessitates making assumptions about the distribution of efficiencies, the distribution of stochastic errors and the functional form of the production technology. These assumptions enable the drawing of statistical inferences from the results. The drawback lies in the arbitrary nature of these assumptions, their susceptibility to analytical processing and their lack of foundation in understanding the true distribution or functional form. On the other hand, DEA does not require such assumptions, ensuring that estimates of technical efficiency are not susceptible to potential errors due to incorrect assumptions. However, the disadvantage lies in the inability to draw statistical inferences from DEA results. Furthermore, DEA has the ability to incorporate efficiency errors resulting from random fluctuations into its estimates, even though it prohibits such error. One more benefit of DEA is that it lets the weights of each input and output indicator change based on observations. This means that using non-traditional production methods won't hurt any decision-making units (DMUs), since it might be possible to give all of them the same weight.

In contrast, SFA imposes the same input and output parameters on all observations. Therefore, in conjunction with the multi-input, multi-output nature of production in higher education, Johnes used DEA analysis primarily for the evaluation

of efficiency in this thesis. In 2010, Johnes [114] employed random effects and stochastic frontier techniques to estimate output distance functions for UK higher education institutions from 1997 to 2007, with the aim of examining the efficiency of these institutions and exploring opportunities for input. Chinese scholars Cheng Gang et al. [115] utilized Structural Factor Analysis (SFA) to evaluate the cost efficiency of a panel of universities directly under the Ministry of Education in China from 2002 to 2005. Their findings revealed that the overall cost efficiency of this group of universities was only 59 percent. They found that factors such as the type of school, its location, the structure of faculty titles, the school's floor space and the number of undergraduate and postgraduate students significantly influenced its cost efficiency.

Liu Xiaojun [116] conducted an analysis of the inputs and outputs of 68 colleges and universities directly under the Ministry of Education using SFA analysis. Based on this analysis, he established a cost efficiency evaluation model for colleges and universities. His findings revealed that cost inefficiency accounts for nearly 39% of the cost difference between colleges and universities in China, with the cost efficiency of colleges and universities directly under the Ministry of Education in China showing a downward trend in recent years. In addition, among the colleges and universities directly under the Ministry of Education, the cost efficiency of colleges and universities in the eastern region is higher than that in the central and western regions, and the cost efficiency of "985" colleges and universities is higher than that of "non-985" colleges. Chen Lin and Yue Zhenxing [117] used 18 industry-specific colleges and universities in China from 2007 to 2016 to look into the research efficiency using SFA analysis. The study's results showed that the research efficiency of these colleges and universities was on the rise and started to stabilise in 2016. There is also a general link between the change in research efficiency and the change in the economy.

Zhang Ruijing and Jia Hong [118] used SFA analysis and a restricted Tobit panel model to study the efficiency of public education in China's provinces. They found that the efficiency of public education in China is on the decline, with the eastern region having the lowest educational efficiency and the western region having the highest. This trend contradicts the proportion of financial input received by the eastern

and western regions, and fiscal decentralisation is one of the factors affecting the efficiency of public education. Among the factors influencing public education efficiency, fiscal decentralisation has a significant positive effect on promoting education efficiency, while fiscal competition among local governments has a certain crowding-out effect on education efficiency.

Hengxin Wang et al. [119] conducted a study to measure the efficiency of scientific research management in 12 research polytechnic universities in China. They achieved this by combining the hierarchical analysis method (AHP) and the cluster decision-making DEA analysis method. By combining these methods, they were able to rank the efficiency units and provide more effective suggestions for improving scientific research funding management. Wei Yaoyang and Li Baoqiang [120] discussed the optimization path for market-based resource allocation in higher education in China from the perspective of the efficient market hypothesis. According to the efficient market hypothesis, the allocation of capital to resources can effectively reflect market demand and the allocation of resources within the efficient market can have a maximum impact on the securities market. Applying the theory of efficient market hypothesis to the field of higher education can ensure the optimal allocation of higher education resources on the basis of respecting the operation law of the market.

The above literature review shows that more scholars in the field of education economics have used data envelopment analysis (DEA) and stochastic frontier analysis (SFA) to study the efficiency of resource allocation in higher education in China, and the two methods have their own advantages and disadvantages. While DEA can measure the efficiency of education with multiple inputs and outputs, it cannot separate technical inefficiencies, whereas SFA can compensate for this inefficiency by analyzing only one output data indicator. SFA analysis can compensate for the lack of separation due to technical inefficiency, but it can only analyze one output data indicator. Nowadays, more and more scholars have combined SFA and DEA analysis with other methods to measure educational efficiency more scientifically and accurately on the basis of overcoming the shortcomings of the methods themselves

and to put forward more reasonable recommendations for the allocation of educational resources.

Furthermore, the research on the allocation efficiency of higher education financial resources in China still lacks consistency in its conclusions. Therefore, we urgently need to explore more reasonable research methods to analyze the allocation efficiency of higher education finances.

Research Methodology for Efficiency Measurement. Selection of methods. This dissertation intends to measure the efficiency of China's higher education financial expenditure. The related research on efficiency measurement primarily focuses on evaluating the selected indicators, categorised into two main types: the subjective assignment method and the objective assignment method. The subjective assignment method, as its name implies, involves assigning the selected efficiency indicators through comprehensive consulting and evaluation systems to determine the overall efficiency. This method heavily relies on the opinions of experts and is more subjective, thereby limiting its scope of use. The objective assignment method more widely uses the stochastic frontier approach (also known as the SFA model) and data envelopment analysis (also known as the DEA model). However, using the SFA model requires the construction of a production function and knowledge of the specific form of the production frontier, making its application less flexible and convenient than the DEA model. The previous discussion reveals a growing body of literature that employs the DEA model for evaluating higher education efficiency, thereby demonstrating the method's effectiveness. However, fewer scholars use the three-stage DEA model to eliminate the influence of environmental and random factors, which makes the evaluation of efficiency biased. Therefore, this dissertation will apply the three-stage DEA model to evaluate the efficiency of higher education financial expenditure in China.

As previously mentioned, Charnos, Cooper and Rhodos [98] initially developed the DEA model, a non-parametric analytical method, to measure the relative effectiveness of decision-making units. They utilized linear programming techniques

to assess the performance of units of the same type. Decision-making units, also known as DMUs, are units of the same type. To assess their efficiency, one typically compares their input and output indicators to obtain a weighted composite score, and then evaluates the efficiency of these units using this composite score. The most basic DEA–CCR model calculates the weight of each indicator for optimisation, converts fractional planning into a linear planning problem, constructs the objective function and then uses the optimisation process to determine the weight. In 1984, Banker, Charnes, and Cooper [99] came up with a better model called the BCC model. This model changed the assumption that returns to scale are constant in the CCR model to variable returns to scale. It also measured technical efficiency along with pure technical efficiency and scale efficiency (technical efficiency = pure technical efficiency × scale efficiency). Subsequently, Andersen and Petersen [100] and Fried et al. [195] introduced the super-efficiency DEA model and the three-stage DEA model, which have gained widespread use in the efficiency measurement field.

The main idea behind the DEA model is to find the difference between the actual outputs of past input decisions and the optimal outputs based on the non-parametric estimation of the linear model. This lets us know how well resources are being used by looking at the gap between them. Let us assume that there are n-decision-making units (DMUs), with m and s representing the number of input types and outputs, respectively. The figure below illustrates the corresponding inputs and outputs of these n DMUs.
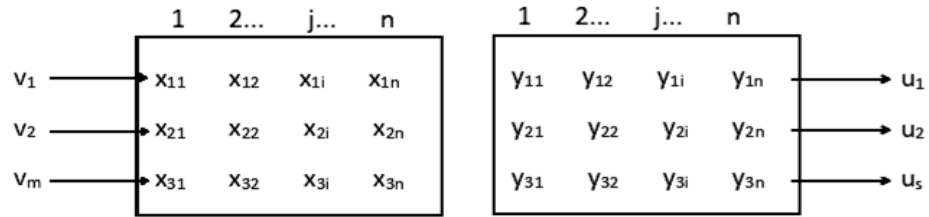
$$X_i=(X_{1i},\ X_{2i}\ldots X_{mi})^T \qquad Y_i=(y_{1i},\ y_{2i}\ldots y_{si})^T$$
$$V=(v_1,\ v_2\ldots v_m)^T \qquad U=(u_1,\ u_2\ldots u_s)^T$$

Figure 2.10 – Inputs and outputs corresponding to n decision units

Note: i represents the decision unit DMUi, and there are $1 \leq i \leq n$; Xij denotes the jth input quantity of the ith decision unit, and Yir denotes the rth output quantity of the ith decision unit, and xij ≥ 0(j=1,2.... .m),yir >0(r=1,2.... .s); vj is the measure of the jth input quantity and ur is the measure of the rth output quantity, both of which can also be called weights.

The transformation of decision units and inputs and outputs into vectors has the form:

- X_i and Y_i are the input and output quantities of the decision unit DMU_i respectively, which are known;
- V and U are the weight vectors, which represent m kinds of inputs and s kinds of outputs, which are variable.

When the input and output weight coefficients are v and u respectively, the input-output ratio of resource allocation is:

$$h_i = \frac{u^r Y_i}{v^T X_i} \tag{2.18}$$

The larger the h_j, the greater the input-output ratio under certain conditions, the more output can be obtained from the same inputs, indicating higher productivity and vice versa.

Three-stage DEA model Traditional DEA models such as CCR or BCC model, in the evaluation of the efficiency of the decision-making unit, does not take into

account the external environment and some random interference factors on the efficiency of consideration, so that the efficiency of the results cannot be truly expressed by the internal management of the chaos, the size of the level of irrationality, or the external environment, the impact of random interference factors.

To accurately measure the efficiency problems caused by internal management and scale level, this dissertation utilizes the three-stage DEA model, improved by Fried et al. [195], which is based on the traditional BCC model. This model is combined with the SFA frontier stochastic analysis method to exclude statistical noise and the influence of the external environment. The objective is to assess the efficiency of the financial expenditures of higher education in various parts of China. The theoretical framework of its assessment logic is shown in the above figure 2.11.
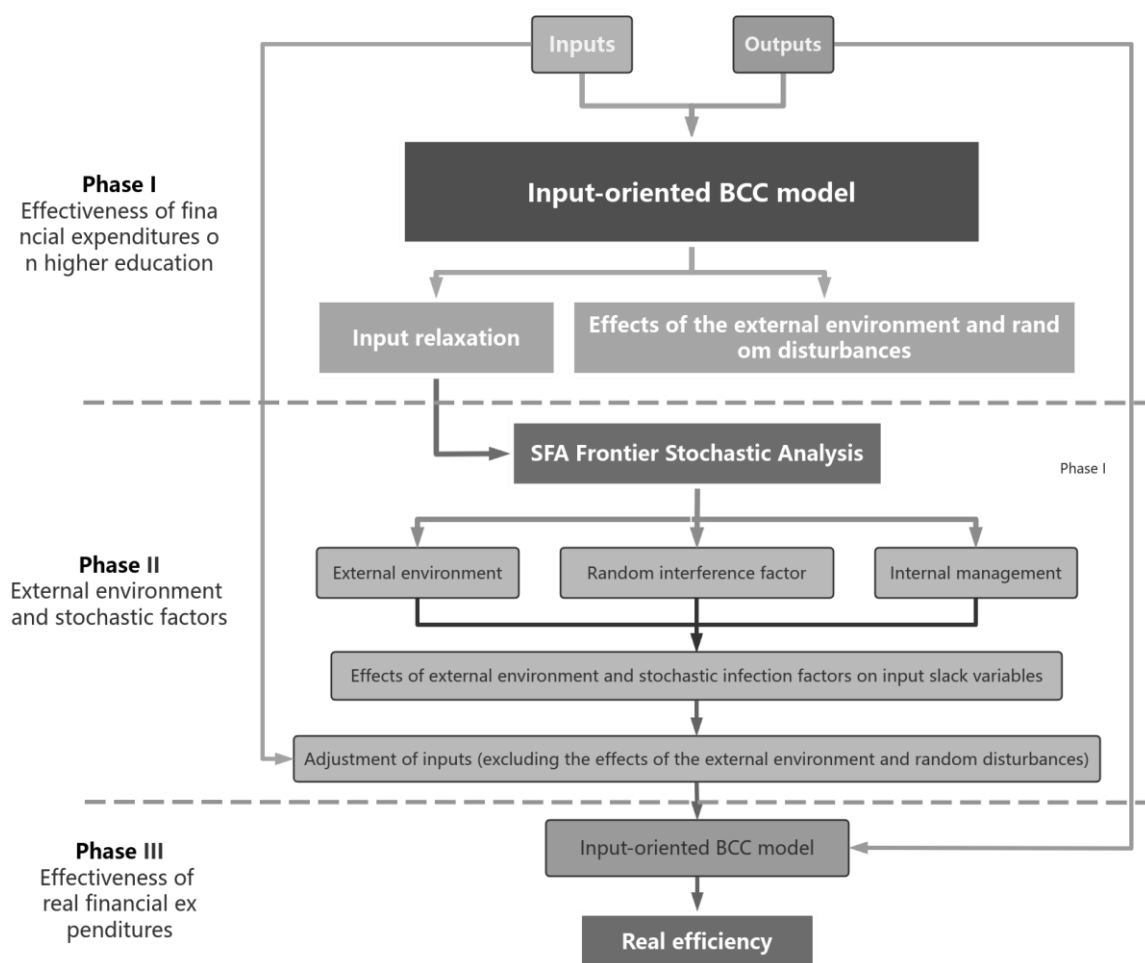
Figure 2.11 – Theoretical framework of the three-stage DEA model

Source: compiled by author

Traditional DEA efficiency measurement models can be divided into two categories according to the relationship between inputs and outputs: input-orientated DEA models and output-orientated DEA models. And because this dissertation is an efficiency assessment from the perspective of resource allocation, the main consideration is the efficiency of the current situation of resource inputs, and inputs are more controllable compared to outputs. For this reason, this study chooses the input-orientated BCC efficiency prompt model.

The input-orientated BCC model is represented in 3 phases.

Phase 1: BCC Modelling for Traditional DEA Efficiency Measurement

$$Min[\theta - \varepsilon(e^t s^- + e^t s^+)] \tag{2.19}$$

$$\text{s. t.} \begin{cases} \sum_{i=1}^{n} \lambda_i y_{ir} - s^+ = y_{0r} \\ \sum_{i=1}^{n} \lambda_i x_{ij} + s^- = \theta x_{i_i} \\ \sum_{i=1}^{n} \lambda_i = 1 \\ \lambda_i \geq 0; s^+ \geq 0; s^- \geq 0 \end{cases} \tag{2.20}$$

where x,y,i,j,r have the same meanings as in the previous section, xij and yir are the jth input and rth output of decision unit i, respectively. θ represents the efficiency value of decision unit DMUi0, s+ and s- are the slack variables of input variable xi and output variable yi , respectively, and λj is the weight coefficients of inputs and outputs.

Assume that this BCC efficiency model has optimal solutions (θ*, λ*, s*+, s*-) when:

(1) A decision unit DMU_{i0} is DEA valid if θ* = 1 and there is s*+ = s*- = 0;

(2) The decision unit DMU_{i0} is weakly DEA valid if θ* = 1 and there is s*+ ≠ 0, or s*- ≠ 0;

(3) If θ* < 1, the decision unit DMU_{i0} non-DEA is valid.

The value so calculated is the technical efficiency value, which can be further decomposed to yield the technical efficiency and scale efficiency.

Phase 2: Similar stochastic frontier analysis (SFA) models

In this stage, I construct a similar SFA analytical model for the initial input decomposition. This model removes the effects of the external environment and stochastic factors from the efficiencies computed in the previous stage, thereby obtaining the DMU input redundancy solely due to internal management inefficiencies. Using the input-oriented efficiency value measurement, I can construct the following SFA regression for n decision-making units, m inputs, and p observable external environment variables:

$$s_{ik} = f^i(z_k; \beta^i) + v_{ik} + \mu_{ik} \tag{2.21}$$

where i represents input factors, i=1,2.... .m; k represents the decision unit, k=1,2.... n; s_{ik} is the slack variable of the ith input factor of the kth decision cell. z represents the p external environment variables, $z_k =(z_{1k} , z_{2k} ... z_{pk})$; β^i is the parameter to be estimated for the external environment; $f_i (z_k ; \beta^i)=z_k \beta^{1'}$ denotes the effect of the p external environment factors of the kth decision cell on the slack value of the ith input factor. $v_{ik} + \mu_{ik}$ is the mixed error term, v_{ik} is the random disturbance term, obeying the distribution of N $(0, \sigma^2_{\mu i})$; the part of μ_{ik} denotes the management inefficiency and input scale irrationality, obeying the distribution of N $(0, \sigma^2_{\mu i})$, which are independent of each other and uncorrelated.

Subsequently, after regressing the above formulae using Frontier 4.1, the inputs to the decision units can be further adjusted. By using the relatively effective decision-making units as a benchmark, I can modify the inputs of other relatively ineffective decision-making units, boost their inputs in favourable external environments and reduce their inputs in unfavourable ones. This approach eliminates the impact of the external environment and random disturbances, leaving the decision-making units' inputs solely influenced by their internal management level and efficiency scale. The adjustment formula is as follows:

$$\hat{x}_{ik} = x_{ik} + \left[\max_k\{z_k\hat{\beta}^i\} - z_k\hat{\beta}^i\right] + \left[\max_k\{\hat{v}_{ik}\} - \hat{v}_{ik}\right] \qquad (2.22)$$

where x_{ik} is the actual value of the ith input of the kth decision cell, $\hat{x}_{ik}$ is its adjusted value according to the SFA regression results, $\hat{\beta}^i$ and v are the estimated value of the external environment variable and the estimated value of the stochastic disturbance factor at $\hat{v}_{ik}$, respectively. $\left[\max_k\{z_k\hat{\beta}^i\} - z_k\hat{\beta}^i\right]$ indicates that all decision units are adjusted to the same external environment and indicates that all $\left[\max_k\{\hat{v}_{ik}\} - \hat{v}_{ik}\right]$ decision units are adjusted to the same stochastic disturbance factor.

Phase 3: Adjusted BCC model. Through the regression and adjustment in the second stage, in the third stage, the input data of the new decision unit $\hat{x}_{ik}$ is estimated, instead of the initial input x_{ik}, original output y_{ik} of the first stage, which is unchanged, and the efficiency of the new decision unit is estimated again by applying the BCC model, so that the real efficiency can be obtained. The specific BCC model is similar to the first stage, so it is not repeated here.

Selection and sources of input indicators. This dissertation aims to investigate the effectiveness of the current allocation of financial resources for higher education. The primary focus of this study is higher education financial expenditure, which I estimate using the DEA model as the input indicator.

The government dominates the allocation of higher education resources in China, primarily investing in various forms of education funds. The "Statistical Bulletin on the Implementation of National Education Expenditure" from previous years expresses the total investment in education of China's entire society as the total investment in national education expenditure. This refers to the sum of manpower, material and financial resources invested in the field of education, tailored to the needs of the development of educational undertakings in a country or a region. According to the data classification of education expenditure in the China Education Statistical Yearbook, the concept of education expenditure encompasses a wide range of expenditures for school education across the entire society, taking into account its

content. Specifically, education funding includes state financial education, private school organizers' input funding, social donations, business income and other education funding. Among them, the state financial education funding mainly refers to the education funding arranged by the general public budget, the education funding arranged by the governmental fund budget, the enterprise appropriation in the state-owned and state-controlled enterprises to run the school and the funding of the school-run industry and social service income used for education and other aspects. Education funding from the general public budget also includes education program fees, infrastructure funding, and education surcharges.

Data availability allows us to explore the efficiency of higher education financial expenditures in this chapter, using the general public budget and the governmental fund budget from the China Education Statistical Yearbook as the basis for studying the equilibrium of higher education financial expenditures. And according to the provisions of the Education Law, the education expenditure arranged by the governmental fund budget is mainly used for the compulsory education stage, not applicable to the study of the higher education stage, so the financial expenditure of higher education in this thesis primarily refers to the part of the general public budget for higher education and the part of the investment in infrastructure.

Selection and sources of output indicators. The output indicators of financial expenditure on higher education mainly reflect the portfolio of higher education products brought about by financial expenditure, including personnel output and material output. After analyzing the available data, this study selected the number of students, the number of full-time teachers, and the new value-added of fixed assets as its efficiency output indicators. Additionally, the output indicators should exhibit isotonicity with the input indicators, meaning that an increase in the input factors should not result in a decrease in the output indicators. Table 2.5 displays the results of the commonly used isotonicity test, the Pearson correlation test. Later, in the empirical analysis of the DEA model, this paper separates the data from the decade 2009–2018 into two segments, each corresponding to a five-year interval. It then calculates the mean value of each segment separately to estimate efficiency and

performs the Pearson correlation test on the mean value of the data in these two time segments.

Table 2.5 – Pearson correlation coefficients between China's financial expenditure on higher education and various output indicators during 2008–2018

Times	Output item		
	Number of students enrolled in general colleges and universities	Number of full-time teachers	New value added to fixed assets
2008-2013	0.7967*** (0.000)	0.8871*** (0.001)	0.9196*** (0.000)
2014-2018	0.7501*** (0.000)	0.8532*** (0.000)	0.9247*** (0.000)

Note: *** indicates significant at the 1 per cent level, and the p-value of the test is in parentheses.

The table shows that all correlation coefficients between the output variables and the input item, financial expenditure on higher education, are positive. This suggests that the input and output indicators selected in this study align with the original model's "isotropy" assumption, which is reasonable.

The Ministry of Education's website and the China Education Statistics Yearbook provided the data for this section.

Selection and Sources of External Environmental Indicators. When selecting external environment indicators, they should satisfy at least the following two requirements: first, external environment variables can have an impact on the efficiency of higher education financial expenditure; second, these variables cannot be within the subjective controllable range of the sample [196]. The existing literature reveals that the primary external environment indicators for selection are the per capita GDP of each province, the environment of university clusters, and the degree of government decentralization. Firstly, in China's current higher education financial expenditure system, a significant portion of the expenditure responsibility falls on local governments. Consequently, a higher level of economic development leads to a wider range of resource allocation combinations, thereby enhancing the efficiency of higher education financial expenditure. Conversely, a low level of economic

development enhances the efficiency of higher education financial expenditure. Conversely, regions with low economic development will see limited improvements in the efficiency of financial expenditure on higher education. Secondly, numerous scholars have examined the correlation between university clusters and the efficiency of allocating higher education resources. Their findings suggest that university clusters foster inter-university exchanges, facilitate resource sharing and integration, and ultimately enhance the allocation efficiency of higher education resources. allocation efficiency of higher education resources. Furthermore, the degree of university clustering is primarily a policy regulation and market choice, falling outside the purview of higher education financial expenditure. However, it can be influenced by external factors, thereby influencing the efficiency of higher education financial expenditure. Finally, studies on the impact of the degree of government decentralisation on fiscal expenditure abound. On the one hand, fiscal decentralisation is conducive to the precise allocation of local resources by local governments according to the actual situation and improves the efficiency of fiscal expenditure [191]. On the other hand, the study by Li Zhenyu and Li Tao [198] argues that fiscal decentralisation leads to the formation of the competition effect of fiscal expenditure among local governments, which brings about the disorderly expansion of education expenditure and reduces the efficiency of higher education fiscal expenditure. However, this paper examines fiscal decentralisation as an external environmental variable that influences the efficiency of higher education fiscal expenditure, irrespective of whether it enhances or diminishes it.

For the calculation of each environmental indicator, I sourced the per capita GDP data for each province from the China Statistical Yearbook. I calculate the degree of university clustering by comparing the number of colleges and universities to the province's area. In this dissertation, I measure the ratio of colleges and universities to the urban area of each province from previous years, using the province database on the National Bureau of Statistics' official website. There are three types of indicators to measure the degree of fiscal decentralization: revenue decentralization indicators, expenditure decentralization indicators, and the ratio of retained revenues at each level

of government. The focus of this paper is on fiscal expenditure. Zhang Fen and Zhao Xiaojun [199] found out that the per capita fiscal expenditure indicator is the most accurate among the fiscal expenditure decentralisation indicators because it doesn't depend on population size or the local economy. For this reason, the decentralisation indicator of per capita fiscal expenditure is used as the standard to measure the level of government decentralisation. I obtain the decentralised indicator of fiscal expenditure per capita, which is the ratio of local fiscal expenditure per capita to national fiscal expenditure per capita, by dividing the total fiscal expenditure of each locality by the total population of each locality at the end of the year, using data from the official website of the National Bureau of Statistics.

Analysis of sample data. This dissertation divides the data from the ten-year period of 2009–2018 into two segments, using the mean value of each segment as the standard data for the period under study. This approach not only estimates the comprehensive efficiency over the time period, but also eliminates the impact of outliers in individual years. Table 2.6 displays the descriptive statistical characteristics of the mean values of all data over the two periods.

The table reveals that the standard deviation of all variables, with the exception of the environment of university clusters, is larger and tends to increase. This is particularly evident in the financial expenditure on higher education, the primary focus of this dissertation. This suggests that there is a significant imbalance in the allocation of higher education resources in China. In the two periods before and after, there has been a significant increase in all the input and output data, suggesting the enrichment of higher education resources during this period. However, further investigation is necessary to determine whether their efficiency has improved. Note that I have averaged the characteristics of the data presented here over a period of five years, leading to the emergence of non-integer numbers, which is a legitimate outcome of this averaging process.

Analysis of the results of the adjusted DEA model at stage 1. This thesis analyses the efficiency of financial expenditure on higher education in China using DEAP2.1 software.

Without considering the effects of environmental factors and random disturbance terms, the results of the average data for the years 2009–2013 are shown in Table 2.7, and the results of the average data for the years 2014–2018 are shown in Table 2.8.

Table 2.6 – Basic statistical description of variables related to DEA efficiency measurement in 31 provinces (cities) of China

2009-2013	Inputs	Output item			Environment variable		
	Financial expenditure on higher education	Number of students enrolled in general colleges and universities	Number of full-time teachers	Additional fixed assets	GDP per capita	Higher education cluster environment	Degree of fiscal decentralisation
Unit (of measure)	$10,000,000	quorum	quorum	$10,000,000	the Yuan or Mongol dynasty (1279-1368)	/	
Average value	856390	744796.5	44956.77	126945.5	46810.17	1.925	7.129
(Statistics) Standard deviation	559393.1	466416.6	26670.39	101107.2	20944.62	1.241	4.734
Minimum value	70429.59	32152.2	2280	4516.69	23111.65	0.517	3.441
Maximum values	2406850	1663580	104020	468493	98336.56	6.228	20.59
2014-2018	Inputs	Output item			Environment variable		
	Financial expenditure on higher education	Number of students enrolled in general colleges and universities	Number of full-time teachers	Additional fixed assets	GDP per capita	Higher education cluster environment	Degree of fiscal decentralisation
Unit (of measure)	$10,000,000	quorum	quorum	$10,000,000	the Yuan or Mongol dynasty (1279-1368)	/	
Average value	1501995	867965.7	51705.81	177581.2	42640.64	1.787	8.058
(Statistics) Standard deviation	968231.9	538026.7	30329.78	129255.2	20645.32	0.953	5.612
Minimum value	127888.6	34814.2	2560	9074.314	20219.3	0.631	3.955
Maximum values	4152718	1949859	110160	567654.8	97509.83	4.261	23.485

Source: compiled by author

Table 2.7 – Analysis of the efficiency of financial expenditure on higher education in 31 provinces (cities) of China in the first stage of 2009–2013

District	TE-1	PTE-1	SE-1	Return on scale	District	TE-1	PTE-1	SE-1	Return on scale
Beijing,	0.955	1	0.955	drs	Hubei	0.986	1	0.986	drs
Tianjin	0.609	0.609	0.999	-	Hunan	0.9	0.902	0.998	irs
Hebei	0.825	0.828	0.996	irs	Guangdong	0.68	0.751	0.906	drs
Shanxi	0.949	0.965	0.984	irs	Guangxi	0.849	0.861	0.986	irs
Inner Mongolia	0.806	0.808	0.997	irs	Hainan	0.94	0.979	0.96	irs
Liaoning	1	1	1	-	Chongqing	0.853	0.861	0.991	irs
Jilin	0.755	0.765	0.987	irs	Sichuan	1	1	1	-
Heilongjiang	0.971	0.975	0.996	irs	Guizhou	0.879	0.893	0.985	irs
Shanghai	1	1	1	-	Yunnan	0.693	0.71	0.977	irs
Jiangsu	0.945	1	0.945	drs	Tibet	0.473	1	0.473	irs
Zhejiang	1	1	1	-	Shaanxi	0.934	0.936	0.997	drs
Anhui	1	1	1	-	Gansu	0.89	0.96	0.927	irs
Fujian	0.959	0.968	0.99	irs	Qinghai	1	1	1	-
Jiangxi	0.869	0.876	0.991	irs	Ningxia g	0.681	0.686	0.993	irs
Shandong	0.863	1	0.863	drs	Xinjiang	0.725	0.764	0.95	irs
He'nan	1	1	1	-					
average value	0.871	0.906	0.962		eastern part	0.880	0.921	0.965	
central section	0.929	0.935	0.993		western part	0.815	0.873	0.940	

Source: compiled by author

The results show that among the 31 provinces (municipalities) in China from 2009 to 2013, there are seven provinces (municipalities) where the efficiency of financial expenditure on higher education is on the technical frontier, namely, Liaoning Province, Shanghai Municipality, Zhejiang Province, Anhui Province, Henan Province, Sichuan Province and Qinghai Province, and all three efficiency values of these provinces (municipalities) are 1. The efficiency of financial expenditure on higher education in the rest of the provinces (municipalities) is not at the most efficient level. Either the pure technical efficiency is slightly lower, or there is a deficiency in the scale efficiency. The province (city) with the lowest comprehensive efficiency is the Tibet Autonomous Region (TAR), with a comprehensive efficiency of just 0.473, a pure technical efficiency of 1, and a scale efficiency of 0.473. It is currently in the stage of increasing returns to scale, indicating a serious inadequacy in the allocation of financial resources for higher education in the TAR.

Table 2.8 – Analysis of the efficiency of financial expenditures on higher education in 31 provinces (cities) of China in the first stage of 2014–2018

District	TE-1	PTE-1	SE-1	Return on scale	District	TE-1	PTE-1	SE-1	Return on scale
Beijing,	0.763		0.763	drs	Hubei	0.887	0.947	0.937	drs
Tianjin	0.905	0.918	0.985	irs	Hunan	1	1	1	-
Hebei	0.839	0.841	0.997	drs	Guangdong	0.645	1	0.645	drs
Shanxi	0.982	1	0.982	irs	Guangxi	0.897	0.907	0.989	irs
Inner Mongolia	0.753	0.779	0.967	irs	Hainan	0.705	0.878	0.803	irs
Liaoning	1		1	-	Chongqing	0.906	0.924	0.981	irs
Jilin	0.861	0.871	0.989	irs	Sichuan	0.996	1	0.996	drs
Heilongjiang	0.936	0.944	0.991	irs	Guizhou	0.772	0.802	0.962	irs
Shanghai	1	1		-	Yunnan	0.893	0.921	0.969	1rs
Jiangsu	0.849		0.849	drs	Tibet	0.463	1	0.463	irs
Zhejiang	0.878	0.912	0.963	drs	Shaanxi	0.928	0.961	0.966	drs
Anhui	0.985	0.986	0.999	drs	Gansu	0.754	0.801	0.942	irs
Fujian	0.901	0.907	0.994	irs	Qinghai	0.771	1	0.771	irs
Jiangxi	0.828	0.833	0.995	irs	Ningxia	0.617	0.733	0.841	irs
Shandong	0.991	1	0.991	drs	Xinjiang	0.735	0.819	0.898	irs
He'nan	0.978	1	0.978	drs					
average value	0.852	0.925	0.923		eastern part	0.879	0.951	0.908	
central section	0.932	0.948	0.984		western part	0.790	0.887	0.895	

Source: compiled by author

According to Table 2.8, the provinces (cities) in which the efficiency of China's higher education financial expenditures was on the technical frontier during the period of 2014–2018 were Liaoning Province, Shanghai Municipality and Hunan Province. Compared with the efficiency values of the previous five years, the efficiency of Zhejiang Province, Anhui Province, Henan Province, Sichuan Province and Qinghai Province declined, and all of them were no longer in the state of the most efficient allocation of financial resources. Out of the 31 provinces (cities), Beijing, Shanxi, Jiangsu, Shandong, Henan, Guangdong, Sichuan, Tibet Autonomous Region and Qinghai all exhibit a pure technical efficiency of 1, signifying that their lower scale efficiency primarily impacts the financial efficiency of higher education in these regions. From the perspective of scale reward, the two western regions of Shanxi, Tibet and Qinghai demonstrate an increasing scale reward, while the remaining six regions show a decreasing scale reward, suggesting

that the issue of excessive input scale is prevalent in the eastern and central provinces. Most provinces have scale efficiencies higher than 0.9, with the exception of Shandong Province and Tibet Autonomous Region, which have scale efficiencies lower than 0.9, 0.863, and 0.473, respectively. These regions all have technical efficiencies of 1, suggesting further improvements in the scale of higher education financial expenditures.

Comparing the two five years before and after, the average comprehensive efficiency of China's higher education financial expenditure in 2014–2018 is 0.852, with a pure technical efficiency of 0.925 and a scale efficiency of 0.923. This represents a decrease of 2.2% and 4.1%, respectively, compared to the 0.871 and 0.962 in 2009–2013. However, the pure technical efficiency has increased compared to the 0.906 in 2009-2013, suggesting a decrease in the comprehensive efficiency of China's higher education financial expenditure over the past five years, primarily due to the decline in scale efficiency. The comprehensive efficiency of China's financial expenditure on higher education has declined in the past five years, primarily due to a reduction in scale efficiency, as evidenced by its increase from 0.906 in 2009–2013. I divided the provinces (cities) into three parts: East, Middle East, and West, based on the existing literature on region division. I then calculated the efficiency of each part of the comprehensive calculation to determine the average, and the table displays the results. The calculation results reveal that none of the three regions have achieved optimal efficiency, with the western region having the lowest three efficiency values. This suggests that the western region's higher education financial expenditures require improvement, both in terms of technical efficiency and scale efficiency. The central region exhibits the highest comprehensive efficiency and scale efficiency, suggesting that its financial allocation for higher education is more efficient. Over the course of the two-five-year period, the three regions have experienced an increase in technical efficiency, albeit a slight reduction in scale efficiency. This suggests that the eastern, central, and western regions share a common challenge in improving the scale efficiency of higher education financial expenditure. Second, looking at the trend of changes in the remuneration of scale, from 2009 to 2013, most provinces (cities) had increasing remuneration of scale. But from 2014 to 2018, most provinces (cities) started to see decreasing remuneration of scale. This

means that China's higher education funds are being wasted in some provinces (cities) because they are being over-allocated, creating waste and inefficiency. However, certain provinces (cities) continue to demonstrate increasing returns to scale. Therefore, on the whole, the allocation of financial resources for higher education in China still leaves room for optimization.

Analysis of the results of the adjusted DEA model at stage 2. Considering that the efficiency of higher education financial expenditure is not only affected by management inefficiency, but also by the environment and random disturbances, etc., this study takes the slack variables of the input variables of the decision-making units in the first stage (higher education financial expenditure in each province) as the explanatory variables and the three environmental variables, namely, GDP per capita, the environment of higher education clusters and the degree of fiscal decentralisation, as the explanatory variables. The study uses the Fronlier4.1 software for SFA regression, and the results for the two periods are shown in Table 2.9 and Table 2.10, respectively.

Table 2.9 – Similar SFA Regression Results for Stage 2, 2009–2013

2009-2013	Constant term (math.)	GDP per capita	Higher education cluster environment	Degree of fiscal decentralisation	γ	LR one-sided error
Slack financial spending on higher education	-18804.908** (-3.1302)	-0.652*** (-1.768)	16060.144*** (3.8491)	-840.267** (-4.92)	0.78*** (2.844)	17.2804**

Note: t-statistics in parentheses, ***, ** and * indicate significance at the 10 per cent, 5 per cent and 1 per cent significance levels, respectively.

Table 2.10 – Similar SFA Regression Results for Stage 2, 2014–2018

2014-2018	Constant term (math.)	GDP per capita	Higher education cluster environment	Degree of fiscal decentralisation	γ	LR one-sided error
Slack financial spending on higher education**	-10652.95*** (-3.0835)	-1.73*** (-1.996)	7257.84*** (4.1790)	-5501.52** (-3.5123)	0.81*** (2.1689)	16.9336***

Note: t-statistics in parentheses, ***, ** and * indicate significance at the 10 per cent, 5 per cent and 1 per cent significance levels, respectively.

The second stage results from 2009 to 2013 demonstrate that the regression coefficients of the three external environment variables on the input slack variables can be significant at the 1% or 5% level. This suggests that the external environment does exert some influence on the input redundancy of higher education financial expenditures in various locations. Also, $\gamma = \sigma_v{}^2/(\sigma_v{}^2 + \sigma_\mu{}^2)$ shows how much internal management and scale level affect inefficiency. The higher the value, the more internal management and scale level affect the overall efficiency of higher education spending, and the opposite is also true: the higher the value, the more random disturbances affect the overall efficiency. The value of γ here is 0.78 and significant at the 1% level, indicating that the ineffectiveness of internal management and unreasonable level of scale are the main factors causing poor comprehensive efficiency, but the impact of random disturbing factors cannot be ignored, and it is necessary to peel off the impact of random disturbing factors on comprehensive efficiency at this stage so as to get the degree of ineffectiveness caused by internal management and scale level only at the third stage.

The results of the second stage regression for 2014–2018 are similar to those for 2009–2013, with all three external environmental variables showing a significant effect on comprehensive efficiency and with internal management and size level remaining the main influences on comprehensive efficiency. The external environmental variables are regressions of input slack. Therefore, when the regression coefficients of these variables are negative, they are inversely proportional to input slack. This implies that an increase in the value of an environmental variable can reduce input slack, input waste, or negative output. Conversely, an increase in these environmental variables can lead to an increase in input redundancy, as well as an increase in both input waste and negative output. Specifically, each environmental variable, GDP per capita, and the degree of fiscal decentralisation significantly impact the efficiency of higher education fiscal expenditure. This means that for provinces (municipalities) with higher levels of economic development, an increase in GDP per capita will appropriately reduce the input redundancy of higher education fiscal expenditure, thereby improving its efficiency. This is in line with the findings of This

aligns with the findings of existing literature; on the one hand, most Chinese provinces (cities) are still in the stage of increasing returns to scale. As economic development increases, the field of higher education receives more financial support, leading to an improvement in the efficiency of its expenditures. On the other hand, as previously mentioned, most scholars acknowledge the promotion of fiscal decentralisation on the efficiency of public product supply. The increasing degree of decentralisation also contributes to the enhancement of China's higher education financial expenditure efficiency.

The HE cluster environment demonstrates a positive impact on the efficiency slack of higher education fiscal spending. This suggests that an increase in the degree of HE clustering, specifically the number of HEIs per 100 square kilometres, will not enhance the efficiency of higher education fiscal spending as some scholars have predicted, but rather lead to a decrease in it. This is understandable. Although clustering of HEIs may enhance inter-university exchanges, excessive concentration of HEIs does not mean that the HEIs are equal in terms of access to financial resources, nor does it mean that the allocation of financial resources for higher education will be more efficient from the point of view of higher education financial expenditures.

Therefore, clustering of higher education institutions may result in fierce competition, and those high-level colleges and universities are more likely to fight for rich educational resources, at which time financial resources may instead be over-concentrated in certain high-level colleges and universities within the region, because the financial investment in certain colleges and universities within the region has been able to satisfy the demand for services in the region, and other colleges and universities, although able to receive some support through the sharing of resources, are ultimately because of the inability to obtain more direct financial support, resulting in the allocation of resources. Direct financial support leads to a reduction in the efficiency of resource allocation [200]. The clustering of colleges and universities leads to the concentration of resources but reduces the overall efficiency of resource allocation, which also explains why it is necessary to allocate higher education resources in a balanced way.

Analysis of the results of the adjusted DEA model at stage 3. According to the regression results of the second stage and the adjustment formula in the research methodology section, the input quantities of each decision-making unit are adjusted to the same environment and the same random errors, and the original output quantities are jointly substituted into the BCC model again for the third stage of the DEA efficiency measurements, and the results of the calculations for the two time periods are shown in Tables 2.11 and 2.12, respectively.

Upon adjusting for environmental factors and random interference terms, a comparison between Table 2.7 in the first stage and the results of Table 2.11 in the third stage reveals an improvement in the efficiency of financial expenditure on higher education in most regions of China from 2009 to 2013. The average comprehensive efficiency of Chinese higher education financial expenditures increased from 0.871 to 0.953, primarily due to an increase in technical efficiency from 0.906 to 0.986, while the scale efficiency only slightly increased from 0.962 to 0.966. The comprehensive efficiency of the eastern, middle, and western regions also experienced a slight increase, while the technical efficiency of all three regions saw a significant increase. However, the scale efficiency of the eastern region experienced a slight decrease, from 0.965 to 0.955, suggesting further optimization of the financial expenditure on higher education in the region.

In terms of provinces (municipalities), the number of provinces (municipalities) that have reached the technological frontier surface has increased significantly, and the provinces (municipalities) with a comprehensive efficiency of 1 have been added to include Tianjin, Shanxi, Jiangxi, Hunan, Guangxi Zhuang Autonomous Region, Hainan, Guizhou, Yunnan, Shaanxi and Gansu, while the comprehensive efficiencies of Anhui, Henan, Sichuan, and Qinghai have decreased. These provinces (municipalities) are located in the central and western regions, where the comprehensive efficiencies are primarily caused by a decrease in scale efficiency, while the scale reward is showing an increasing trend. This indicates that after eliminating the external environment and random disturbing factors, the financial expenditure on higher education in these regions cannot reach scale efficiency, and it

is necessary to further increase the financial investment in the field of higher education. Out of all the provinces (cities), the Tibet Autonomous Region maintains the lowest overall efficiency, primarily due to scale inefficiencies.

Table 2.11 – Analysis of the efficiency of financial expenditure on higher education in 31 provinces (cities) of China in the third stage, 2009–2013

District	TE-3	PTE-3	SE-3	Return on scale	District	TE-3	PTE-3	SE-3	Return on scale
Beijing	0.869	1	0.869	drs	Hubei	0.955	0.958	0.997	drs
Tianjin	1		1	-	Hunan	1	1	1	-
Hebei	0.878	0.903	0.972	irs	Guangdong	0.846	0.999	0.845	drs
Shanxi	1	1	1	-	Guangxi	1	1	1	-
Inner Mongolia	0.842	0.930	0.905	irs	Hainan	1	1	1	-
Liaoning	1	1	1	-	Chongqing	0.976	0.991	0.985	irs
Jilin	0.967	0.968	0.999	irs	Sichuan	0.998	1	0.998	drs
Heilongjiang	0.972	0.977	0.995	irs	Guizhou	1	1	1	-
Shanghai	1	1	1	-	Yunnan	1	1	1	-
Jiangsu	0.915	0.988	0.926	drs	Tibet	0.757	1	0.757	irs
Zhejiang	1	1	1	-	Shaanxi	1	1	1	-
Anhui	0.973	1	0.973	irs	Gansu	1	1	1	-
Fujian	0.843	0.945	0.892	irs	Qinghai	0.901	1	0.901	irs
Jiangxi	1	1	1	-	Ningxia	0.850	0.897	0.948	irs
Shandong	0.999	1	0.999	drs	Xinjiang	0.995	1	0.995	irs
He'nan	0.998	1	0.998	irs					
average value	0.953	0.986	0.966		eastern part	0.941	0.985	0.955	
central section	0.983	0.988	0.995		western part	0.943	0.985	0.957	

Source: compiled by author

In the third stage, from 2014 to 2018, there has been a significant shift in the efficiency of financial expenditure on higher education compared to the first stage. A comparison of Tables 2.10 and 2.12 reveals that half of the provinces (municipalities) have experienced an increase in comprehensive efficiency, while the other half have experienced a decrease. Overall, the country's comprehensive efficiency has declined, indicating that China's higher education financial expenditure is not as efficient as it could be when environmental and stochastic factors are removed. Both the national average comprehensive efficiency and scale efficiency have decreased compared to the first stage, with the comprehensive efficiency declining from 0.852 to 0.842 and the scale efficiency decreasing from 0.923 to 0.904.

Table 2.12 – Analysis of the efficiency of financial expenditures on higher education in 31 provinces (cities) of China in the second phase of 2014–2018

District	TE-3	PTE-3	SE-3	Return on scale	District	TE-3	PTE-3	SE-3	Return on scale
Beijing	0.786	1	0.786	drs	Hubei	0.902	0.948	0.952	drs
Tianjin	0.891	0.918	0.971	irs	Hunan	1	1	1	-
Hebei	0.842	0.844	0.998	drs	Guangdong	0.665	1	0.665	drs
Shanxi	0.974	1	0.974	irs	Guangxi	0.903	0.919	0.983	irs
Inner Mongolia	0.728	0.78	0.934	irs	Hainan	0.63	0.873	0.721	irs
Liaoning	1	1	1	-	Chongqing	0.882	0.91	0.969	irs
Jilin	0.866	0.886	0.977	irs	Sichuan	1	1	1	-
Heilongjiang	0.964	0.982	0.982	irs	Guizhou	0.77	0.819	0.941	irs
Shanghai	1	1	1	-	Yunnan	0.888	0.932	0.953	irs
Jiangsu	0.872	1	0.872	drs	Tibet	0.332	1	0.332	irs
Zhejiang	0.886	0.912	0.971	drs	Shaanxi	0.969	0.995	0.974	drs
Anhui	0.997	0.998	0.999	irs	Gansu	0.76	0.833	0.912	irs
Fujian	0.908	0.92	0.987	irs	Qinghai	0.622	1	0.622	irs
Jiangxi	0.845	0.853	0.991	irs	Ningxia	0.542	0.743	0.73	irs
Shandong	0.984	1	0.984	drs	Xinjiang	0.708	0.833	0.85	irs
He'nan	0.992	1	0.992	drs					
average value	0.842	0.932	0.904		eastern part	0.861	0.952	0.905	
central section	0.943	0.958	0.983		western part	0.759	0.897	0.85	

Source: compiled by author

However, the pure technical efficiency has increased from 0.925 to 0.932, suggesting that the unreasonable scale remains the primary factor influencing the efficiency of China's higher education financial expenditures. The three regions in the east, centre, and west have improved their technical efficiency compared to the first stage, but the scale efficiency has shown a reduction. Only the central region has seen a slight improvement in comprehensive efficiency, suggesting that higher technical efficiency has bolstered this improvement, while the reduction in scale efficiency in the eastern and western regions has clearly led to a decrease in comprehensive efficiency. Among the three regions, the highest efficiency is in the central region, the lowest efficiency is in the western region, and the comprehensive efficiency, technical efficiency, and scale efficiency of the western region are lower than those of other regions. Therefore, we should improve both internal management and the scale of higher education financial expenditures in the western region to enhance their efficiency.

In terms of provinces (municipalities), the number of provinces (municipalities) that have reached the technological frontier has increased to include Sichuan Province, where all three efficiency values are 1. The number of provinces (municipalities) with rising comprehensive efficiency is 16, namely Beijing, Hebei Province, Jilin Province, Heilongjiang Province, Jiangsu Province, Zhejiang Province, Anhui Province, Fujian Province, Jiangxi Province, Henan Province, Hubei Province, Guangdong Province, Guangxi Zhuang Autonomous Region, Sichuan Province, Shaanxi Province and Gansu Province; the number of provinces (municipalities) with declining comprehensive efficiency is 12, namely Tianjin Municipality, Shanxi Province, Inner Mongolia Autonomous Region, Shandong Province, Hainan Province, Chongqing Municipality, Guizhou Province, Yunnan Province, Tibet Autonomous Region, Qinghai Province and Yunnan Province, respectively. There are 12 provinces (municipalities) with declining comprehensive efficiency, namely Tianjin, Shanxi, Inner Mongolia Autonomous Region, Shandong, Hainan, Chongqing, Guizhou, Yunnan, Tibet Autonomous Region, Qinghai, Ningxia Hui Autonomous Region and Xinjiang Uygur Autonomous Region.

The east-central region concentrates the provinces (municipalities) with rising comprehensive efficiency, while the western region is home to most provinces (municipalities) with declining comprehensive efficiency, primarily due to a decline in scale efficiency. Most provinces (municipalities) have seen an increase in their technical efficiency, while only Hainan Province and Chongqing Municipality have seen a slight decline in their technical efficiency, from 0.878 and 0.924 to 0.873 and 0.91, respectively. While the comprehensive efficiency of Jilin, Heilongjiang, Fujian, Jiangxi, Guangdong and other provinces has increased, the scale efficiency continues to decline, suggesting that addressing the issue of irrationality is the key to enhancing the efficiency of higher education in China. We urgently need to solve the issue of financial expenditure efficiency.

In summary, our findings indicate that the real efficiency of China's higher education financial expenditures experienced a slight increase from 2009 to 2013 but remained unsatisfactory from 2014 to 2018. The primary factor affecting this

efficiency is the unreasonable scale of expenditures. Combined with the previous chapter's study of the gap and convergence trend of China's higher education financial expenditures, I found that after a period of decline from 2007 to 2014, the regional gaps in China's higher education financial expenditures began to increase again after 2014. It demonstrates the need for further optimization of China's financial expenditure on higher education in recent years, both in terms of overall scale and expenditure structure.

2.3 Coordinating undergraduate education and regional economies in mainland China's provinces: findings for state management

The coordinated development of undergraduate education and the regional economy is an important topic for the cross-study of many disciplines, such as education, economics, and management. Some scholars have conducted qualitative research on the relationship between undergraduate education and economic development based on the theories of knowledge economy, regional competitiveness, human capital, etc. Pan Maoyuan [204] presented two main ideas: firstly, the demand for undergraduate education varies at different stages with the development of the local economy; and secondly, from an economics perspective, there exists a two-way and multi-dimensional non-equilibrium interactive relationship between the two. In addition, some scholars have conducted quantitative analyses using statistical data and technical tools such as comprehensive evaluation methods, principal component analysis and factor analysis. They have also employed the ranked level difference method and correlation coefficient method to evaluate the coordination between the two. Despite the high reference value of existing studies, their focus is primarily on value analysis and theoretical discussion, with less emphasis on data analysis and empirical research. Furthermore, the majority of these studies rely on time-series data, with relatively little cross-sectional data. This dissertation aims to address this status quo by conducting correlation analyses and producing a coordination schematic based on data related to the scale of undergraduate education and the regional economic

development of 31 provinces in mainland China in 2018. This will be done from the perspectives of multiple disciplines, including pedagogy, economics and management. At the same time, this dissertation will propose corresponding strategies for the three regions where the scale of undergraduate education is ahead of economic development, lags behind it and has a low level of both.

The coordinated development of the scale of undergraduate education and the regional economy is an inevitable product of historical development and their combination has a deep foundation.

Research on undergraduate education has shown that, on the one hand, undergraduate education is the intermediate level of higher education in China, occupying a dominant position in the structure of higher education and belonging to the first stage of the third level of UNESCO's International Standard Classification of Education (granting the first level of a university degree or the equivalent of a qualification certificate). Undergraduate education typically lasts four years and is one of the three levels of higher education, along with specialised education and postgraduate education. On the other hand, according to Gu Mingyuan [205], the scale of education is defined as "the sum of educational institutions of all levels and types and the number of human, financial and material resources they possess". We can divide the scale of education into three aspects: internal activities, vertical and horizontal. We can divide its internal activities into the scale of educational investment, the scale of educational equipment and the scale of teachers and students; its vertical structure into the scale of pre-school education, the scale of primary education, the scale of secondary education and the scale of higher education; and its horizontal structure into the scale of school education and the scale of social education. The size of the population, its age structure and the level of economic development constrain it. An appropriate scale of education can yield significant educational benefits. We can divide indicators for measuring the scale of education into relative and absolute ones. Relative indicators refer to the use of demographic or economic indicators to measure the scale of education relative to the level of development of the region; absolute indicators refer to the absolute number of colleges and universities, the number of

students, the number of teachers and other absolute quantities owned by a region. In short, the scale of undergraduate education refers to the sum of undergraduate colleges and universities and the number of people, property and materials they possess. The term "people" refers to the faculty, "finance" refers to the investment of education funds, and "material" refers to instruments, equipment, campus buildings, etc. The standard of measurement includes relative and absolute indicators.

On the one hand, clarifying the term "region" is crucial for understanding research on the regional economy. The concept has been interpreted in very different ways by different scholars due to constraints of cognitive level, research direction, and differences in time. In the Dictionary of Western Economics, "region" refers to "the economic and social complex created by human economic activities with specific geographical components, which can be distinguished from other territorial and spatial complexes due to the high degree of correlation between the various components' certain characteristics". It follows that a region can be as small as a village, as large as a country, or even as a cross-border place jointly developed by several countries. On the other hand, regional economy is a comprehensive and systematic concept. Regional economy encompasses two aspects: According to Li, K.P., & Ho, Steriliser, "one refers to the economic behaviour and economic relations between regions of a country; the other refers to the economic behaviour and economic relations between economic areas, organisations and sectors within a region [206]. Statistical classification, economic centre analysis and economic linkage, among other methods, can divide regional economies. This dissertation divides the regional economy by administrative regions and uses the quantitative characteristics of regional economic development, such as GDP, to reflect the regional economy.

Research has demonstrated that the coordinated development of undergraduate education and the regional economy is crucial. Undergraduate education and regional economy, as two indispensable subsystems in the process of advancing the orderly development of society, depend on and promote each other. Overly advanced undergraduate education can result in a surplus of undergraduate graduates compared to the need for social and economic development, which could lead to a decrease in

college graduates' employment rates and a waste of human resources. Conversely, if the regional economy is overly developed, the demand for talent will rise significantly, but the supply of graduates won't meet the demand, which could hinder the regional economy's growth due to insufficient talent. According to Zhang Zheng [207], the further development of the regional economy will be hindered in the end. Referring to the definition of the coordinated development of higher education and regional economy, the coordinated development of undergraduate education scale and regional economy can be understood as the provinces and regions under the unified leadership of the central government, the provinces and municipalities according to the actual situation of their own socio-economic development, to determine the number of colleges and universities of undergraduate education, the number of students, the number of teachers, etc., so that the undergraduate education can cultivate talents in line with the actual needs of the society, which can promote the sustainable development of the local economy. sustainable development. This research naturally discusses the coordinated development of undergraduate education within the framework of priority development, rather than establishing a synchronous standard between the scale of undergraduate education and the regional economy.

The purpose of this study is to evaluate how well 31 provinces in mainland China's undergraduate education system align with the region's economic development. The study uses a multi-stage methodological approach that includes indicator selection, data collection, data processing and analysis and result interpretation in order to accomplish this goal.

This study selected several significant variables to assess the extent of undergraduate education in the region and the level of economic development in the area. Among these indicators are:

Indicators of the scope of undergraduate education include the number of higher education institutions, enrolled students, full-time teachers, total education spending and the amount spent per student. These metrics provide clear, quantifiable methods to assess the quality of education and accurately depict the allocation and utilization of educational resources.

Gross domestic product (GDP) and GDP per capita are measures of the degree of regional economic development. While GDP per capita offers a per capita view of the degree of economic development, GDP acts as an indicator of the total amount of economic activity.

I chose these indicators because they can provide a comprehensive picture of the scale of education and economic development, and because they have high data availability to facilitate comparative analyses across provinces and territories.

The 2018 statistical yearbooks for the mainland China's 31 provinces, government reports from the education sector and other trustworthy public data sources serve as the foundation for the data collection process. I double-verified all the data and appropriately interpolated it to account for any potential missing data, ensuring its dependability and quality.

This study standardised the data to eliminate the impact of disparate data units and orders of magnitude on the analysis's outcomes. Particular techniques comprised:

Normalizing is the process of transforming unprocessed data into dimensionless relative values in order to make it easier to compare various indicators.

Z-score normalisation. To evaluate each provincial administrative unit's relative position with respect to the amount of undergraduate education and the degree of economic development, a Z-score is computed for each indicator.

This study employed the following analyses to evaluate the relationship between the size of undergraduate education and regional economic development:

- Correlation analysis assessing the strength of the correlation between undergraduate education size indicators and GDP and GDP per capita by calculating the correlation coefficients between the two.

- Regression analysis. A linear regression model was used to explore the relationship between undergraduate education size indicators and economic development indicators.

A schematic of coherence is constructed to visualise the relative position of the size of undergraduate education and the level of economic development of each provincial administrative unit, as well as the coherence between them.

Based on the results of the analyses, this study will provide an in-depth discussion of the phenomena of coherence and incoherence found, along with specific recommendations. The aim of these recommendations is to align the undergraduate education scale with the regional economy, thereby fostering sustainable socio-economic development.

An analysis of the correlation charts derived from the research design reveals an imbalance in the regional development of undergraduate education in China, as evidenced by the significant differences in data of the five indicators of the undergraduate education scale across different provinces and regions. The linear regression analysis graphs comparing the five indicators of the undergraduate education scale to the regional GDP and regional per capita GDP demonstrate a strong correlation, although the correlation with per capita GDP is less evident. The schematic diagram illustrating the relationship between the undergraduate education scale and the regional economic development level reveals that in certain provinces and regions, the undergraduate education scale is not in line with the latter's level of development. I analysed the real conditions in each province and region, and the results revealed that a number of elements, including history and culture, influenced the variations in undergraduate education levels.

Uneven regional development of undergraduate education in China. After an in-depth analysis of the scale of undergraduate education in 31 provinces in mainland China, this study finds that there is a significant imbalance in the regional development of undergraduate education in China. The following aspects primarily reflect this imbalance:

Geographical differences in the number of undergraduate colleges and universities. The distribution of resources for higher education in a region can be inferred from the number of undergraduate colleges and universities in that area. With 77 undergraduate colleges and universities, Jiangsu Province leads the list, according to the analysis's findings, which highlight the province's concentrated edge in higher education resources. However, there are just four undergraduate colleges and universities in Tibet Autonomous Region and Qinghai Province, indicating a severe

lack of resources for higher education in these areas. This inequality restricts the possibilities for social and economic growth in these areas as well as local citizens' access to higher education (see Figure 2.12).
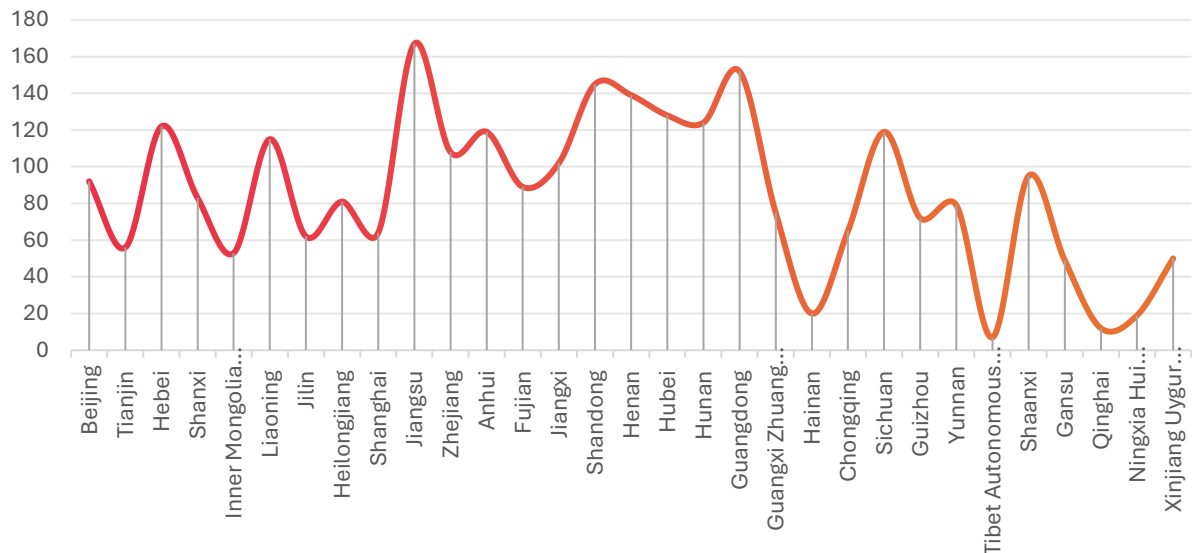

Figure 2.12 – Number of undergraduate colleges and universities by province (city)

Source: developed by the author

Interprovincial differences in the number of students enrolled. The number of enrolled students directly reflects the coverage and popularity of higher education. It is found that the number of students enrolled in Jiangsu, Henan and Guangdong provinces exceeds 1 million, and these provinces have made remarkable achievements in the popularisation and expansion of higher education. However, the number of enrolled students in Hainan Province, Tibet Autonomous Region and Qinghai Province is less than 200,000, indicating that there is still much room for improvement in the popularisation of tertiary education in these regions (see Figure 2.13).
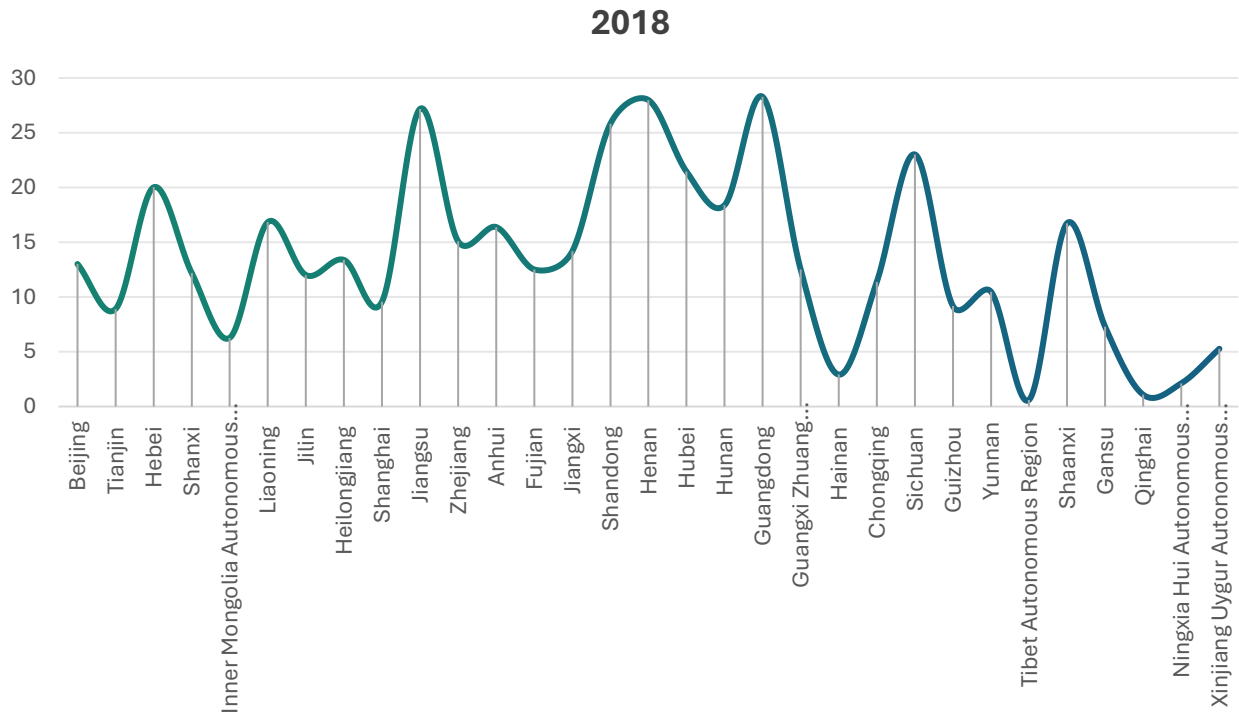
2018

Figure 2.13 – Number of students enrolled in undergraduate colleges and universities by province (city)

Source: developed by the author

Regional disparities in funding for education. Investment in education funding is a key factor in ensuring the quality and development of higher education. This study shows that the total funding for undergraduate education in places such as Guangdong Province and Beijing is close to 30 billion yuan, whereas in places such as Tibet Autonomous Region, Qinghai Province, Xinjiang Uygur Autonomous Region and Hainan Province, the investment is less than 5 billion yuan. This huge difference in funding input directly affects the hardware facilities, faculty and teaching quality of undergraduate education in each place (see Figure 2.14).
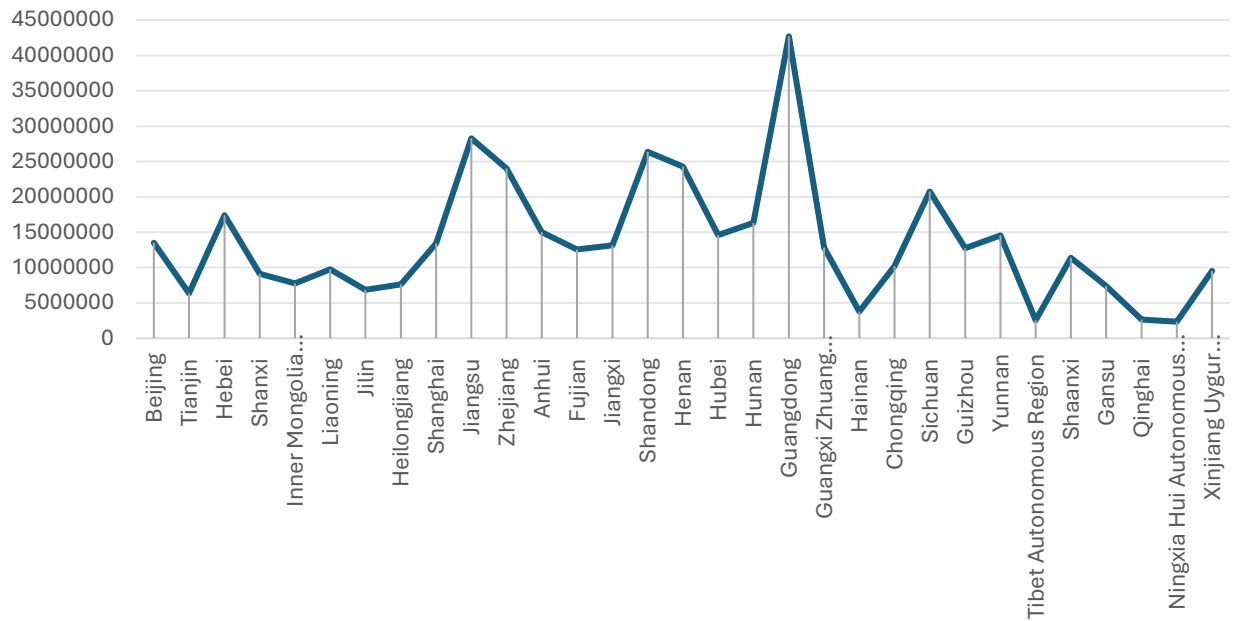
Figure 2.14 – Total funding for the size of undergraduate education by province (city)

Source: developed by the author

Inter-provincial differences in per-pupil funding. Per-pupil funding is an important indicator of equity in the distribution of educational resources. The study found that the per pupil funding in Liaoning Province is RMB 14,580.39, while the per pupil funding in Beijing is as high as RMB 63,273.24, which is more than three times that of Liaoning Province. This difference in per-pupil funding not only affects students' educational experience and learning quality but also reflects the uneven distribution of educational resources (see Figure 2.15).
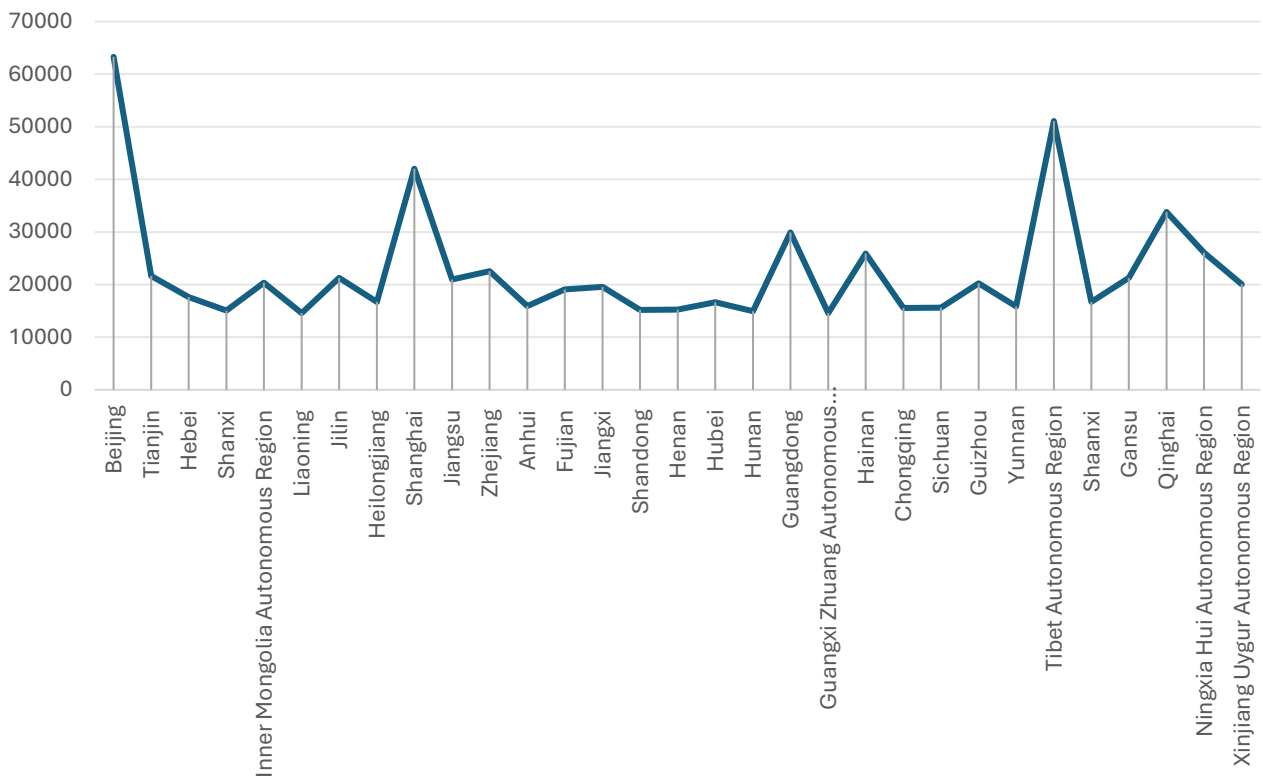
Figure 2.15 – Undergraduate education scale per student funding by province (city)
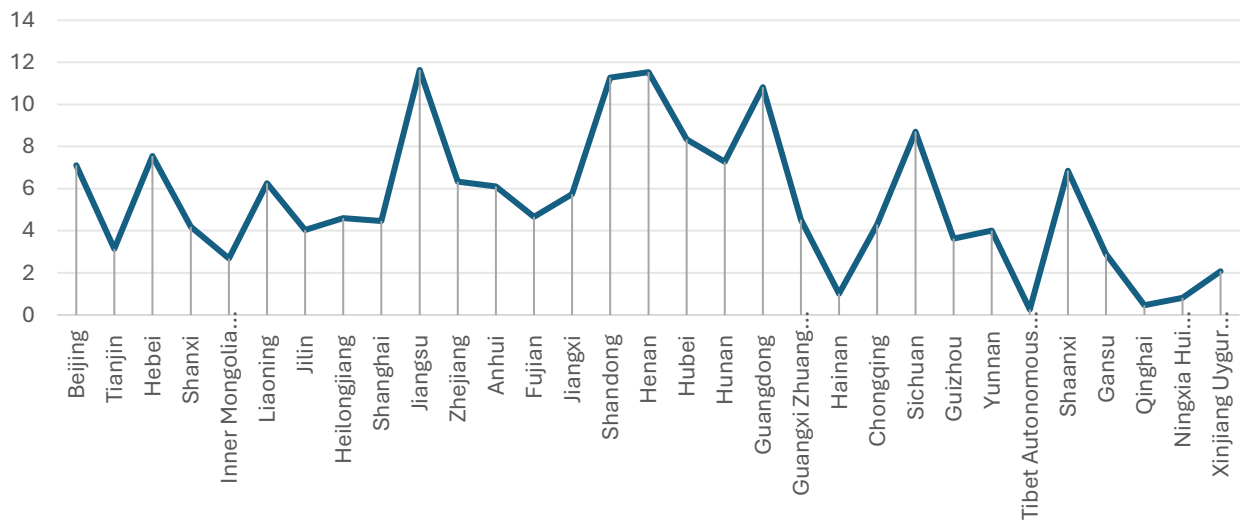
Source: developed by the author

Figure 2.16 – Number of full-time faculty in undergraduate colleges and universities by province (city)

Source: developed by the author

Geographical differences in the number of full-time teachers. The number of full-time teachers is an important indicator of human resources in higher education. Jiangsu Province ranks first in the country with 116,350 full-time teachers, while the Tibet Autonomous Region has only 2,629 full-time teachers. This discrepancy not only affects the quality of teaching and student learning outcomes but also limits the development and innovation capacity of higher education in these regions (see Figure 2.16).

In summary, the problem of uneven regional development of undergraduate education in China is very prominent. This imbalance is not only reflected in the distribution of educational resources, but also in the quality of education and development opportunities. In order to promote the balanced development of higher education in China, it is necessary to start from many aspects, such as human resources, financial resources, and policy to better support areas with limited educational resources, optimise the distribution of educational resources, and raise educational standards in order to attain equitable education and well-coordinated socioeconomic development. Number of HEIs and GDP: The coefficient of determination of the number of HEIs and GDP, R^2, reaches 0.7823, indicating that 78.23 percent of the change in the number of HEIs can be explained by the change in GDP, which shows a strong positive correlation (see Figure 2.17).
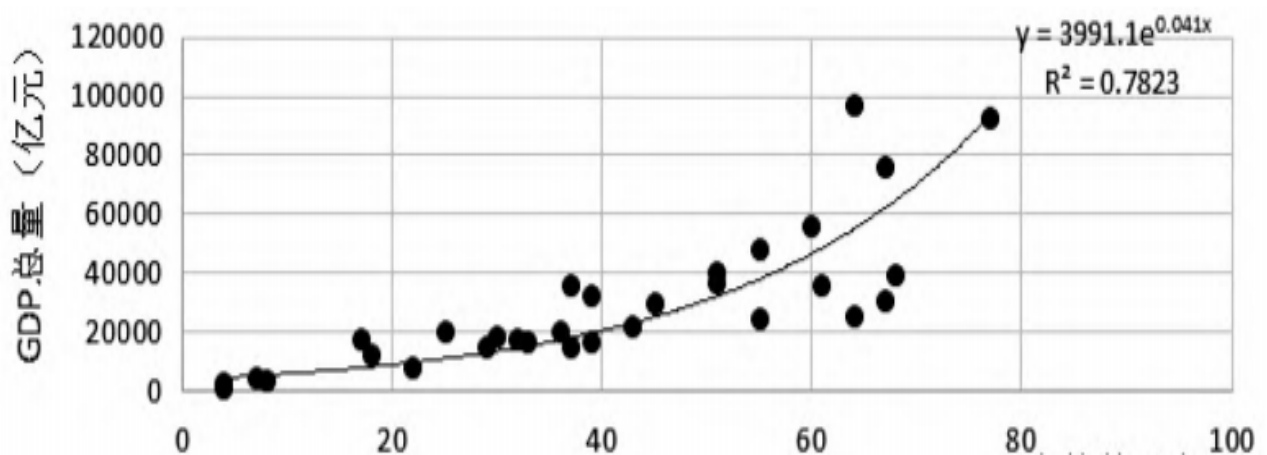

Figure 2.17 – Relationship between the number of undergraduate colleges and universities and regional GDP by province

Source: developed by the author

The size of undergraduate education has a strong correlation with GDP. After comprehensively analysing data on the size of undergraduate education and regional economic development in 31 provinces in mainland China in 2018, this study reveals a significant positive correlation between the size of undergraduate education and gross domestic product (GDP). This correlation suggests that as the regional economy develops, the demand for and investment in undergraduate education increases, reflecting the close link between education and economic development.

Number of students enrolled and GDP. The coefficient of determination of the number of students enrolled and GDP, R^2, is 0.7825, further confirming the close relationship between the size of education and economic development (see Figure 2.18).

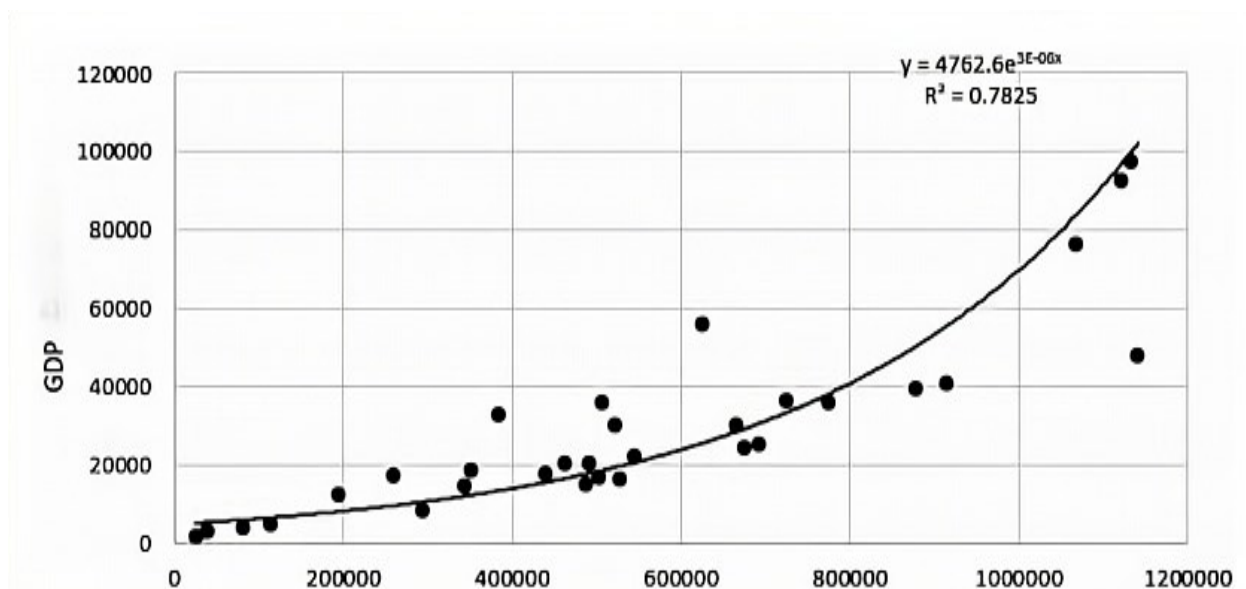Figure 2.18 – Relationship between the number of undergraduate students enrolled and regional GDP by province

Source: developed by the author

Number of full-time teachers and GDP. The coefficient of determination (R^2) between the number of full-time teachers and GDP shows a strong positive correlation between the rise in the local economy and the number of full-time teachers (see Figure 2.19).
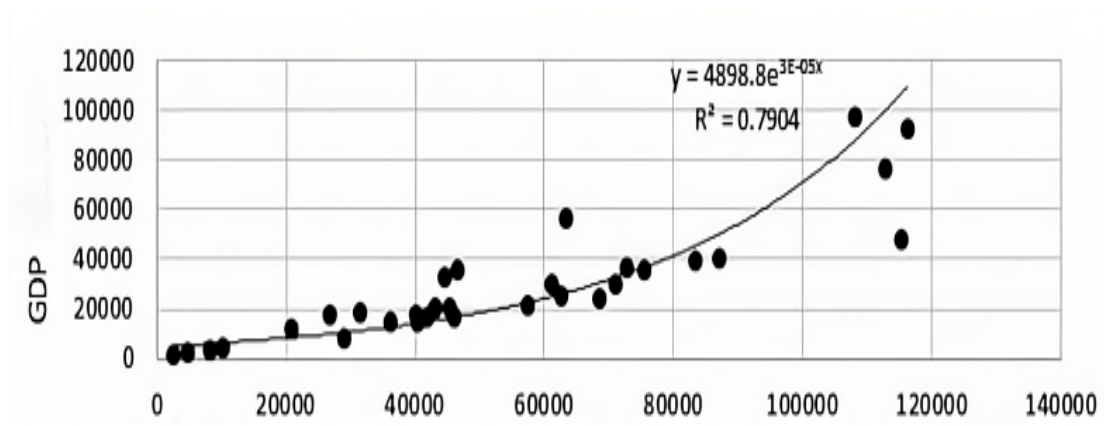
Figure 2.19 – Relationship between the number of full-time faculty in undergraduate institutions and regional GDP by province

Source: developed by the author

Education spending and GDP. The R² of the resolvability coefficient of education spending and GDP is 0.6844, which is slightly lower than the previous indicators, but still shows a strong correlation. (See Figure 2.20.)
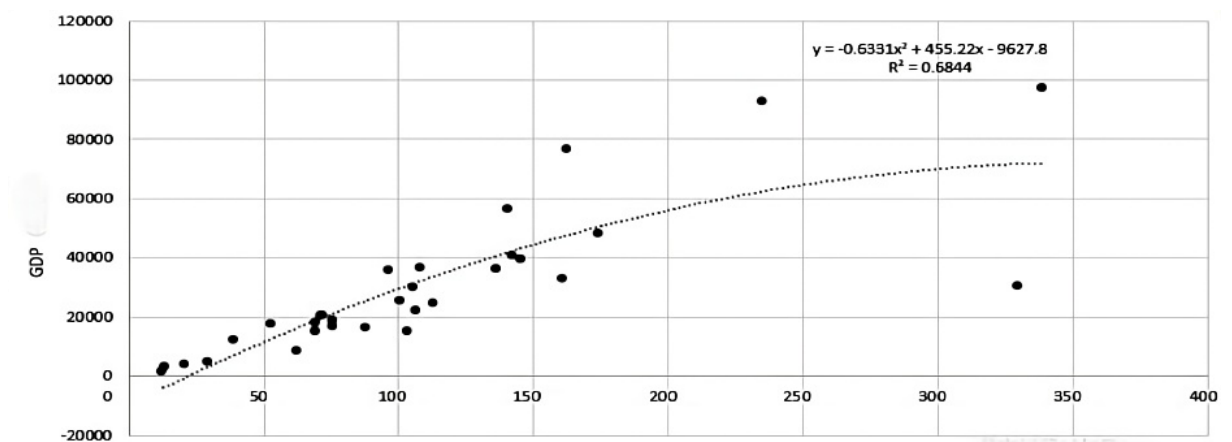
Figure 2.20 – Relationship between undergraduate education funding and regional GDP by province

Sources: developed by the author

These results suggest that as GDP grows, investment in undergraduate education increases in each provincial region, probably because economic growth provides more financial resources for investment in education and also reflects increased social demand for higher education. In addition, the development of undergraduate education

may also have contributed to regional economic growth, as higher education is able to train more specialised personnel and promote technological innovation and industrial upgrading, thereby contributing to economic development.

The strong correlation between the size of undergraduate education and GDP reveals the two-way interactive relationship between education and economic development. To fulfil the demand for highly qualified persons for economic development, more must be done to optimise the allocation of educational resources and raise the standard of education in order to promote sustained regional economic development. In order to encourage the general improvement of the social economy through education, the government and other societal sectors should simultaneously raise their investment in education, particularly in the more economically disadvantaged areas.

The scale of undergraduate education in some provinces is not coordinated with regional economic development. Upon conducting a thorough analysis of the undergraduate education scale and the regional economic development level in 31 Chinese mainland provinces, this study finds several provinces where there are notable disparities in the way the scale of undergraduate education and economic development are coordinated. This discrepancy is a problem for the regional economy's ability to grow sustainably and shows up differently in each province.

This study classifies provincial administrative units based on the relative positions of their scales of undergraduate education and levels of economic development by creating a schematic diagram of the coordination between the two variables. The following schematic diagram (see Figure 2.21) illustrates how the scope of undergraduate education and the degree of economic development in some regions are out of sync:
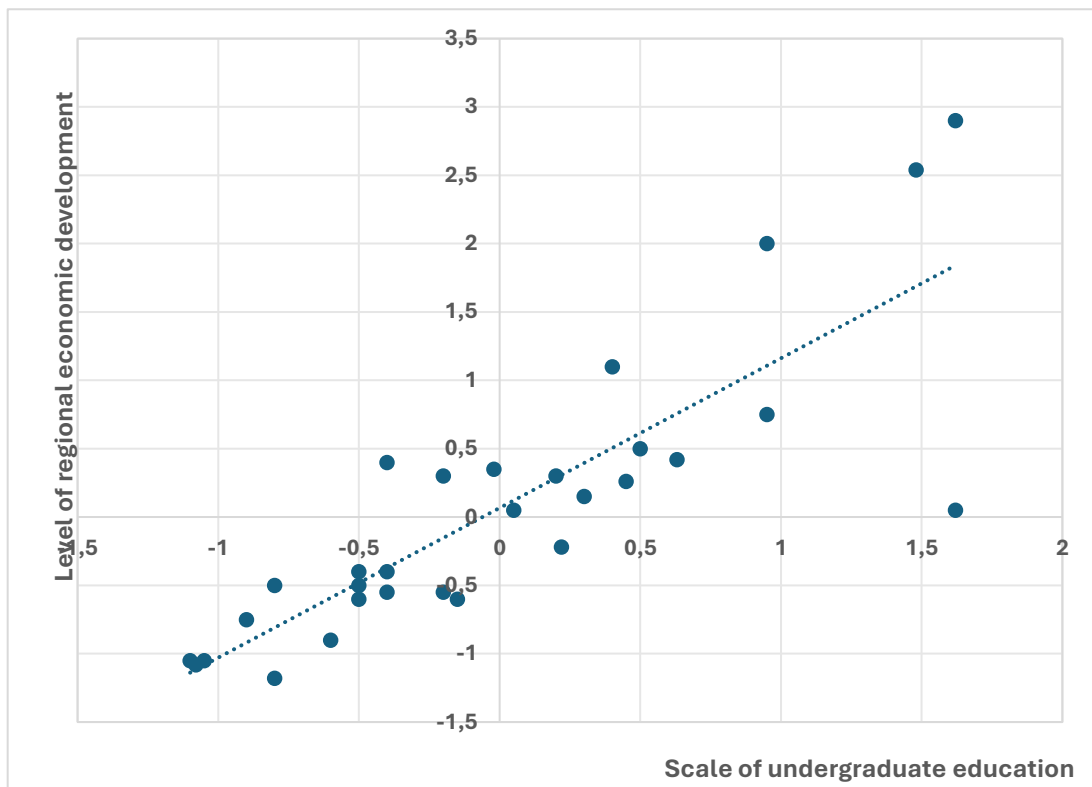
Beijing	1.62	0.05	Anhui	0.05	0.05	Chongqing	-0.5	-0.4
Hebei	0.45	0.26	Fujian	-0.2	0.3	Sichuan	0.5	0.5
Shanxi	-0.4	0.4	Jiangxi	-0.02	0.35	Guizhou	-0.5	-0.6
Inner Mongolia	-0.8	-0.5	Shandong	0.95	2	Yunnan	-0.5	-0.5
Liaoning	0.22	-0.22	Henan	0.95	0.75	Tibet	-0.8	-1.18
Jilin	-0.15	-0.6	Hubei	0.63	0.42	Shaanxi	-0.4	-0.55
Heilongjiang	-0.2	-0.55	Hunan	0.2	0.3	Gansu	-0.6	-0.9
Shanghai	0.3	0.15	Guangdong	1.62	2.9	Qinghai	-1.1	-1.05
Jiangsu	1.48	2.54	Guangxi	-0.4	-0.4	Ningxia	-1.08	-1.08
Zhejiang	0.4	1.1	Hainan	-1.05	-1.05	Xinjiang	-0.9	-0.75

Figure 2.21 – Schematic diagram of the coordination between the scale of undergraduate education and the level of regional economic development

Source: developed by the author

Quadrant 1: Regions with both high economic and educational scales. For example, the scale of undergraduate education and the level of economic development in Sichuan and Anhui provinces are both at a high level in the country, but further analysis reveals a certain imbalance between undergraduate education inputs and economic outputs in these regions, suggesting that there is room for improvement in the efficiency of the use of educational resources.

Quadrant 2: Economically developed but undersized education regions. Fujian Province, as an example, has a high level of economic development but a relatively small scale of undergraduate education, which may limit its potential for economic development, as the supply of talent may not be able to meet the demands of economic development.

Quadrant 3: Regions with both low economic and educational scale. Provinces and regions such as Qinghai Province, Ningxia Hui Autonomous Region and Hainan Province have low levels of undergraduate education scale and economic development, suggesting that these regions face greater challenges in both education and economic development.

Quadrant 4: Regions with lagging economies but large education scales. Provinces such as Shaanxi and Liaoning have relatively large undergraduate education, but their level of economic development fails to match it, which may lead to wasted educational resources and brain drain.

Multifactorial Impact Analysis of Interprovincial Differences in Undergraduate Education Scale. Differences in the scale of undergraduate education between provinces in mainland China are shaped by a series of complex and interacting factors. According to Liu Guorui (2019), these factors include historical background, policy orientation, level of economic development, demographics, geographic location and cultural traditions. This study will delve into these dimensions to explore the major factors affecting interprovincial differences in the size of undergraduate education.

Historical background and policy orientation. Historical background and policy orientation have a profound impact on the allocation of educational resources in a region. For example, in the early years of New China, the government focused on investing in higher education institutions in the northeast in order to promote the development of heavy industry. This led to the concentration of higher education resources in the Northeast and the formation of a group of higher education institutions focusing on engineering. After the reform and opening -up, the policy of "separate feeding" between central and local finances further exacerbated the imbalance of

educational resources between provinces, with the eastern coastal region gaining access to more educational resources as a result of its early advantage in economic reform.

Level of economic development. The scope of undergraduate education is significantly influenced by the degree of economic development. Higher economic development levels enable regions to draw in more top faculty members and students as well as offer greater financial assistance, all of which encourage the expansion of undergraduate education. Furthermore, areas with higher economic development tend to have a greater need for highly qualified workers, which encourages businesses and local governments to invest more in higher education.

Population structure and geographical location. Demographics and geographical location also have an impact on the size of undergraduate education. Provinces with large populations usually have a greater demand for education, which prompts local governments to expand the scale of education to meet the population's educational needs. At the same time, geographic location advantages, such as coastal areas, can attract more foreign investment and talent, promoting local education and economic development.

Cultural traditions and social values. The importance attached to education by cultural traditions and societal values also affects the scale of undergraduate education. In regions where education is valued, families and individuals are more and social climate helps to create a sustained demand for and support for higher education.

Mechanisms for the distribution of educational resources. The mechanism for allocating educational resources, including central and local fiscal allocations and educational investment policies, is also an important factor influencing inter-provincial differences in the scale of undergraduate education. Some provinces have been able to expand their education scale more quickly because they have received more central financial support or have developed effective education investment policies.

The study enables the formulation of targeted policy recommendations aimed at fostering integrated growth in education and the economy, curbing interregional

disparities, and enhancing overall educational and economic efficiency. These recommendations are based on the study's analysis of the coordination between the size of undergraduate education and regional economic development in 31 provinces in mainland China.

For regions where the scale of undergraduate education is outpacing economic development.

Optimising education structure: These regions should focus on optimising the professional structure of undergraduate education, reducing the enrolment scale of oversupplied professions and increasing the number of professions that are closely related to the development of the local economy, so as to improve the match between education and market demand.

Enhancing the quality of education: By improving the quality of teaching and scientific research, I will shift the focus of education development from expansion of scale to internal enhancement, so as to produce higher-quality graduates to meet the demand for top-quality talents for economic development. Fostering collaboration between industry, academia and research entails bolstering the relationship between academic institutions and businesses, encouraging the translation of scientific research findings, giving students real-world experience and simultaneously supplying businesses with highly innovative, application-focused personnel.

For regions where the scale of undergraduate education is lagging behind economic development.

Increasing investment in education: The government should increase financial investment in undergraduate education, and at the same time encourage social capital to participate in education and broaden the sources of education funding. Improvement of educational facilities: using the additional education funding to improve teaching facilities and upgrade educational technology to create a better learning environment for students.

Attracting and retaining talent: Attracting and retaining outstanding teachers and scholars by offering competitive salaries and career development opportunities to enhance the region's educational attractiveness.

For regions with low levels of both undergraduate education and economic development.

Priority is given to the development of basic education: on the premise of ensuring the quality of basic education, the scale of vocational and higher education is gradually being expanded to meet the demand for all types of personnel for economic development. Implementation of education for poverty alleviation: through the education for poverty alleviation programme, more educational opportunities are provided to students in poor areas, and the number of students who are unable to receive tertiary education due to financial constraints is reduced.

Utilising resources with regional characteristics. Developing special education and industries in conjunction with the natural resources and cultural characteristics of the region, so as to enhance the region's educational competitiveness and economic development potential.

For all regions. Establishment of a dynamic monitoring mechanism: establish and improve the monitoring and evaluation mechanism for education and economic development, and promptly identify and resolve problems of incompatibility between education and economic development. Promoting regional cooperation in education: Encouraging cooperation in education between different regions, sharing educational resources and facilitating the mobility of talents in order to achieve balanced regional development.

Ongoing policy support and evaluation. Governments should provide ongoing policy support and conduct regular evaluations of the effectiveness of policies to ensure that their implementation effectively promotes the coordinated development of education and the economy.

Through the implementation of the above recommendations, it is possible to promote the coordinated development of the scale of undergraduate education in different provinces of mainland China in relation to the regional economy, to reduce inter-provincial disparities, to improve the quality of education and economic efficiency, and ultimately to realise comprehensive and sustainable socioeconomic development.

Conclusions of the chapter 2

Chapter 2 of the dissertation provide an integrative analysis of regional disparities, convergence trends, and the efficiency of financial resource allocation for higher education in China. Here is a structured summary of the conclusions:

1. Regional Disparities and Convergence in Financial Expenditure. China's financial expenditures for higher education exhibit significant regional disparities, with resources concentrated in the eastern regions. These gaps predominantly stem from inter-regional rather than intra-regional differences.

2. The dissertation employs a mix of econometric and efficiency analysis methods to evaluate the allocation and effectiveness of financial resources for higher education in China: (1) the Gini coefficient and β-convergence methods (both absolute and conditional) were used to assess inter-regional disparities and trends in financial expenditure equalization across China; (2) β-convergence models account for catching-up effects in financial expenditure and provide insights into regional progression towards economic equity.

3. Trends indicate a general convergence in national financial expenditures on higher education, particularly in the eastern and central regions. However, this convergence is less evident in the western and north-eastern areas, highlighting a need for more targeted resource allocation strategies to promote balanced development. Significant disparities exist between the eastern, central, western, and north-eastern regions in higher education financial expenditure.

4. Efficiency of Financial Expenditures. A three-stage Data Envelopment Analysis (DEA) model was implemented to measure efficiency while removing external environmental factors and random noise. Efficiency was evaluated at the provincial level to identify structural issues in expenditure, like scale inefficiency in certain regions.

5. The efficiency of financial expenditures in higher education across China remains suboptimal, with a declining trend in recent years after controlling for external environmental and random factors. Regional differences in expenditure efficiency

reveal that the central region performs best, while the western region lags. Provinces in the eastern region often show diminishing returns to scale, whereas those in the central and western regions generally display increasing returns to scale. Structural inefficiencies in expenditure, coupled with inadequate investment scales, hinder overall efficiency. This necessitates reforms in expenditure structures and further scaling investments.

6. Coordination Between Undergraduate Education and Regional Economies. Regression models integrating regional economic and educational data assessed the synergy between higher education outputs and regional economic needs. Mediating factors such as human capital (average education years) and intellectual capital (patents) were incorporated into the analysis.

7. Enhanced coordination between undergraduate education and regional economies is vital for reducing inter-provincial disparities and aligning education outputs with economic needs. Investments in higher education significantly contribute to regional GDP growth, particularly when mediated through human and intellectual capital development. Education expenditures are more impactful when aligned with regional economic characteristics, highlighting the need for tailored regional strategies. Recommendations include increased investment in education, improved infrastructure, talent attraction strategies, and a focus on education tailored to regional characteristics.

8. Synthesis and Policy Implications. Advanced statistical tools such as STATA, ARCGIS, and VOSviewer facilitated empirical computations and visualization.

9. Balanced and equitable financial resource allocation is essential to achieve sustainable growth in higher education expenditures and enhance the overall efficiency of the sector. Policymakers must address both quantitative and structural deficiencies in higher education financing, with an emphasis on promoting regional equity and efficiency. The integration of regional economic development goals with educational strategies will foster socioeconomic cohesion and optimize the impact of financial investments in higher education.

The conclusions underscore the critical need for policy interventions to bridge regional disparities and ensure the efficient and equitable allocation of financial

resources in China's higher education system. Governments should prioritize increasing investment in underdeveloped regions, especially the western and north-eastern areas, and focus on optimizing expenditure structures to enhance returns. The dissertation recommends dynamic allocation strategies that adjust resources based on evolving socio-economic conditions and region-specific needs. Establish a dynamic monitoring and evaluation system to ensure alignment between educational investments and economic objectives, reducing inefficiencies. In lagging regions, priority should be given to developing vocational and basic education while leveraging local natural and cultural resources for economic-educational synergy. In developed areas, efforts should centre on optimizing returns on higher education through innovation and scaling back overinvestment. These findings and recommendations are aimed at fostering balanced socio-economic development through equitable and efficient allocation of financial resources in China's higher education system.

The primary findings of this chapter were published by the author in the following works: [231, 233, 235, 236].

CHAPTER 3. REGIONAL EQUITY AND THE ADEQUACY OF FINANCIAL PROVISION IN MANAGEMENT OF STATE FINANCIAL RESOURCES OF HIGHER EDUCATION IN CHINA

3.1. Direct and indirect impacts of investment in education in stimulating economic growth with consideration of the contribution of human and intellectual capital

China has been reforming and opening up for more than 40 years. During this time, the socialist market economy system has been established and is continuously improving. China's economy has transitioned from high-speed growth to a new normal characterized by high-quality development. In the past, however, economic growth was overly reliant on low-cost production factors and quantitative expansion, ignoring the quality of economic development and investment in human capital. As supply-side structural reform advances, China's industrial structure needs transformation, and economic development requires the introduction of new driving forces. Therefore, at the beginning of the 14th Five-Year Plan, it is essential to further transform the mode of economic growth. Education is a centennial plan for a nation's development, and the future of every individual in the next generation is at stake. Talent is the key to achieving high-quality economic growth and thus deserves special attention. The government should increase its investment in education finance, finance education through various channels and work to resolve the current issues of insufficient total investment in education resources and unreasonable regional allocation to achieve high-quality and sustainable development of the local economy.

This dissertation's research question is how local investments in education affect the economic growth of different regions in China and how this growth occurs. The study distinguishes between the direct and indirect effects of local financial investments in education and considers local investment in financial education as a factor of production and examine its immediate effect on economic growth in different areas. Look at how human and intellectual capital, acting as mediators, indirectly

affect economic growth. This dissertation's primary objective is to investigate how education affects regional economies in China. This dissertation uses a panel data model and a mediating effect model to conduct an empirical analysis of China's data from 2000 to 2018. This helps achieve the objective. The findings show that local financial investment in education has a significant positive impact on economic growth. The magnitude of this effect varies by region. Investing in education positively impacts the accumulation of human and intellectual capital, which indirectly promotes economic growth. This dissertation argues that increasing investment in education and cultivating innovative, high-level talents are two of the most essential steps to achieving high-quality economic development in China.

In recent decades, investment in education has been increasingly recognized as a key factor in promoting technological progress and economic development [208]. According to the theory of human capital, education can enhance individual workers' human capital, increase labor productivity, and promote economic growth. The new view of economic growth demonstrates that the economy can achieve sustained growth without relying on external forces, and endogenous technological progress based on human capital is a key factor in ensuring sustained economic growth. Romer and Lucas, among others, link human capital with technological progress and economic growth. They argue that human capital affects the capacity to innovate knowledge and the capacity to imitate, absorb, and apply new technologies, which in turn can influence technological progress in production and thus promote economic growth, elaborating on the role of human capital in economic growth. Nelson and Phelps argue that education and adopting new technologies are closely intertwined, and a well-educated workforce can implement new technologies more quickly [208–211]. Other studies indicate that innovation is a more significant driver of economic development. The study by Grossman and Helpman demonstrates that the skill composition of the workforce is correlated with the level of innovation in the economy, and they conclude that an increase in skilled workers promotes growth. In contrast, an increase in unskilled workers inhibits development. According to Acemoglu et al. (2006), innovation and imitation are two sources of productivity

growth [212]. In a similar vein, Vandenbusche, Agueio and Meghir contend that technological progress has a dual source, and economic growth results from learning and imitating existing technologies and innovation, particularly in technologically advanced economies. Like other types of investment, investment in human capital through education also has an opportunity cost. That is, in the short run, more workers receiving higher levels of education means fewer workers involved in productive activities. From this perspective, an increase in the scale of education may have a retarding effect on short-term economic growth [212, 213]. In the long run, the quantity of human capital represented by the level of education will support economic development, whereas in the short run, it may not have a significant impact.

Investment in education has been extensively examined in relation to economic growth. Early articles [208] did not assign human capital a special function because they believed that the supply of productive labor and technological progress were exogenously determined. Schultz and others proposed the theory of human capital in the 1960s [214], which argued that human factors (especially human quality) play a crucial role in the production process and that human capital consists of the expenditures on human education and training as well as the opportunity costs arising from these expenditures. However, the disparity in regional population growth rates has not been deemed a consequence of technological and economic progress. According to human capital theory, development significantly contributes to economic growth [215]. Particularly, educational inputs can increase worker productivity and decrease income disparity, thereby fostering economic expansion. Human quality has a significant impact on the production process, and investing in human and intellectual capital can promote the growth of knowledge assets, increase innovation, and boost total factor productivity, thereby accelerating economic growth.

Besides the quantity of human capital, the quality of human capital can also contribute to economic growth. Undoubtedly, workers with higher human capital will contribute more to economic growth, and education quality directly affects human capital. Among the numerous factors that influence the quality of education, teacher resources are frequently among the most significant. Teacher factors considerably

impact educational efficacy and student development [216]. In addition, the impact of the mechanism through which teacher resources are invested to enhance the quality of human capital is similarly long-lasting. In addition to being an investment in human capital, the consumption characteristics of education can also contribute directly to economic growth [217]. Keynesian fiscal spending theory proposes that governments should increase budgetary spending by implementing expansionary fiscal policies, thereby increasing aggregate social demand, stimulating consumption, and accelerating economic growth. And education finance is an essential component of public finance. In China, education expenditures rank first in the field of public finance. According to Keynesian economic theory, government spending on education can boost economic development by increasing demand and consumption [218].

Some international studies have concluded that government expenditure on private consumption has crowding-out and complementing effects [219]. However, due to the various stages of economic development in China, some studies have found a positive correlation between government expenditure and resident consumption [220]. The effect of the state's active fiscal policy on the consumption of urban residents is more pronounced [221]. Government expenditures on agricultural support significantly impact rural residents' consumption [222]. From a structural point of view, government consumption expenditure items crowd out residents' consumption, while government investment expenditure crowds in residents' consumption [223]. According to Keynesian fiscal expenditure theory, education expenditures can increase social demand. On the one hand, the education expenditure used to organize schools, which itself constitutes a part of social consumption, directly increases domestic consumption demand. On the other hand, according to Keynesian absolute income theory, the salary paid to teachers will be used as teachers' income, which affects teachers' consumption and thus forms residents' personal consumption. Moreover, in China, the government's expenditures on education may demonstrate a positive correlation with resident consumption, indicating a crowding-in effect.

Studies show that investing in education promotes economic development in developed nations but not necessarily in developing ones. Most of the money for

higher education comes from central transfer payments. In the Western region, there is less investment in education due to limited financial resources and unfair investment structures. Studies have also revealed that the overdevelopment of higher education may hinder local economic development and that the productivity of college students in China has not yet reached its maximum potential. While some nations have discovered no significant effects, others have found significant ones. According to studies, educational investment positively impacts the economies of countries underperforming in academic development, especially in countries with high levels of educational development.

Nevertheless, the effect of fiscal and educational investment on GDP growth is frequently region-specific. On the transmission path of education investment to economic growth, a growing body of research concludes that financial education investment improves the quality of the labor force or promotes technological innovation, increasing national income levels. Studies have also found that higher growth rates of fiscal education expenditures and labor force education levels contribute substantially to economic expansion. Additionally, increased total financial investment in higher education and per capita financial investment is associated with an increase in the region's human capital. According to the works (Yao et al., 2017; Cai, 2020), it has been determined that an increase in education level in each province of China promotes science and technology innovation.

The amount and stock of human capital greatly affect the economy's growth. Early foreign researchers [224] discovered that human capital accumulation had a limited effect on economic growth but still contributed considerably. Some ideas argue that both the process and current stock of intellectual capital significantly contribute to the growth of the national income level. Intellectual capital drives economic growth by promoting the increase of TFP, and economic growth is crucial for innovative development. Using the DEA method, some researchers measured the technological progress index and TFP and argued that technological progress promotes the change of economic growth mode, which in turn supports economic growth [225]. Studies have shown that educational investment can promote economic growth, but the impact

varies in different regions. Some scholars believe that excessive development of higher education will hinder local economic development. In contrast, others believe that educational inputs can improve the quality of human capital and promote technological innovation. Foreign scholars have different views on the effects of academic inputs. Some argue that some countries do not experience an impact on economic growth, while others claim that they can contribute significantly to economic growth in developed countries.

Few empirical studies on the relationship between education and economic growth have examined the causal mechanism explicitly. Typically, correlation analysis is conducted using a single factor, and no unified framework exists. This dissertation will attempt to construct a causal inference model based on mediating effects from the dual perspective of human capital and intellectual capital to identify the transmission mechanism of educational input on economic growth and make a small contribution to the existing body of knowledge. Based on the past studies published by economists, the following generalizations can be made. Human capital is an important factor of production that is widely involved in production activities in all sectors of society and contributes to economic growth. Second, human capital accumulation promotes technological innovation and imitation, resulting in technological progress (represented by an increase in intellectual capital), which is the growth engine of a nation. On the other hand, human capital accumulation encourages technological innovation and imitation, resulting in technological progress (in the form of increased intellectual capital), which is the propelling force behind a nation's long-term economic development. Second, education investment is also consumption-oriented and can stimulate demand-side economic growth in the immediate term. Therefore, two hypotheses can be formulated:

H1: Educational inputs will directly stimulate economic growth.

H2: Educational investment will promote the level of human and intellectual capital, which will indirectly affect economic growth.

Design model of baseline regression: It is presumed that China's economic growth follows a Cobb-Douglas (C-D) production function. The local financial

investment in education is regarded as a production factor added to the model based on the concept of the C-D production function. The following production function incorporating financial education inputs is postulated in this dissertation.

$$Y=AK^{\alpha}L^{\beta}X^{c} \tag{3.1}$$

where Y is the total economic output of the region, X represents the capital stock, and L is the number of laborers (with the resident population of each province used as a proxy). X also denotes the local financial education input of each region. A represents the technology level, which is typically considered constant. α, β, and c represent the elasticities of physical capital input, labor force input, and financial education input, respectively.

Logarithmically linearize both sides of the equation to determine the contribution of each factor to economic growth. This helps reduce the heteroskedasticity of the sample, moderate the variation in variables, and make it easier to understand the estimated coefficients as elasticities. Then, consider each individual fixed effect and add a set of control variables. This gives us the following regression equation:

$$\ln Y_{it}=\ln A+\alpha \text{lin} K_{it}+\beta \ln L_{it}+c \ln X_{it}+\gamma \times conrtol_{it}+\mu_{i}+\varepsilon_{it} \tag{3.2}$$

Design model of intermediate effect: When considering the mediating impact from the perspectives of intellectual capital and human capital, the technological level A is no longer a constant. Instead, it becomes the mediating variable, intellectual capital Ait, which is measured by the number of invention patents in each province (Patent). The other mediating variable is human capital H, which is measured by the average number of years of education per capita Hit. Subsequently, model the mediating effects of the dual mediating variables.

$$A_{it}=aX_{it}+b \times conrtol_{it}+jA_{i,t-1}+\mu_{i}+e_{1,it} \tag{3.3}$$

$$H_{it}=fX_{it}+h \times conrtol_{it}+KH_{i,t-1}+\mu_{i}+e_{2,it} \tag{3.4}$$

$$lny_{it}=\varphi+c`lnx_{it}+\alpha link_{it}+\beta lnL_{it}+d_1A_it+d_2Hit+g\times conrtol_{it}+\mu_i+e_3 \qquad (3.5)$$

(3.2) and (3.5) have an endogeneity problem that needs to be fixed through IV estimations. In (3.3) and (3.4), use dynamic panels to regress A and H as mediating variables (3.3) and (3.4). It is because Romer (1990) argues in his endogenous growth theory that the production of the research sector, i.e., technological innovation, depends on the level of technology in the previous period; similarly, since human capital may have a similar agglomeration effect, a region with abundant human capital may attract more human capital. This is consistent with the way human capital grows in Lucas' endogenous growth model, and it will enhance the model's explanatory power. Introducing one-period lags for A and H leads to the endogeneity problem when the regression coefficients obtained even with the within-group estimator (FE) are biased. Arellano et al. (1991) proposed successive differential GMM and horizontal GMM methods address this issue. Blundell et al. (1998) proposed a GMM system with higher efficiency by combining the two approaches. Using the system GMM method, estimate (3.3) and (3.4).

Selection of variables for the benchmark regression model:

－The dependent variable Y represents the total economic output, measured by GDP (in billions of yuan).

－The main explanatory variable X represents the education input, measured by local fiscal education expenditure (in billions of yuan).

－The other explanatory variables include capital stock K (in billions of yuan) and labour force L (in ten thousand people).

－ The control variables include urbanization rate(urban), degree of economic dependence on foreign trade(trade), and natural population growth rate (pop). These variables are selected to account for the factors that affect economic production.

－Selection of variables for the mediation effect model

－The dependent variable Y and the explanatory variable X are the same as in the benchmark model: GDP and local fiscal education expenditure Xp.

－The mediating variable human capital is measured by the average years of education H (in years).

− The mediating variable, knowledge capital, is measured by the number of domestic invention patents granted (in pieces).

− The instrumental variable used in the IV estimation is the dummy variable (sunwage), which is 0 for 2000–2007 when sunwage is not implemented and 1 for 2008 onwards when sunwage is implemented.

The provincial macroeconomic data used in this article includes China's GDP, GDP growth index, per capita GDP, local fiscal education expenditure (from 2008 to 2018), total fixed asset investment, central fiscal education expenditure, resident population, domestic invention patent application authorization volume, total import and export of domestic destinations and sources of goods, natural population growth rate, etc. from 2000 to 2018. These data are obtained from the website of the National Bureau of Statistics. Use formula (2) to perform mixed regression, fixed-effects regression, and random-effects regression on the panel model respectively. The results are shown in Table 3.1.

Table 3.1 − Mixed regression, fixed effects regression and random effects regression

VARIABLES	1	2	3
	POLS	FE	RE
	InY	InY	InY
lnXp	0.3430***	0.4749***	0.4749***
	(-0.0114)	(-0.0114)	(-0.0114)
lnK	0.5130***	0.3089***	0.3089***
	(-0.0189)	(-0.0178)	(-0.0178)
lnL	0.3090***	0.3916***	0.3916***
	(-0.0137)	(-0.0202)	(-0.0202)
urban	0.6876***	0.6203***	0.6203***
	(-0.0614)	(-0.0569)	(-0.0569)
trade	0.1844***	0.1758	0.1758***
	(-0.0216)	(-0.0337)	(-0.0337)
Pop	-0.0101***	-0.0100***	-0.0100***
	(-0.0022)	(-0.0028)	(-0.0028)
Consiant	-0.4199***	0.0893	0.0893
	(-0.0842)	(-0.1543)	(-0.1543)
Observations	589	589	589
Individual fixed effects	No	Yes	Yes
Time fixed effects	No	Yes	Yes
R2	0.9907	0.9909	0.9905
F test	10320.36***	10009.36***	/
Wald test	/	/	57778.93***
Hausman test	/	36.61***	/

****$p<0.01$,Σ**$p<0.05$,Σ*$p<0.1$

Sources: developed by the author

In Table 3.1, the mixed regression shows that when controlling for other variables, the coefficient of the main explanatory variable lnXp is 0.3430 and is significant at the 1% significance level, initially indicating that fiscal education investment significantly promotes regional economic growth. However, mixed regression is not suitable for panel data. Therefore, perform fixed-effects or random-effects panel regression analysis. The Hausman test statistic value is 36.61 and is significant at the 1% level, indicating that fixed-effects regression should be used. According to the results of fixed-effects regression, when controlling for other variables, the coefficients of the explanatory variables lnXp, lnK, and lnL are 0.4749, 0.3089, and 0.3916 respectively, and are all significant at the 1% significance level. That is to say, when education investment, capital investment, and labor input increase by 1%, economic output increases by 0.4749%, 0.3089%, and 0.3916% respectively. This shows that local fiscal education investment, capital investment, and labor input all significantly promote economic growth, with the former having the greatest effect. In addition, the urbanization rate and economic dependence on foreign countries also have a significant positive impact on economic growth, while the natural growth rate of the population has no significant effect on economic growth. The goodness-of-fit R^2 value is 0.9909, indicating that the model fits well. To further investigate how local fiscal education investment influences regional economic development, use the mediation effect model to examine the mechanism of the impact of local fiscal education investment on economic growth from the perspectives of human capital and knowledge capital. Run regressions on the mediating effects model and analyze the results. In the first step, examine the total impact of factors such as Xp (local financial input to education) on economic output Y without considering the mediating variables. Regress equation (3.2) using the 2SLS approach, where the instrumental variable IV is Sunwage. The 2SLS regression results are shown in Table 3.2.

Table 3.2 − 2SLS regression of the total effect of educational inputs

VARIABLES	Phase 1	Phase 2
	InXp	InY
InXp		0.4852***
		(0.0211)
LnK	0.8978***	0.2975***
	(0.0306)	(0.0275)
InL	1.4189***	0.3988***
	(0.1872)	(0.0821)
urban	1.2012	0.5744***
	(0.1793)	(0.0680)
trade		0.0900**
		(0.0399)
POP		-0.0045
		(0.0031)
sunwage	0.4966***	
	(0.0316)	
Observations	589	558
Number of id	31	31
R2	/	0.9907
Instrumental variable F-test	242.2***	/
Weak instrumental variable test		240.2

****p<0.01,Σ**p<0.05,Σ*p<0.1

Source: developed by the author

The regression of the endogenous variable on the instrumental variable (IV) in the first stage of 2SLS shows that the regression coefficient of the endogenous variable (Xp) on the instrumental variable (sunwage), while controlling for other variables, is 0.4966 with a positive coefficient and is significant at the 1% significance level. This indicates that the instrumental variable is highly correlated with the endogenous variable. The F-test statistic for the exogenous instrumental variable is 242.2, which is significant at the 1% level, also indicating that the exogenous instrumental variable meets the correlation requirement. The regression results from the second stage of the 2SLS show that the coefficient of the main explanatory variable (lnXp), when controlling for other variables, is 0.4852 and is significant at the 1% level. This indicates that, at the national level, increased local financial expenditure on education significantly contributes to regional GDP growth. The other control variables such as capital stock (K), labour force (L), urbanization rate (urban), and natural population

growth rate (pop) also have a significant positive relationship with regional GDP. With an R² of 0.9907, it indicates that the model fits well and has sufficient explanatory power. Table 3.2 shows that the value of F is 240.2, which means a significant rejection of the claim that sunwage is a weak instrumental variable. Therefore, sunwage meets the correlation requirement. I can thus consider sunwage as an ideal instrumental variable. Therefore, the coefficient c of the endogenous variable estimated using this instrumental variable is unbiased, i.e., it can more accurately estimate the magnitude of the impact of local financial expenditure on education on economic output. Perform a systematic GMM regression of (3.2) and (3.3). The regression results are shown in Table 3.3.

Table 3.3 − Regression of overall mediating variables on explanatory variables

VARIABLES	(2) patent	(3) H
L.H	/	0.5244*** (0.0918)
Xp	1.0528** (0.4152)	0.0011*** (0.0003)
L.patent	1.0816***(0.0281)	/
Controls	YES	YES
Observations	556	558
Number of id	31	31
GMM	YES	YES

****p<0.01, Σ**p<0.05,Σ*p<0.1

Source: developed by the author

Table 3.2 shows that the regression coefficients of the main explanatory variable (education) on the mediating variables knowledge capital (P) and human capital (H) are 1.053 and 0.0011 respectively, which are positive and significant at the 1% significance level. Therefore, it can be concluded that local fiscal education investment in various regions has significantly increased local knowledge capital and human capital. Considering the unit issue, since the unit of the explanatory variable (local fiscal education investment) is 100 million yuan, the unit of knowledge capital (i.e., the number of invention patents) is pieces, and the unit of human capital (i.e., years of education) is years. Thus, the larger coefficient of the former explanatory variable Xp

and the smaller coefficient of the latter Xp can also be reasonably explained. And from the table, it can be seen that the mediating variables P and H are very significant in their regression on their respective lags. This also verifies the previous hypothesis that the creation of knowledge capital depends on the existing technology level and that human capital also has an agglomeration effect. Considering both direct and indirect effects, perform a 2SLS regression of equation, with IV still being sunwage. The regression results are shown in Table 4. In the first stage of the 2SLS, the regression of the endogenous variable on the independent variable IV reveals a significant coefficient of 0.46 for sunwage at the 1% significance level. The exogenous instrumental variable's F-statistic value of 250.25 indicates that this instrumental variable and the endogenous variables are significantly correlated, satisfying the correlation requirement for instrumental variables. From the 2SLS second-stage regression, it can be observed that the coefficient of InXp, c', is 0.4715, a positive coefficient statistically significant at the 1% level, indicating that local financial investment in education has a significant direct effect on regional economic growth. Also, after controlling for other variables, it can be observed that the coefficients of the intellectual capital variable are statistically significant at the 1% level.

Table 3.4 − Equation (4)2SLS regression considering direct and indirect effects

VARIABLES	Phase 1 InXp	Phase 2 InY
InXp	/	0.4715***(0.0226)
Inpatient	0.0753***(0.0197)	0.0186*(0.0095)
H	03082***(0.0327)	0.0581***(0.0135)
InK	0.6160***(0.0375)	0.2524***(0.0252)
InL	0.6656***(0.1511)	0.2551***(0.0688)
urban	0.7829***(0.1626)	0.4726***(0.0670)
trade	0.4628***(0.0949)	0.0735***(0.0350)
pop	-0.0296***(0.0073)	-0.0036 (0.0031)
sunwage	0.465***(0.0294)	
Observations	588	588
Number of id	31	31
R2	/	0.9913
Instrumental variable F-test	250.25***	
Weak instrumental variable test		273.7

****p<0.01,Σ**p<0.05,Σ*p<0.1

Source: developed by the author

The coefficients of intellectual capital and human capital H are 0.0186 and 0.0581 respectively, which are significant at the 10% and 1% significance levels, indicating that intellectual capital and human capital also contribute substantially to regional economic growth (although intellectual capital contributes less). The Kleibergen-Paap Wald F test value of 273.7 rejects sunwage as a weak instrumental variable. Thus, sunwage is considered to satisfy the correlation requirement. Finally, compare the regression results for equations (1) and (4), as shown in Table 3.5.

Table 3.5 − (3.1) (3.4) Comparison of regression results

VARIABLES	(1)InY	(4)InY
InXp	0.4852*** (0.0211)	0.4715*** (0.0226)
InK	0.2975*** (0.0275)	0.2524*** (0.0252)
InL	0.3988*** (0.0821)	0.2551*** (0.0688)
urban	0.5744*** (0.0680)	0.4726*** (0.0670)
trade	0.0900** (0.0399)	0.0735** (0.0350)
pop	-0.0045 (0.0031)	-0.0036 (0.0031))
Inpatient		0.0186* (0.0095)
H		0.0581*** (0.0135
Observations	558	557
Number of id	31	31
R2	0.9907	0.9913
Weak instrumental variable test	240.2	273.7

****p<0.01, Σ**p<0.05,Σ*p<0.1

Source: developed by the author

In equations (3.2) and (3.5), the coefficients of the main explanatory variables lnXp are positive at 0.4852 and 0.4715 respectively, and both are statistically significant at the 1% significance level (Table 3.5). Thus, the total effect coefficient c of lnXp is 0.4852, while the direct effect coefficient c' is 0.4715, indicating that local financial expenditures on education have a substantial direct impact on economic growth. And the coefficients of the mediating variables (Inpatient) in equation (3.4)

are 0.0186 and 0.0581, which are both significant at the 10% and 1% significance levels respectively, i.e., both d1 and d2 are significantly positive. In the second step of regression of mediating variables on explanatory variables, the coefficients of regression of financial investment in education (Xp) on mediating variables intellectual capital (patent) and human capital H are 1.0530 and 0.0011 respectively, and both are significant at the 1% significance level, i.e., both a and b are highly significant and positive. Consequently, c − c' is greater than 0, and ad1 + bd2 is also notably greater than 0. Therefore, local government's financial investment in education effectively promotes the growth of regional intellectual and human capital (a and b are significantly greater than 0). The increase in human capital and intellectual capital promotes regional economic growth (d1 and d2), so the indirect contribution of local financial investment in education to economic growth is also significant. Since local financial expenditure on education substantially directly affects regional economic development and indirectly through mediating variables, regional financial expenditure on education promotes economic growth through partial mediating effects. The study demonstrates that financial investment in education considerably contributes to China's regional economic growth. Moreover, the study indicates that financial investment in education not only contributes directly to economic development but also indirectly by fostering the accumulation of human and intellectual capital across the nation. Using a mediating effects model, this dissertation analyzes the transmission path of financial investment in education to economic growth and observes significant disparities in the transmission of effects across regions.

Science and technology are primary productive forces, but humans are primarily responsible for creating and utilizing science and technology. Therefore, the government should continue to adhere to the national strategy of strengthening the nation with talent, continuously increase its financial investment in education, and effectively use financial leverage to finance education through multiple channels. Ensure that everyone has access to the education they deserve, enhance the human capital of the entire society, achieve economic growth, and promote social justice. First, increasing education expenditures is beneficial for economic growth. We should make

effective use of education investments and focus on resolving the prevailing issue of limited education supply. To address the problem of students dropping out of school due to poverty, the government should, on the one hand, collaborate with schools to establish scholarships and grants for poor students and subsidize them by providing part-time jobs to assist students, reducing school fees and providing living subsidies, etc. Second, it should strengthen cooperation with commercial banks and other financial institutions to promote interest-free and low-interest student loans suitable for students in need. The government can use financial leverage to provide credit guarantees for poor students by establishing guarantee funds, establishing a personal credit system for needy students, and enhancing the credit collection system to reduce the difficulty of approval and the incidence of bad loans so that more poor students can benefit. Third, in order to address the issues of inadequate educational infrastructure and talent shortage, it is necessary to make effective use of financial support and social influence while relying on financial resources. Establish education investment funds, relax financing restrictions, and encourage social capital to invest in education and participate in funding and donation activities. Fourth, to make up for the current shortage of educational resources, there should be increased investment in and treatment of teachers through initiatives such as joint running of schools by the government and society. Only by increasing investments in education, strengthening talent development, and improving population quality can we foster scientific and technological innovation and economic growth.

This dissertation's novel contribution lies in employing the instrumental variables (IV) estimation approach for the mediated effects model. Currently, this approach is underutilized in economics due to the endogeneity of the model. This research makes a significant effort to identify a causal relationship between educational expenditures and economic expansion. It is hoped that future researchers on this topic will seek further, more diverse, and precise causal inference methods to verify or refute the theories presented here. The results of this dissertation suggest that increasing educational expenditures can have positive spillover effects on economic expansion through various channels, such as human capital accumulation, innovation,

and institutional quality. However, these findings are subject to some caveats, such as the validity of the IVs used, the potential heterogeneity of the effects across countries and periods, and the possibility of omitted variable bias. Future research on this topic could explore alternative causal inference methods, such as randomized controlled trials, natural experiments, or structural models, to test the robustness and generalizability of the IV approach. Moreover, future research could examine more closely the mechanisms through which educational expenditures affect economic expansion, such as by disaggregating the effects by level and quality of education, the sectoral composition of output, and institutional context.

3.2. Differentiation of state regional expenditure on education in China reflecting region's differentiation by natural, economic and social development: enhancing the equity and the adequacy in management of state financial resources in higher education

Compared with compulsory education, which improves the basic literacy of the entire population, higher education is regarded as education that provides high-level talents for the progress and development of society, and therefore the popularity of higher education and the total amount of resources invested in it have been far less than that of basic education for some time [121]. However, with the rapid development of China's economy and society and the rising demand for the quantity and quality of high-tech talents, it is particularly important to regulate the higher education system, expand the scale of higher education, increase the investment in higher education, and cultivate more and better high-level talents for our country as well as to improve the scientific literacy of the nationals. Although the scale of China's investment in higher education has been increasing year by year, the problems of uneven and insufficient investment in higher education between regions remain unresolved.

Around the 1980s, the concept of "financial adequacy" was developed in the United States as education finance gradually shifted from the provision of equal educational opportunities for school-age children to the provision of equal and

sufficient resources for education under the perspective of "equity". In 1989, in the Kentucky lawsuit "Ross Committee for Better Education", [122] the court held that the existing financial investment policy in public schools was not conducive to promoting educational equity, resulting in inadequate and low-quality education, and proposed that a substantial and efficient education financial policy should be formulated, which was the first time that legal attention was paid to the financial adequacy of education. Clune (1993) [123] that the original education compensatory financial expenditure is too uniform, centralised, and education financial adequacy can be based on different regions to set the standard of financial expenditure to achieve specific educational goals, improve the efficiency of education financial expenditure, at the same time, he calculated that the minimum per capita education financial expenditure should be about 5000 U.S. dollars, i.e., the standard of financial adequacy of education. Subsequently, the academic field Clune [124] in 1991 for the first time clearly pointed out that due to the changes in the modern education finance litigation and policy in the United States, education finance is experiencing a change from the emphasis on equity to adequacy, at the same time that financial adequacy is the minimum cost of funding expenditures in order to provide a certain amount of education resources from the point of view of the needs of the students. Augenblick et al. (1997) [125] argued that Fiscal adequacy is the ability of state education funding to provide adequate educational services to all students at all levels of education in the state. Odden (2007) [126] further suggests that while state education funding may have been able to enable the state to achieve a level of "excellence" for students at the state level, if it has not been able to meet the state level of "excellence" for students at the state level, the state may not have been able to meet the state level of "excellence" for students at the state level. While state funding may be able to achieve state-level "excellence" for students within the state, if state-level "excellence" is not yet met, greater financial investment in education will be required, and different regions, individuals, races, and societal developmental needs will affect the level of financial adequacy in education. Over the past three decades, many states in the United States, such as New Jersey, West Virginia and Kentucky, have used lawsuits on the financial

adequacy of education to determine adequate standards of education funding for their districts, and a total of 33 states have conducted studies on the estimation of the "cost of financial adequacy of education".

Fang Fang (2010) [127] summarises the methods used by US states to estimate the cost of educational adequacy, with four main approaches: cost function, successful district, professional judgement and evidence-based. The cost function method is based on the cost function derived from the education production function, and calculates the minimum amount of money to be spent on the quantity and price of relevant elements (e.g., teacher-student ratios, the number of courses offered, the number of students and educational inputs such as students' home environments) to achieve defined educational objectives (e.g., educational outputs such as students' academic performance). Odden (2003) [128] in order to investigate whether the education funds provided by the government can meet the educational goals expected by the students, respectively in Wisconsin and Texas, using the cost function method to measure the index of financial adequacy of education in various regions of the state, and found that the results of the adequacy of the different regions ranges from 49 per cent to 460 per cent, which indicates that there are still some regions in the state can not satisfy the goal of financial adequacy of education, and there are some regions that are over-sufficient in education financial resources, and the distribution of financial resources is very uneven among the different regions. The distribution of financial resources is very uneven across districts. The Successful School District Method is a method of selecting a successful school district in a state that has already met the education goal through the judgement of experts and others, using the data related to the basic expenditures of the district to measure the effective financial expenditures for meeting the education goal, and using this as a criterion for adjusting to the cost of living in different districts to obtain adequate financial expenditures. Maryland used this method to select 59 successful schools in the state and measured the financial adequacy standards for education from primary schools to high school, resulting in a basic per pupil financial expenditure of $5,969 in 1999−2000 [129]. The professional evaluation method is a method of evaluating the financial adequacy of a school district

using data on the district's basic expenditures, adjusted for the cost of living in different areas. The Professional Evaluation Method (PEM) is a method in which a panel of authoritative experts rate the inputs of educational resources necessary for a regulated school district to meet its educational goals and substitute the prices of each element to sum up to obtain the funding standards for the level of adequacy. Verstegen and Deborah (2006) [130] developed a set of standards for adequate educational services through the PEM by educational experts and administrators, containing class size, number of basic school buildings, student attendance and other indicators to measure the financial adequacy of education in Kentucky, which showed that Kentucky should have invested an additional $1.097 billion in education services. The physical consumption quota method is more like a combination of the first three methods, in which an expert selects a school district that has been proven to be effective at high instructional quality, and then applies the appropriate costing method to estimate the adequate investment of educational resources needed to reach the standard school district with high instructional quality. Odden (2007) [131] was this method that was used in Arkansas to measure the level of educational adequacy and increase the state's spending on education by 25%. In conclusion. The concept of financial adequacy of education is to gradually increase the input of educational resources according to the location of different regions, social and economic factors, while specific regions are treated specifically, to provide equal quality of educational resources for different regions, but different standards of educational expenditure can be set, rather than the pursuit of absolute fairness in the allocation of educational resources.

As early as around the 1990s, China's scholar Wang Shanmai (1985) [132] proposed that investment in education should be increased to ensure that per capita education expenditure grows gradually, and that the proportion of education allocation in fiscal expenditure needs to maintain a steadily rising trend. Since then, Qin Wanshun and Li Yining (1992) [133] have pointed out that China's education expenditure as a proportion of GDP and fiscal expenditure at all levels of government is relatively low, and that although the proportion of public education expenditure in China's fiscal expenditure rose in the 1980s, a major reason for this was the reform of

the original highly centralised economic and financial system, which resulted in a decline in the proportion of fiscal expenditure to GNP. However, a major reason for this was the reform of the previous highly centralised economic and financial system, which led to a decline in the ratio of financial expenditure to GNP. As a result, the proportion of China's public education expenditure to fiscal expenditure has not yet reached a reasonable level, and is lower than the proportion of education expenditure that is comparable internationally at the same economic level, and fiscal expenditure on education is far from adequate. With the continuous improvement of China's financial resources, education expenditure accounted for a steady increase in the proportion of general budget expenditure, but it is difficult to achieve a balance between the efficiency and equity of education inputs, and the concept of educational adequacy can to a certain extent take into account the efficiency and fairness of China's education reform and development to provide a suitable "middle way". The concept of educational adequacy can to some extent balance efficiency and equity, providing a suitable "middle way" for the reform and development of education in China. Huang Bin and Zhong Yuping (2008) [134] used McMahon model as the basis for the construction of a new model and research pointed out that the fairness and efficiency of education can be interdependent co-progressive relationship, and financial adequacy of education is to enhance the efficiency of education through the promotion of fairness of a means of intervention in public finance. Fei Yu and Li Xiaopeng (2006) [135] on the basis of the factor analysis method constructed the measurement function of the government's standard education expenditure taking into account regional differences and differences in development costs. The scientists also calculated the difference between China's average standard education expenditure and the actual expenditure on education during the period of 1999−2003, and concluded that the relevant policies should be formulated in order to increase investment in education while increasing education support in the western poverty-stricken areas. Bu Zizhou et al. (2011) [136] use as the basis the physical consumption quota method of the United States, as well as the "compulsory education assessment and acceptance" (according to "Compulsory Education Curriculum Experimental Programme') in the

basic education goals (enrolment rate), educational capacity (teacher-student ratio, etc.), educational expenditure (teacher salary level), infrastructure investment and other indicators, in order to build a standard education financial input model to derive the total input of standard compulsory education. According to it, the financial education input is calculated using the usual ratio of 60%−80%. It is concluded that China's financial compulsory education funding is not sufficient. Wang Dong et al. (2017) [137] combined the cost function method and the physical consumption quota method to construct a multiple regression equation for measuring the national standard education financial expenditure, which proved that China's education financial input at the current stage can basically meet the development needs of the education cause, but there are still problems such as the poor match between the programme objectives and the funding input, and the unequal level of adequacy between urban and rural areas. Tang Yipeng's (2019) [138] study found out that the proportion of higher education financial funding to GDP is low, and the government should still strengthen the long-term growth mechanism of higher education per capita financial funding.

At present, most of the studies on the financial adequacy of education in China focus on the compulsory education stage and the whole education stage, and there are relatively few studies on the financial adequacy of higher education. On the basis of the existing research, the future research should choose a reasonable method to measure the existing financial investment in higher education in China, and get the gap and ratio between the actual input value and the standard input value of financial expenditure in higher education, which on the one hand, can further explore the adequacy of financial investment in higher education, and on the other hand, can reflect the status quo of the balance of higher education resources among regions.

Nowadays, China's higher education financial resource allocation still exists problems such as large regional disparities, unsatisfactory resource allocation efficiency and inefficient scale is the main factor hindering the improvement of the comprehensive efficiency of higher education financial expenditures, which is still a bit far from the vision of balanced allocation of higher education financial resources

that takes into account both fairness and efficiency. This chapter will study the adequacy of China's higher education financial expenditures based on the fiscal budget, so as to lay the foundation for optimising the balanced allocation of higher education financial resources.

According to the previous literature review, there are four main international methods for measuring the financial adequacy of education, including the cost function method, the successful school district method, the professional assessment method and the physical consumption quota method. Among them, few scholars in China have used the Successful School Districts Method and the Professional Assessment Method to conduct research on the financial adequacy of education due to the fact that the selection of the normative school districts and expert groups is more subjective and is not applicable to measuring the financial adequacy of education among districts with large differences in demographic characteristics. Cost function method and physical consumption quota method can use more scientific statistical methods to determine the level of financial adequacy of educational output for calculation, domestic more used in compulsory education stage research, such as Bu Zizhou. For the study of financial adequacy of higher education, on the one hand, due to the current stage of China's financial expenditure on higher education in the GDP accounted for a medium level, Tang Yipeng and other scholars believe that it is more adequate; on the other hand, the purpose of higher education is to cultivate scientific and technological talents, the lack of compulsory education stage on academic performance, dropout rate, class size and other definitions to determine the goal of education. Therefore, the study of the financial adequacy of higher education is not suitable for the use of the cost function method or the physical consumption quota method to directly extrapolate its level of adequacy.

The study of financial adequacy at the tertiary level is more concerned with the balance of the allocation of resources to higher education. This dissertation also explores how the allocation of financial resources for higher education can be considered adequate under the existing economic conditions.

According to the "budget-vision-planning" system of financial adequacy in education, the prerequisite for the realisation of financial adequacy in education is to meet the requirements of budgetary guidance. According to the 2008 Measures for the General Transfer of Payments from the Central Government to Local Authorities, issued by the Budget Department of the Ministry of Finance, the standard financial expenditures for the education sector in China are calculated as follows:

Standard financial expenditure = $\sum_i$ ($\sum_z$ number of students at each level x standard per pupil expenditure at that level x expenditure cost variance factor)

The calculation method is clear, simple and easy to calculate, and has a certain degree of flexibility. Based on the calculation method of this standard financial expenditure budget, this dissertation will construct a more detailed and reasonable method of measuring the standard financial expenditure of higher education in full consideration of the government's responsibility for the balance of higher education, the regional cost of living differences, and the financial burden rate of higher education, in order to find out the standard financial expenditure of higher education that meets the vision and plan of the balanced allocation of financial resources for higher education. At the same time, by comparing with the actual expenditure of higher education in different regions, the adequacy of higher education finance can be derived, which can be used to illustrate the optimisation space of the allocation of higher education finance resources in China.

Based on the above analyses, it can be seen that the degree of financial adequacy of higher education can be described objectively through the comparison between the standard financial expenditures of higher education and the actual expenditures. Therefore, accurately calculating the standard financial expenditure of higher education is the first step in measuring the financial adequacy of higher education.

In order to further construct a set of standard financial expenditure calculation methods that can realise the vision of balanced allocation of financial resources in higher education, this dissertation optimises the formulae from the following perspectives:

Firstly, when applying the standardised method of calculating financial expenditure in the education sector as described above to the higher education sector, I can write the specific formula in the following form:

$$E_i = P_i \times D_i \times F_i \tag{3.6}$$

where E_i is the demand for standard financial expenditure on education in the ith region, i.e., the standard financial expenditure on higher education in each province that I want to measure; P_i is the number of students in the higher education stage, which is expressed here as the number of students enrolled in colleges and universities in the ith province (city); D_i is the standard of higher education per-student expenditure in the ith province (city); and F_i is the coefficient of difference in the cost of expenditure.

Second, in order to narrow the regional gap in the allocation of financial resources for higher education and realise the vision of a balanced allocation of financial resources, I will further unify the standard of per-student expenditure for higher education in each region. At present, the budget standards set by each region according to the financial strength of the province (city) are different, for example, in 2018, the average per-student general public budget utility expenditure for higher education in Guangdong Province was 25,877.26 yuan, and the average per-student general public budget utility expenditure for higher education in Guangxi Zhuang Autonomous Region was only 14,606.9 yuan. In order to promote the coordinated development of higher education, the unified higher education per capita expenditure standard contains the following principles: first, it reflects the government's responsibility. In the previous chapters, this dissertation has discussed the legitimacy of government intervention in higher education and the provision of sufficient financial support to realise the public value of higher education. Theoretically, the central government should implement a transfer payment policy that can balance the conditions of higher education in the region1 [135]. Therefore, there is a certain theoretical basis for setting a uniform standard of per capita expenditure on higher education. Secondly, it reflects

the government burden rate. The government burden rate of higher education is the size of the proportion of higher education financial expenditure in all higher education funding inputs, which not only reflects the size of the government's responsibility for the provision of higher education services, but also reflects the high level of the government's ability to utilise the resources available for education inputs. The government burden rate has been an important factor considered by scholars in previous studies of standard financial expenditures on education. Therefore, in this study, the government burden rate is also included in the calculation of the standard financial expenditure on higher education.

To summarise, I further improve the tertiary education per capita expenditure standard Di for the ith province (city) to a uniform tertiary education per capita expenditure standard D.

$$D = \frac{R}{\sum_{j=1}^{31} P_j} \times G \tag{3.7}$$

In the above equation, R is the total expenditure on higher education in all regions of the country (total investment in higher education). $\sum_{j=1}^{31} P_j$ It is the sum of the number of students enrolled in general colleges and universities in each province (city) of the country, i.e. the total number of students enrolled in general colleges and universities in the country; G is the average financial burden rate of higher education funding in the country, which is calculated as follows: G=B/R, and B is the total amount of national higher education financial expenditure.

Finally, on the choice of the coefficient of variation in expenditure costs. Since the reform and opening up to the present day, due to the influence of many factors, including policy, history and culture, there have been large differences in the natural, economic and social conditions of China's regions, which have led to differences in development costs between regions. Regions with better natural, economic and social conditions have lower regional development costs, and the cost of individuals being able to receive the same level of education is relatively low; conversely, the cost is

higher. The regional development cost difference index contains natural, economic and social information such as altitude, price index, population density, etc., which can reflect the development cost difference between regions, so it is more reasonable to use it as the expenditure cost difference coefficient of this study.

In the existing studies on the regional development cost difference index, there are several calculation methods, including the geometric mean method, the regression geometric mean benchmark method with constant terms and the regression geometric mean benchmark method without constant terms. Among them, the regression geometric mean benchmark method without constant term can not only avoid the problem of high regional development cost difference index calculated by the geometric mean method, but also can adjust the benchmark value of regional development cost difference index according to different research purposes. Therefore, this study will use the regional development cost difference index to calculate the expenditure cost difference coefficient of China's standard financial expenditures on higher education by combining the relevant methods and indicators in the studies of Fu Runmin and Yu Zhuanzhuan (2006) [201] and Liu Wei et al. (2007) [202].

The regional development cost difference index system contains three main categories of indicators that affect the cost of regional development: the natural base, the economic base and the social base, covering in particular elevation, forest cover, price index, GDP per capita, cargo turnover, total length of urban public transport operations, the number of graduates from general colleges and universities, and population density of municipal districts, etc., all of which together determine the level of the cost of regional development. The systematic framework of the Regional Development Cost Difference Index is shown in the figure 3.1.
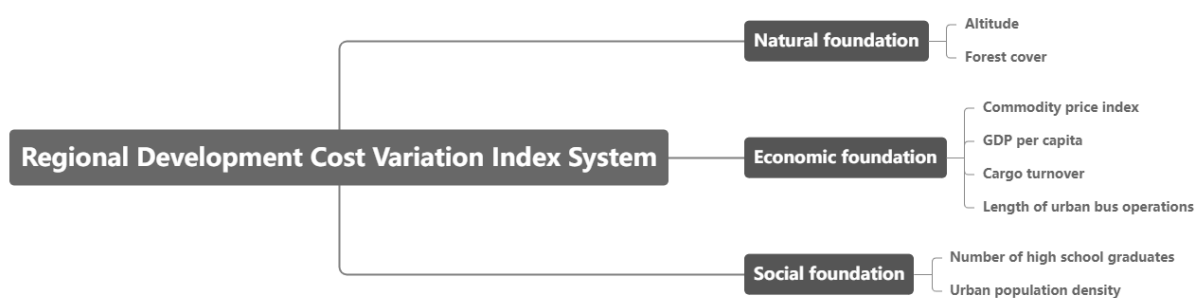
Figure 3.1 − Systematic framework of the Regional Development Cost Variation Index (RDCVI)

Source: compiled by author

The natural base refers to the natural space and components on which people's production and life depend, which is both the foundation of regional development and provides unique prerequisites for regional development. Unlike economic and social foundations, natural foundations are relatively fixed in distribution and weak in variability, mainly including topography, hydrology and climate, and soil and vegetation. Most of the existing studies have chosen the degree of surface relief and forest cover, which can have a greater impact on regional development, as indicators of the impact of the natural base on the cost of regional development. The interpretation of the specific indicators of the natural base category is shown in Table 3.6.

Table 3.6 − Indicators for the Natural Basis Category

Level 1 indicators	Secondary indicators	Note
Natural background	Relief	This indicator refers to the difference in elevation between the highest and lowest points in an area of a defined range and is able to quantitatively reflect the characteristics of ground relief in a macro-region, describing different topographic features.
	Forest cover	This is an important indicator of the actual level of forest resources in a given area, being the ratio of forest area to total land area.

Source: compiled by author

Among the indicators mentioned above, the Relief Degree of Land Surface (RDIS) can be calculated in a variety of ways, and based on the availability of data, this study chooses the height difference method for the calculation of the degree of relief of the land surface. The RDIS method is based on the definition of the degree of land surface relief and the requirement of reflecting the differences in regional development, and is calculated as follows:

$$RDLS = \frac{\max(h) - \min(h)}{\max(H) - \min(H)} \tag{3.8}$$

where max(h) is the highest elevation of a province (city), and min(h) is the lowest elevation of that province (city); max(H) is the highest elevation in the country, and similarly, min(H) is the lowest elevation in the country. The sources of the data in the natural basis category are: national and regional elevation data from the National Sub-Provincial 12.5m DEM Database of the Centre for Resource and Environmental Science and Data of the Chinese Academy of Sciences; and forest cover from the CECN statistical database.

The economic base is a relevant indicator of the productivity of a region, created through human activity. As human society progresses, the role of the natural base in promoting development gradually diminishes and the role of the economic base gradually increases. Therefore, the economic base is also a very important category of indicators for measuring the cost difference index of regional development, which mainly includes the price index, GDP per capita, cargo turnover and the total length of urban public transport operations. The interpretation of the specific economic base category of indicators is shown in Table 3.7.

The data of the above various types of basic economic indicators come from the statistics database of CEIC.

The progress of a region depends not only on its natural and economic foundations, but also on a sound social foundation. Reasonable infrastructure arrangement, use and management, perfect talent cultivation and retention

mechanisms, and a suitable social and human environment are all important social foundations for the development of a region. Related to the standard financial expenditures on higher education, I selected the number of graduates of general colleges and universities and the population density of municipal districts as the indicators of social foundation when calculating the coefficient of regional development cost difference. The interpretation of specific social foundation category indicators is shown in Table 3.7.

Table 3.7 − Indicators in the economic base category

Level 1 indicators	Secondary indicators	Note
Socio-economic base	GDP per capita	GDP per capita, one of the most commonly used indicators in the field of economics to measure the macroeconomic development of a region, plays a fundamental role in the calculation of the index of differences in the cost of regional development.
	commodity price index	This refers to the index of the level of consumption of the population, which is a composite indicator of regional differences in the level of consumer prices, and which is indispensable in adjusting the amount of standard financial expenditures in each region.
	Cargo turnover	This indicator, which is the product of the volume of goods transported in a region over a period of time and the distance travelled, provides a comprehensive picture of the results of regional goods transport and is an important indicator for evaluating the basis of economic development in a region.
	city public transport Total length of operation	Urban public transport system is an important infrastructure construction for promoting regional economic development, including various public transport modes such as buses, taxis, subways and light railways, etc. The total length of its operation reflects not only the level of economic development of a region, but also the quality of that region's economic development.

Source: compiled by author

Data on the number of graduates from general colleges and universities come from the education statistics on the official website of the Ministry of Education, and data on the population density of municipal districts come from the statistics database of WI.com.

Table 3.8 − Indicators in the social base category

Level 1 indicators	Secondary indicators	Note
Social foundation	Number of graduates from general colleges and universities	This indicator not only reflects a region's ability to supply high-quality talents, but also concerns regional employment and other livelihood development issues, and is a commonly used indicator for the cost index of regional development differences.
	Population density in municipal districts	This indicator describes the distribution of population in each city through the number of people per unit of land area in the municipal district. By analysing the population density of a municipal district, it is possible to determine the development dynamics and space of a region, which also has a more pronounced impact on the cost of regional development.

Source: compiled by author

The calculation of the regional development cost differential index using the geometric regression average benchmark method without a constant term requires that the data for the above indicators be varied first. Since it is necessary to use the regional development cost difference index in this study to reflect the development costs of different regions in order to formulate a reasonable amount of standard fiscal expenditure, the larger the value of the index, the more inputs should be required for the region to obtain the same degree of development, i.e., the larger the standard fiscal expenditure will be. Therefore, when making adjustments to the data, the benchmark value used as a reference should be the largest value in each region:

$$X_i = \frac{\text{Data for one province } i}{\max(\text{reference value})}$$

(3.9)

In the above formula, x_i is the indicator to be adjusted, and the numerator in the formula is the value of this indicator in ith province, and the denominator is the maximum value of this indicator value in 31 provinces (municipalities), e.g., the degree of surface undulation and the number of graduates from colleges and universities, respectively, can be done as follows to adjust the data:

$$\text{Adjustment for surface undulation in Province} \, i = \frac{\text{Surface relief in Province} \, i}{\text{max(relief)}} \qquad (3.10)$$

$$\begin{aligned}
&\text{Adjustment for the number of graduates from general colleges and universities in province} \, i \\
&= \frac{\text{Number of graduates from general colleges and universities in province} \, i}{\text{max(Number of graduates from general colleges and universities)}}
\end{aligned} \qquad (3.11)$$

The seven indicators in the three categories of natural, economic and social bases, except for GDP per capita, are substituted into the following regression equation after making the above adjustments:

$$y_i = x_{ij}^{\beta}, i = 1,2,\ldots,31, j = 1,2,\ldots,7 \qquad (3.12)$$

where y_i is the ratio of GDP per capita in the ith province to national GDP per capita, and x is the jth indicator adjustment term for the ith province.

Transform the above regression equation into a linear model:

$$\ln y_i = \beta_j \ln(x_{ij}) \qquad (3.13)$$

Finally, the formula for the calculation of the regional development cost differential index using the geometric regression average benchmark method without constant terms is:

$$F_i = \Sigma_{j=1}^{7} \beta_i \sqrt{\Pi_{j=1}^{7} x_i^{\beta_j} j} \qquad (3.14)$$

where Fi is an index of regional development cost differentials and a coefficient of expenditure cost differentials in standard financial expenditures on higher education.

In summary, the formula for calculating the standard financial expenditure on higher education in this study can be expressed as follows:

$$E_i = R \times \frac{P_i}{\sum_{i=1}^{31} P_j} \times G \times F_i \tag{3.15}$$

The ratio between the standard financial expenditure on tertiary education, once calculated, and the actual expenditure is known as the tertiary education financial adequacy ratio:

$$\text{Standardised financial adequacy rate for tertiary education} = \frac{\text{Fiscal expenditure on higher education in real terms}}{\text{Value of standard financial expenditure on higher education}} \tag{3.16}$$

When the tertiary education financial adequacy ratio is greater than 1, it means that the actual value of regional tertiary education financial expenditure is greater than the standard expenditure value, and the region's tertiary education financial expenditure is sufficient; on the contrary, when the tertiary education financial adequacy ratio is less than 1, the region's tertiary education financial expenditure is insufficient, and it is necessary to further increase the region's tertiary education financial inputs.

3.3. Optimization of the system of horizontal transfer payments for the balanced inter-regional distribution of state resources within the framework of the management of state financial resource sin higher education in China

According to the existing research, domestic and foreign scholars usually intuitively use the proportion of higher education financial expenditure to GDP to examine the adequacy of higher education finance based on the perspective of international comparison. In this dissertation, this data of some economically more developed countries are selected to be compared with China's data, and the results are shown in Table 3.4.

Among them, the international data come from the statistics on the official website of OECD, and the data in China are calculated based on the data in China Education Statistics Yearbook and China Statistics Yearbook. As can be seen from

Table 3.9, the proportion of financial expenditure on higher education to GDP in western developed countries has been relatively stable in recent years, except for Australia, which basically stays around 1%, and Canada even reaches the level of 1.5%. The proportion of China's financial expenditure on higher education to GDP is lower than the level of Western developed countries, but slightly higher than Japan, South Korea and other countries in Asia, and has shown a rising trend year by year, from 0.53% in 2008 to 0.77% in 2017, the proportion of which has increased by nearly 45% in more than a decade. However, it should be noted that the level of China's financial expenditure on higher education as a proportion of the national GDP in 2017 is still lower than that of economically developed countries in 2015, and there is more room for further improvement.

Table 3.9 − Financial Expenditure on Tertiary Education as a Share of GDP by Country

Nations	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
China	0.53	0.59	0.56	0.69	0.77	0.69	0.69	0.75	0.73	0.77
USA	1.05	1.08	1.07	1.07	1.04	0.95	0.92	0.91	-	-
German	0.92		1.01	1.03	1.03	1.02	1.03	1.01	-	-
French	1.12	1.21	1.19	1.16	1.13	1.14			-	-
Australia	0.69	0.74	0.78	0.74	0.72	0.72	0.72	0.77	-	-
Canadian	1.49	1.52	1.49	1.35	1.29	1.24	1.21	1.20	-	-
Japanese	0.48	0.53	0.50	0.52	0.51	0.52	0.49	0.45	-	-
South Korea	0.53	0.62	0.66	0.66	0.69	0.75	0.78	0.66	-	-

Source: developed by author

Although the proportion of China's financial expenditure on higher education to GDP has increased, the growth rate of financial expenditure on higher education is much lower than the growth rate of China's GDP. As shown in Figure 3.2, China's fiscal expenditure on higher education has grown in tandem with the total investment in higher education, and the growth rate of both has been lower than the growth rate of China's GDP.

Figure 3.2 − Total China's National GDP, Total Higher Education Funding and Fiscal Funding, 2007−2017

Source: developed by author

In addition, China's higher education financial expenditures are mainly divided into business funding and infrastructure investment, of which the volume of infrastructure investment is small and the growth is flat. Figure 3.2 reflects the classification status of China's higher education financial expenditure and the proportion of total financial funding investment in GDP from 2007 to 2017.

Observation of Figure 3.3 shows that the level of investment in higher education infrastructure in China over the years has been low, and its growth has been slower than the growth of career funding, and the infrastructure investment of 37.27 billion yuan in 2017 was only 2.88 times that of 2007, with a total increase of 24.36 billion yuan between 2007 and 2017.
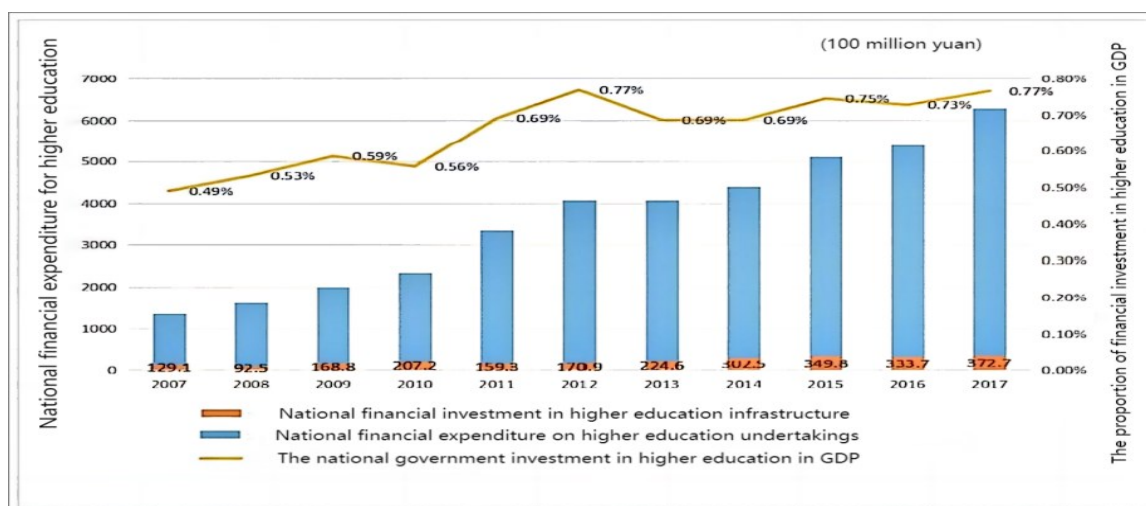
Figure 3.3 − Breakdown of China's national fiscal funding for higher education and share of GDP, 2007−2017

Source: developed by author

The growth of national higher education financial expenditure as a percentage of GDP, on the other hand, came mainly from the contribution of the continued growth of financial career funding. Between 2007 and 2017, higher education career funding expenditure grew from 123.384 billion yuan to 591.223 billion yuan, an increase of 3.79 times. Among them, the fastest growth in higher education career expenditure was in 2011, from 214.23 in 2010 to 320.364, an increase of nearly 50 per cent. The ratio of national financial expenditure on higher education to GDP, on the other hand, reached its highest point in 2012, and then declined slightly after that, but finally reached the same high point in 2017 as in 2012.

Checking the relevant information, it is found that the reason why China's expenditure on higher education in 2011 had a large level of improvement is that the main government, in order to encourage and guide localities to gradually establish a sound system of per-pupil funding for higher education schools, so as to continuously improve the level of funding, has promulgated the "Outline of the National Medium- and Long-Term Educational Reform and Development Plan (20102020)" in 2010 and the "Opinions on Opinions on Further Improving the Level of Per-Pupil Allocation for Local General Undergraduate Colleges and Universities" (hereinafter referred to as the "Opinions"). The Opinions pointed out that localities should establish a dynamic

adjustment mechanism for the per-student allocation standard of local colleges and universities in accordance with the reasonable needs of colleges and universities, and at the same time, take into account the situation of their respective financial resources, the level of price changes, changes in the number of students enrolled in colleges and universities, and adjustments in salary standards, etc., so as to gradually increase the per-student allocation level. Under this guidance, expenditure on higher education programmes in 2011 and 2012 showed a trend of growth.

Although China's funding for higher education has continued to grow steadily, it is also worth noting that investment in higher education infrastructure has been growing slowly, and the total amount has always been relatively small. In recent years, the number of college students in China has been increasing, the scale of higher education schools across the country has been expanding, and many colleges and universities are building new campuses in many places, and as science and technology continue to improve, the need to build high-tech laboratories is also increasing day by day. Therefore, the need to strengthen investment in infrastructure should not be overlooked, and financial support for higher education infrastructure projects should be gradually increased at the same time as higher education spending is increased.

Due to the availability of data, some provinces (cities) lacked data related to the forest cover rate in 2014−2016, therefore, according to the above measurement formula, I calculated the values of the standard financial expenditures on higher education and the financial adequacy ratio of 31 provinces (cities) in China in 2017, and the results are shown in Table 3.10.

As can be seen from the table, in 2017, China's actual expenditure on higher education totalled 526.697 billion yuan, but the amount of standard financial expenditure was 666.205 billion yuan, which was 139.508 billion yuan higher than the actual expenditure, indicating that the existing actual expenditure on higher education finances can not reach the level of standard expenditure, and there is a real need to increase the amount of China's actual expenditure on higher education finances; the comprehensive higher education financial The overall adequacy rate of higher

education finance is only 0.79, indicating that overall, China's existing higher education financial expenditure gap is still large, and the overall adequacy is not high.

Table 3.10 − Actual, Standard and Adequacy Rates of Our Financial Expenditure on Higher Education, 2017

| District	Index of regional development cost differentials	Fiscal expenditure on tertiary education in real terms ($ billion)	Standardised value of fiscal expenditure on tertiary education ($ billion)	Difference (in billions of dollars) = standard value - actual value	Adequacy = actual/ standard
Beijing,	0.85	394.84	108.20	-286.64	3.65
Tianjin	1.03	111.09	113.82	2.73	0.98
Hebei	1.13	229.30	307.86	78.55	0.74
Shanxi	1.14	107.29	186.75	79.46	0.57
Inner Mongolia	1.27	86.76	122.19	35.43	0.71
Liaoning	1.05	139.22	221.16	81.94	0.63
Jilin	1.12	119.04	154.84	35.80	0.77
Heilongjiang	1.23	114.03	193.89	79.85	0.59
Shanghai	0.86	212.41	95.08	-117.33	2.23
Jiangsu	1.03	371.089	390.97	19.88	0.95
Zhejiang	0.92	207.15	198.00	-9.16	1.05
Anhui	1.22	179.71	300.56	120.85	0.60
Fujian	0.97	143.51	156.41	12.89	0.92
Jiangxi	1.26	194.56	283.60	89.04	0.69
Shandong	1.10	276.01	475.99	199.98	0.58
He'nan	1.27	290.70	546.64	255.93	0.53
Hubei	1.08	229.89	324.85	94.96	0.71
Hunan	1.15	182.19	314.38	132.19	0.58
Guangdong	0.87	514.69	359.73	-154.96	1.43
Guangxi	1.29	150.91	240.06	89.15	0.63
Hainan	1.20	37.03	47.80	10.78	0.77
Chongqing	1.11	114.56	178.00	63.44	0.64
Sichuan	1.21	207.80	389.63	181.82	0.53
Guizhou	1.28	125.25	172.50	47.26	0.73
Yunnan	1.35	112.4688	204.60	92.13	0.55
Tibet	2.23	14.69	18.52	3.83	0.79
Shaanxi	1.09	184.41	250.27	65.86	0.74
Gansu	1.38	96.29	138.13	41.83	0.70
Qinghai	1.43	19.25	20.56	1.32	0.94
Ningxia	1.49	38.07	38.73	0.66	0.98
Xinjiang	1.47	62.75	109.22	46.47	0.57
Total		5266.97	6662.92	1395.95	0.79

Source: developed by author

Sub-regionally, in 2017, the financial adequacy rate of higher education in most regions of China is less than 1, that is, the actual value of financial expenditure on higher education is less than the standard value of the input, and the adequacy rate of the eastern region is generally higher, followed by the western region, and the adequacy rate of the central region provinces (cities) is lower, which is also in line with the findings of existing scholars on the allocation of financial resources for higher education in China. This is also consistent with the existing scholars on China's financial resource allocation for higher education "east high, west low, middle collapse" research conclusions. Among the provinces (municipalities) with an adequacy rate of higher education financial expenditure less than 1, the provinces (municipalities) with the smallest adequacy rate are Henan and Sichuan provinces, where the financial adequacy rate of higher education is only 0.53, and the difference between the actual value and the standard value of higher education financial expenditure in Henan province is 25.593 billion yuan, and the difference in Sichuan province is 18.182 billion yuan. In addition to Henan and Sichuan Provinces, Anhui, Shandong and Hunan Provinces also have a shortfall of more than 10 billion yuan in fiscal expenditure on higher education, amounting to 12.085 billion yuan, 19.998 billion yuan and 13.219 billion yuan, respectively, with a sufficiency rate of less than 0.6.

Only Beijing, Shanghai, Zhejiang and Guangdong Provinces have a sufficiency rate of more than 1, and all of them belong to the economically developed eastern region. Among them, Beijing has the highest financial adequacy rate for higher education, 3.65, and its actual expenditure value is higher than the standard value by the largest amount, 28.664 billion yuan; followed by Shanghai, with a financial adequacy rate for higher education of 2.23, and the actual value is 11.733 billion yuan more; Guangdong Province also has a high financial adequacy rate (1.43), and the actual value of its higher education financial expenditures is 15.496 billion yuan more than the standard value; Zhejiang Province's financial adequacy rate is also high (1.43), and its actual value of higher education financial expenditures is more than the standard value by 15.496 billion yuan; Zhejiang Province's tertiary education financial

adequacy rate is only 1.05, and the actual value of financial expenditure is only slightly higher than the standard value by 916 million yuan.

To provide a more visual representation of the level of financial adequacy of higher education across the region, Figure 3.4 exhaustively depicts the financial adequacy of higher education in the country in 2017.
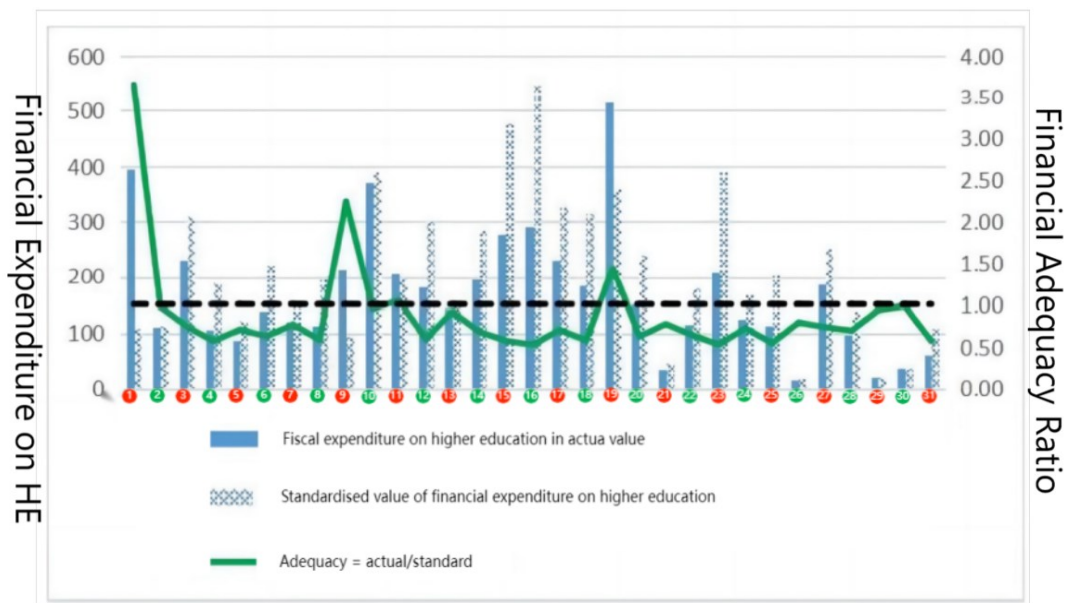
1	Beijing,	8	Heilongjiang	15	Shandong	22	Chongqing	29	Qinghai
2	Tianjin	9	Shanghai	16	He'nan	23	Sichuan	30	Ningxia
3	Hebei	10	Jiangsu	17	Hubei	24	Guizhou	31	Xinjiang
4	Shanxi	11	Zhejiang	18	Hunan	25	Yunnan		
5	Inner Mongolia	12	Anhui	19	Guangdong	26	Tibet		
6	Liaoning	13	Fujian	20	Guangxi	27	Shaanxi		
7	Jilin	14	Jiangxi	21	Hainan	28	Gansu		

Figure 3.4 − Actual, Standardised and Fiscal Adequacy Ratios of China's Fiscal Expenditure on Higher Education, 2017

Source: developed by author

From Figure 3.4, we can see more clearly that there are not many provinces (cities) that are higher than the standard financial adequacy ratio (black dotted line), and the financial adequacy ratio of higher education in most regions of the country is close to 0.6 or below, and fewer regions have a financial adequacy ratio that is close to 1. In addition, the financial adequacy ratios of higher education in some of the western regions are even higher than those in the eastern regions, such as Qinghai Province

and Ningxia Hui Autonomous Region, which are higher than other eastern regions, with 0.94 and 0.98 respectively. For example, Qinghai Province and Ningxia Hui Autonomous Region have higher financial adequacy ratios for tertiary education in the western region, with 0.94 and 0.98 respectively; Hebei Province belongs to the eastern region, but its adequacy ratio differs greatly from that of other eastern provinces (cities), with only 0.74, which is lower than that of some central and western regions. On the one hand, this may be related to the different numbers of students enrolled in general colleges and universities in each province. The ratio of the number of students in colleges and universities is one item in the formula for calculating the standard financial expenditure on higher education. The number of students in colleges and universities in Hebei Province is close to 1.27 million, which is at the forefront of the country, so its standard financial expenditure on higher education is also higher, but the existing actual expenditure is far from the standard expenditure; whereas, the number of students in colleges and universities in the western regions, such as Qinghai and Ningxia, is small, and the standard financial expenditure required is relatively low, so a higher adequacy rate is also relatively reasonable. The higher adequacy rate is also relatively reasonable. On the other hand, it may be influenced by national policies. Although the adequacy rate of financial expenditure on higher education in the western region has not yet reached the standard value, there are some regions that have reached the national average or above, indicating that the attention paid by the state to higher education in the central and western regions in recent years and the implementation of some tilted policies have been slightly effective, for example, the "Outline of the National Medium- and Long-Term Educational Reform and Development Plan (2010−2020)" proposes to "increase transfer payments for education in old revolutionary, ethnic, border and poverty-stricken areas", and the Plan for the Revitalisation of Higher Education in the Central and Western Regions (2012−2020), which plans to invest 10 billion yuan to support the rapid development of 100 local general undergraduate colleges and universities, and so on.

Taken together, the overall adequacy of China's financial expenditure on higher education is not high; for this reason, we need to further increase the total amount of

financial funding for higher education and optimise the proportion of financial transfers for education.

Conclusions of the chapter 3

1.   The chapter utilizes a combination of econometric models, including regression analysis (2SLS) and production functions, to evaluate the relationship between financial inputs in education and economic growth. A mediation model incorporates human and intellectual capital as mediators to assess the direct and indirect effects of education investments. Human capital is quantified by average years of education, while intellectual capital is represented by the number of invention patents. The study employs data from the National Bureau of Statistics of China, spanning multiple years, providing robust insights into provincial variations.

2.   Local financial investments in education significantly contribute to regional economic growth, both directly and indirectly. Direct impacts stem from education's role as a factor of production, while indirect impacts are mediated through enhancements in human and intellectual capital. Education spending fosters the accumulation of human capital, measured by average years of education, and intellectual capital, represented by the number of invention patents granted. Both factors play a crucial role in driving regional development.

3.   Dynamic panel regression techniques address endogeneity issues, enhancing the reliability of findings. The use of the DEA (Data Envelopment Analysis) model evaluates efficiency in financial allocations, removing external environmental and random factors for more accurate assessment.

4.   Significant disparities exist in educational expenditures across regions, reflecting variations in natural, economic, and social development. The eastern provinces typically receive higher funding levels and exhibit surplus expenditure in some cases, while central and western provinces face significant deficits. These differences exacerbate regional inequalities, underlining the need for targeted strategies to ensure equity and adequacy in financial provisions for higher education.

5.   The current system of horizontal transfer payments requires optimization to balance inter-regional resource allocation effectively. This includes ensuring that financial transfers account for regional disparities and are aligned with the broader goal of equitable higher education access and quality. Reforms should aim to reduce gaps between resource-rich and resource-deficient regions, promoting a more balanced distribution of state resource.

6.   China's overall financial expenditure on higher education is inadequate, particularly in central and western regions. Substantial increases in funding, along with improved allocation mechanisms, are essential to achieve balanced and equitable educational development. Emphasizing underfunded regions while maintaining efficiency in resource use is critical. Tailored policies should address specific regional challenges, fostering uniform development across provinces. Strengthen investment in central and western regions to address gaps in educational and economic development.

7.   Sustainable economic growth and human development depend on integrating education financing into regional planning. This requires continual adjustment of funding models based on evolving demographic, economic, and social conditions.

8.   It found necessity to refine horizontal transfer payments by adopting dynamic allocation models responsive to regional socio-economic conditions. Optimizing the horizontal transfer payment system and introducing monitoring mechanisms to evaluate and adjust resource allocation will ensure alignment with national development goals.

9.   It is recommended to introduce initiatives to attract and retain talent in underserved areas, offering competitive remuneration and career development opportunities. Enhance infrastructure and technology to create conducive learning environments.

10.   Developing dynamic systems to monitor the alignment of financial allocations with regional economic growth and educational needs is recommended to improve government policy. Regular evaluations should ensure efficient resource use and guide future policy adjustments.

11.   Promote collaboration between regions will allow to share resources and facilitate talent mobility, contributing to more equitable and efficient educational outcomes.

The primary findings of this chapter were published by the author in the following works: [230-234].

CONCLUSIONS

The dissertation, focusing on the management of state financial resources in China's higher education: enhancing regional equity, efficiency and adequacy of financial provision, addresses a critical issue in educational policy and resource management. By examining regional disparities, efficiency in resource utilization and adequacy in financial provision, the research provides a comprehensive framework for improving the financial management of higher education in China.

The relevance of the study lies in its response to pressing challenges in China's higher education system. With significant regional disparities in financial resource allocation, there is an urgent need to ensure equity, improve efficiency, and achieve adequacy in funding to foster socioeconomic cohesion and drive sustainable development. These goals are aligned with national strategic plans, such as "China Education Modernization 2035", emphasizing equitable and effective higher education to strengthen human capital and regional economies.

Comprehensive literature review, bibliometric analysis and comparative analysis of international practices in education funding from countries such as the United States, Japan, and the European Union.

Theoretical principles of equity, efficiency and adequacy were defined and contextualized within China's educational policies. The analysis revealed that global best practices emphasize multi-channel financing and mechanisms to support underdeveloped regions. These insights provide a foundation for adapting successful strategies to China's unique challenges.

Gini coefficient and β-convergence models (absolute and conditional) were applied to assess regional disparities and trends in convergence. While convergence trends were observed nationally, significant gaps persisted in western and north-eastern regions. These findings highlight the need for policy interventions tailored to lagging regions.

A three-stage DEA model measured the efficiency of financial expenditures while accounting for external environmental factors. Efficiency varied significantly across

provinces, with central regions showing higher efficiency compared to the western regions. This emphasizes the need for optimized allocation strategies.

Regression analysis and coordination indices assessed the alignment between education investments and regional economic development. Better coordination was noted in developed regions, while underdeveloped areas struggled to align educational outputs with economic needs. This underlines the necessity for region-specific educational strategies.

Econometric modelling assessed direct and mediated effects of education investments through human and intellectual capital are employed. Investments significantly enhanced regional GDP growth directly and indirectly, validating the role of education in economic development.

Analysis of fiscal expenditures and socio-economic indicators. Persistent disparities in educational investment were identified, with underdeveloped regions facing critical funding gaps. This calls for targeted financial support policies.

Dynamic modelling of transfer payment systems is provided. The current system inadequately addresses regional disparities. Optimized horizontal transfer payments were proposed as a solution for balanced inter-regional resource allocation.

Substantial disparities in higher education financing persist across regions, necessitating increased financial support and tailored interventions for underdeveloped provinces. Inefficiencies in financial expenditure allocation were identified, especially in regions with diminishing returns. Improved allocation structures and scaled investments are critical to maximizing efficiency. The overall adequacy of financial provision is insufficient, with critical funding deficits in central and western provinces. This undermines the broader goals of equitable access and educational quality.

Recommendations for increasing investments in underfunded regions, optimizing transfer payment systems, and aligning financial strategies with regional economic characteristics are developed. Establishing national platforms for evaluating efficiency and equity in resource allocation are suggested. It was proposed the adapting global best practices, such as multi-channel financing, to China's higher education context.

Enhancing the synergy between educational outputs and economic goals through targeted programs and incentives is proved.

The dissertation provides a robust framework for addressing financial disparities in China's higher education. By combining advanced methodologies with a focus on practical applications, it offers actionable insights for policymakers to foster a more equitable, efficient, and adequate system of financial resource management. The findings contribute significantly to the academic discourse on education financing and offer a pathway for achieving balanced regional and national development.

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APPENDIX

APPENDIX A

LIST OF PUBLICATIONS

Publications in Ukrainian scientific specialized journals

8.   Yu, Y., Tingting, Y., Ruoxi, L., & Xinxin, W. (2023). Examining the Role of Education Spending on China's Regional Economy from the Standpoints of Human and Intellectual Capital. Marketing and Management of Innovations (WoS, category A), 14(2), 127-137. https://doi.org/10.21272/mmi.2023.2-12. (1.14 printed pages). *Yu, Y. personal contribution:* developing methodology and analysis *of the examination of the direct and indirect impact of financial investment in education on the economic growth of different regions of China (0,9 printed pages). Co-author's contribution:* Tingting, Y.: preparation of statistical data and their processing to analyze the relationship between education spending and the economic development of Chinese regions from the perspective of human capital *(0,04 printed pages)*; Ruoxi, L.: formulating conclusions on strategies for increasing the efficiency of education spending, taking into account the impact of intellectual capital on the regional development of the Chinese economy *(0,1 printed pages)*; Xinxin, W.: theoretical analysis of the main approaches to assessing the impact of education spending on human capital development and development of a research methodology *(0,1 printed pages))*.

9.   Yu, Y. (2023). Performance Analysis of Public Investment in Chinese University Education Based on Regional Differences and Influencing Factors. Business Ethics and Leadership (category B), 7(1), 37-49. https://doi.org/10.21272/bel.7(1).37-49.2023 (1,41 printed pages).

10.   Yu, Y., Xinxin, W., Ruoxi, L., Tingting, Y. (2023). The Mediating Role of Human Capital in the Relationship between Education Expenditure and Science and Technology Innovation: Evidence from China. SocioEconomic Challenges (category B), 7(1), 129-138. https://doi.org/10.21272/sec.7(1).129-138.2023 (0,97 printed pages). *Yu, Y. personal contribution: the influence of human capital as a mediator in*

the relationship between education spending and innovation in science and technology was investigated, a conceptual research model was developed, and empirical data was analysed (0,75 printed pages). Co-author's contribution: Xinxin, W. – a theoretical analysis of previous studies on the impact of education spending on innovation activity was conducted, recommendations were developed for improving investments in education (0,1 printed sheets); Ruoxi, L. – processed statistical data and quantitatively analysed the research results, correlations between education spending and the level of innovation were assessed (0,1 printed sheets); Tingting, Y. – ensured the integration of the research results into a generalized conclusion, prepared conclusions and highlighted practical aspects of implementing the research results (0,02 printed sheets).

11.   Yu, Y., Ruoxi, L., Tingting, Y., Xinxin, W. (2023). Convergence and Disparities in Higher Education Fiscal Expenditures in China: A Regional Perspective. Financial Markets, Institutions and Risks (category B), 7(3), 31-47. https://doi.org/10.61093/fmir.7(3).31-47.2023. (1,49 printed pages). *Yu, Y. personal contribution: regional features of convergence and disparities in financing higher education in China were investigated, the research methodology was developed, and the primary statistical data were collected and analysed (1,1 printed pages). Co-author's contribution: Ruoxi, L. – a detailed analysis of regional budgets for higher education was performed, and key trends and deviations in financial expenditures between regions were identified (0,19 printed pages); Tingting, Y. – The integration of the research results was carried out, and practical recommendations were developed to optimize funding distribution in the education field (0,1 printed pages); Xinxin, W. – a literature review was conducted on methods for assessing disparities in the financing of education, and the article's conclusions were edited and structured (0,1 printed pages).*

12.   Yu, Y., Xinxin, W., Ruoxi, L., Tingting, Y. (2024). The Influence of Regional Socioeconomic Features On the Distribution of Financial Resources For Higher Education. SocioEconomic Challenges (category B), 8(1), 269-285. https://doi.org/10.61093/sec.8(1).269-285.2024 (1,7 printed pages). *Yu, Y. personal*

contribution: analysed the impact of regional socio-economic characteristics on the distribution of financial resources for higher education, identified vital factors and developed a conceptual research model (1,1 printed pages). Co-author's contribution: Xinxin, W. – analysed statistical data by region and identified features and differences in financing higher education depending on socio-economic conditions (0.2 printed pages); Ruoxi, L. – developed methods for assessing the impact of socio-economic factors on financial provision and conducted a quantitative analysis of the research results (0,2 printed pages); Tingting, Y. – summarized the research results, prepared practical recommendations for optimizing the distribution of financial resources in the field of higher education, and edited the article (0,2 printed pages).

13.   Yu, Y., Tingting, Y., Ruoxi, L., & XinXin, W. (2024). Effectiveness of Higher Education Financing: DEA and SFA Modelling. Business Ethics and Leadership (category B), 8(1), 172-189. https://doi.org/10.61093/bel.8(1).172-189.2024 (2,26 printed pages). *Yu, Y. personal contribution: developed a conceptual framework for researching the efficiency of higher education financing using DEA (data envelopment analysis) and SFA (stochastic frontier analysis) models, carried out modelling using the above methods, and assessed the efficiency of financial resource allocation in higher education (1,8 printed pages). Co-author's contribution: Tingting, Y. – collected and systematized data for empirical analysis using the DEA model (0,2 printed pages); Ruoxi, L. – conducted a theoretical analysis of external factors impact on financing efficiency (0,1 printed pages); Xinxin, W. – analysed the results, formulated conclusions and practical recommendations, and provided structuring and editing of the text of the article (0,16 printed pages).*

14.   Yu, Y. (2024). A study on the coordination between the size of undergraduate education and regional economy in mainland China's provinces: analysis and pathway recommendations based on 2018 data. Herald of Khmelnytskyi National University. Economic sciences (category B), 4, 482-491. https://doi.org/10.31891/2307-5740-2024-332-72 (0,86 printed pages).

Conference Proceedings

5.   Yang Yu (2022). Market-oriented reform and resource allocation in UK higher education. Socio-Economic Challenges: Proceedings of the International Scientific and Practical Conference, Sumy, November 14–15, 2022 / edited by Prof., Dr. Vasilyeva Tetyana. – Sumy : Sumy State University, 193-196 (0,29 printed pages).

6.   Yang Yu (2023). Implications of resource allocation for higher education in the United States. Digital transformations and innovative technologies in the economy: challenges, realities, strategies: materials of the International Scientific and Practical Conference (Sumy, 17-19 May 2023) / edited by L. L. Hrytsenko, I. V. Tiutiunyk. Sumy: Sumy State University, 120-123 (0,28 printed pages).

7.   Yang Yu (2021). The current status and characteristics of Japan's higher education resource allocation system. Financial Markets, Institutions and Risks: Proceedings of the International Scientific and Practical Online-Conference, Sumy, November 20-22, 2021 / edited by Prof., Dr. Vasilyeva Tetyana. – Sumy: Sumy State University, 85-88 (0,26 printed pages).

8.   Yang Yu (2023). Theoretical foundations and practical paths of educational adequacy and optimal allocation of higher education resources. Problems and prospects for the development of the financial and credit system of Ukraine: materials of the VIII International Scientific and Practical Conference (Sumy, 4-5 December 2023) / edited by L.L. Hrytsenko, I.V. Tiutiunyk. Sumy : Sumy State University, 80-84 (0,35 printed pages).

APPENDIX B

European Marketing and Management Association
5 Knezopoljska Street, 78000 Banja Luka, RS, Bosnia and Herzegovina

…connecting leaders

19 September 2024

The confirmation of the implementation of the dissertation results

We confirm that the findings of the dissertation, entitled "The management of state financial resources in China's higher education: enhancing regional equity, efficiency, and adequacy of financial provision", prepared by Yang Yu, a postgraduate student at Sumy State University, and submitted for the degree of Doctor of Philosophy in the field of specialty 073, "Management", have been incorporated into the activities of EUMMAS.

In particular, the current activities of EUMMAS are oriented towards the conclusions presented by the doctoral student on the comparison of international experience in the implementation of public management, with a specific focus on regional equity, efficiency and the adequacy of financial support in higher education.

Prof. Dr. Mile Vasic
President

https://eummas.net

APPENDIX C

Centre of Sociological Research
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Rzeszów dn. 17.07.2024

Certificate verifying the incorporation of the findings of the dissertation into the ongoing endeavours of the Centre of Sociological Research

reference number 1/17/7/24

This certificate serves to confirm the Centre for Sociological Research's acquaintance with the dissertation entitled "The management of state financial resources in China's higher education: enhancing regional equity, efficiency, and adequacy of financial provision", prepared by Yang Yu, a postgraduate student of Sumy State University, and submitted for the degree of Doctor of Philosophy in the specialty 073 'Management'.

The author's proposals for the analysis of educational inequality and disparity in the distribution of financial resources for higher education between regions, employing the Dagum's Gini coefficient, are of practical value for the Centre for Sociological Studies.

FUNDACJA
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Yuriy Bilan

prof. dr hab. Yuriy Bilan

Członek z arządu

APPENDIX D

ГО «Центр освіти впродовж життя»

NGO "Lifelong learning Centre"

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On 15th of August, № 1-08

The Confirmation Letter

This letter is to formally confirm the incorporation of findings from the dissertation titled *"The Management of State Financial Resources in China's Higher Education: Enhancing Regional Equity, Efficiency, and Adequacy of Financial Provision,"* authored by Yang Yu, a postgraduate student at Sumy State University pursuing the degree of Doctor of Philosophy in the specialty 073 "Management."

We are pleased to announce that select findings from this research—specifically those related to clustering regions based on the coordination level between economic and educational development, as well as the development of localized management strategies to ensure coherence between the demand for highly qualified professionals and the scale of economic development of local communities — have been successfully integrated into the activities of the NGO "Lifelong Learning Centre."

These contributions have enhanced our efforts to address critical challenges in education management and regional development.

Sincerely,

CEO of NGO "Lifelong Learning Centre"   **Hanna Shvindina**

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APPENDIX E

**EASTERN EUROPEAN ASSOCIATION
FOR CIVIC EDUCATION**

10 October 2024 №1

The Confirmation

This letter serves to certify that certain conclusions drawn from the dissertation of Yan Yu, a postgraduate student at Sumy State University, were utilised in the activities of the East European Association for Civic Education (EENCE).

The dissertation, entitled "The management of state financial resources in China's higher education: enhancing regional equity, efficiency, and adequacy of financial provision", which was submitted for the degree of Doctor of Philosophy in the specialty 073 "Management", contains a series of interesting and practically oriented conclusions on the optimisation of the system of horizontal transfer payments, with a view to achieving a balanced interregional distribution of public resources.

These findings were considered by the East European Association for Civic Education (EENCE) in formulating recommendations for enhancing existing mechanisms for the management of public resources in higher education.

Sincerely,

Dr. Yuriy Petrushenko   Chairman of the Board