The Rebalancing of Human Capital Disparity in China

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List of Abbreviations

ARWU	: Academic Ranking of World Universities
CCDC	: Chinese Center for Disease Control and Prevention
CFPS	: China Family Panel Studies
CHLR	: China Center for Human Capital and Labor Research Center
CHNS	: China Health and Nutrition Survey
GDP	: Gross Domestic Product
HCI	: Human Capital Index
HDI	: Human Development Index
J-F Method	: Jorgenson-Fraumeni Method
LAYS	: Learning Adjusted Years of Schooling
MDGs	: Millennium Development Goals
OLS	: Ordinary Least Squares
PCA	: Principal Components Analysis
SDGs	: Sustainable Development Goals
UN	: United Nations
UNDP	: United Nations Development Program
WTO	: World Trade Organization

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Chapter 1 Introduction

1.1. Background

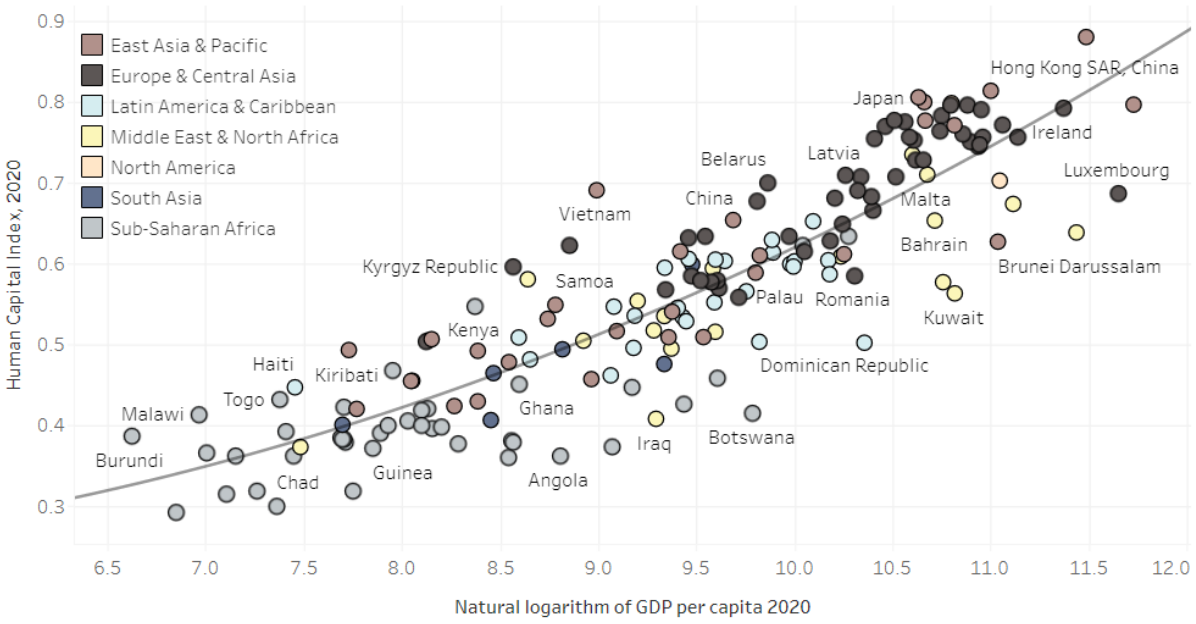
As one of the most critical perspectives in economic and social development studies, human capital has proven important in stimulating sustainable economic growth and keeping social balance. Relative to physical capital, human capital has also emerged as a key production factor due to its effect on innovation, productivity, and knowledge creation. The term human capital, introduced by Fisher (1906), which was developed by Schultz (1961) and Becker (1962), is one of the most popular subjects in recent policy studies since it can quantify human's various outcomes and translate them into economic interpretations. For most scenarios, human capital is defined as a variable that influences economic growth and social development (Becker, 1962; Mincer, 1958; Schultz, 1961). We can observe clear evidence from the existing literature of such impacts. Figure 1-1 demonstrates the latest findings by the World Bank (2018, 2020) with their Human Capital Project[1]. It revealed a high correlation between the human capital index and the natural logarithm of Gross Domestic Product (GDP) per capita from a global view. According to the definition, human capital is an aggregated concept affected by education and health in general terms.

However, when the international community realized the importance of providing solutions to fix the worldwide development issues, the sustainability of the major production

[1] Human Capital Project (HCP) is a project that raised by the World Bank since 2018. It is a global effort to accelerate more and better investments in people for greater equity and economic growth by providing innovative solutions. As of October 2022, the HCP has 86 countries participating and takes action in three distinct areas.

process became crucial. The history of humankind's development in the past centuries is filled with imbalance and inequality. International economic and social development sacrificed massive, immeasurable value from humans and the environment, especially in undeveloped regions. To solve the serious consequences of such development history, the United Nations (UN) launched the Sustainable Development Goals (SDGs) and Millennium Development Goals (MDGs) program to rebalance the developing global disparities in 2015. Under such circumstances, human capital has become an independent subject of research rather than only a source of economic growth since the sustainable and balanced development of human capital's internal accumulation is equally crucial to its external impacts on the economy.

Figure 1-1 Human Capital Index vs. GDP per capita 2020



Source: World Bank Human Capital Project Report 2020 (World Bank, 2020).

As far as we know, from early studies (Heckman, 2005) to the recent research on human capital (Égert et al., 2020), education has been acting the leading role in representing human capital as a variable proxy. This is because of the significant economic contribution of education. Even so, within the literature regarding education-based human capital development, issues regarding the quality of education have been seldomly engaged with until several recent studies (Filmer et al., 2020) discussed a new way to quantify it. In the meantime, although human capital research has attracted attention, the integrated impact of people's health qualities and education investments on human capital accumulation was much less seen in the previous research than in single-factor analysis. The lack of studies on the subject has increased interest in developing an improved human capital index that integrates education and health components.

Two major human capital measurement approaches have attracted major attention recently. One is the human capital project launched by the World Bank (2018). It has presented its great effectiveness in studying the connections between human capital and economic development across countries. Their index-based approach offered a trustworthy result and involved multiple factors. It also discussed the impact of these sub-indexes as human capital components, which can be recognized as key determinants.

Different from the World Banks' method, another famous human capital index is the Jorgenson-Fraumeni method (Also known as the J-F method), introduced by Jorgenson and Fraumeni (1989, 1992b). It uses a lifetime income depreciation approach to calculate the human capital productivity for a certain region. However, there are still several issues that remain unsettled in these two approaches. Variables related to the quality of education are not involved properly, and there are limitations in the estimations of the return to education and health factors. These issues may have important implications in the analysis between human capital and economic performance. It is, therefore, important to present a suitable index for studying human capital development and its internal impacts. This dissertation attempts to address these issues using China as a case study.

China is an important case study for several reasons. First, China is an ideal research subject for human capital study as its large population, vast land area, long-term economic growth, uneven regional development, and consistent policy planning. China also has an attractive development history and a fascinating future with adequate labour force and vast infrastructure construction. After starting the opening strategy in the 1980s and participating the World Trade Organization (WTO) in 2001, China's international role has become more indispensable. This success requires long-term policies in many ways and cannot be achieved without the Chinese people. China's well-known "Five-year Plan" guided economic and social development from the most advanced technology research to the basic living demand. With other long-term vision projects in nearly every field, international society has observed a new power's peaceful rise.

However, as a colossal country with a large population and vast area, issues regarding imbalance and inequality during its development cannot be overlooked. When people investigate human capital development across the whole country, the eastern and coastal areas and capital areas have grown first and fast, which leads to substantial inequality issues in the remaining provinces in the west and northern locations (Mendoza et al., 2022). As is well known, China's fast-growing economy did not happen in all places and provinces. Dozens of provinces are not located in the eastern coastal area, where making international business connections is relatively easy, and there is greater port access. They also did not serve as any satellite areas of the capital city or advanced provinces, so that they could not receive value chain dividends and industrial transition with suitable incentives. Although China has implemented long-term policies from top to bottom to equalize development chances and reduce poverty problems, the initial deficit of these western and northern provinces cannot be eliminated easily. How implemented policies related to human capital in China have been working so far and what policies can be provided to rebalance human capital development and ensure sustainable growth in the future are the main research questions we plan to answer in this dissertation.

1.2. Problem Statement

Regarding the rebalance of human capital disparities in China, three phases of the problem require detailed investigation. Following the order of human capital's determinants, the first phase of the problem is the education issue in China. In order to understand the overall trend of education development and embedded disparity issues requires the latest evidence and analysis. How to involve health parameters in the analysis is the second phase of the problem, which connects to the analysis of sustainability and inequality issues of the human capital in China at the provincial level. Multiple steps are required to fulfill that. Lastly, how policies from education and health perspectives affect human capital development at China's subnational level will be the final phase of the problem. The policy and funding issues should be estimated with a well-designed index, comprehensively collected data, and aggregated models for offering suggestions to reduce the human capital development disparities across China.

Education has been widely discussed from the beginning of human capital research history since it is the main engine of cultivating human capital productivity. The return to education analysis is the most common way of assessing education development. Many researchers have been featuring the Mincer-type equation (Mincer, 1974) to evaluate return to education for different scenarios. One of the most famous and earliest returns to education analysis from a global view was done by Psacharopoulos and his co-authors (Patrinos & Psacharopoulos, 2020; Psacharopoulos, 1981; Psacharopoulos & Patrinos, 2018), and he has been continuously updating the findings until the present time. Their works demonstrate that return to education should be divided into two categories: return to years of schooling and educational attainment (levels). Previous research has also analysed the education development under the human capital narratives in China. Although the increasing trend of China's universal return to education was found in the early 2000s, the descending period and multiple kinds of disparities reflect serious imbalance issues in China's education strategy (Guifu & Hamori, 2009; Kang & Peng, 2010; Xiu & Gunderson, 2013). However, there is still a lack of long-term investigations into the return to years of schooling and return to educational attainment at the same time in China using longitudinal data. Such research can illustrate the overall educational outcomes trend and reflect the specific issues in the development of different educational levels alongside the return to years of schooling. It is useful to figure out what is truly causing the human capital disparities from the education perspective since policies and funding have been designed to maintain growth and equality of return to education.

Furthermore, adding the aggregate effect of health factors to education impacts as a comprehensive human capital indicator is another critical issue that has received far less attention in the literature. As the second phase of the problem, it combines the education and health development issues into overall consideration, inevitably influencing the analysis of human capital imbalance (Grossman, 2017). Throughout the integrated human capital indicator, its trend and convergence propensity across provinces shall reveal the most informative findings on China's human capital disparities. There are two stages in the process of fixing such a problem. In the first stage, although a separate analysis of education and health influences as human capital components can be commonly estimated, how to measure their aggregated effect is still a debatable question in the literature. To solve such problems, we will learn from the existing approaches and figure out how to aggregate the health and education measurement into one indicator with proper theory. Some studies have utilized people's height and BMI as health and nutrition indicators for the long and short term. Human capital research can determine health impacts by examining their effects on labor productivity (Fogel, 1994; Schultz & Tansel, 1997; Strauss & Thomas, 1995; World Bank, 2020). Another approach uses life expectancy as an integrated health variable for regional studies (Cervellati & Sunde, 2005; UNDP, 2016). We aim to extend this literature with China's case and suggest a suitable approach. For the second stage, a detailed analysis of China's human capital disparities will be analysed. The newly established human capital indicator in the previous stage is designed for this purpose. Several concerns are mostly discussed through China's human capital development issues, while geographical disparities are one of the most severe issues in China. The imbalance between eastern and western provinces and coastal and inland regions are two of the most significant human capital development disparities (Heckman, 2005; Wei, 2008). The convergence research on China's provincial human capital further shows the different diversified groups of provinces with various growth rates (Mendoza et al., 2022).

Lastly but most importantly, the problem of rebalancing the human capital development across China requires an effective combination of identifying the government's policy intentions and a reasonable modeling structure. For this third phase of the problem, this research will turn to the internal effect of the implemented policies from education and health perspectives. Many studies have focused on education policy and health policy's effect on human capital development. China's education policies were effective for many provinces but required further extensions for common equality and sustainable development (Heckman, 2005). We can observe the gradual promotion of free compulsory and vocational education in rural and urban areas in recent decades. Simultaneously, China implemented a long-term health strategy to build healthy human capital (Yip et al., 2019). Since they found that the government affirmed a critical role in the health sector, from the health care financing strategy to the local-based health piloting programs, balanced and sustainable health policies should be continuously reformed according to reality. However, it is rare to see the aggregated effect from the education and health sectors on human capital.

1.3. Research Objectives and Questions

This study's main objective is to examine how to promote human capital development in China by reducing inter-regional disparities. The detailed research objectives of this study are as follows:

1. To provide consistent estimates of the return to education in China in the past decades.
2. To develop a comprehensive, quality-based human capital index for China.
3. To identify lagging regions based on the new human capital index.
4. To reveal the imbalance issue of human capital.
5. To assess the determinants of human capital imbalances.
6. To provide policy suggestions to reduce human capital disparities in China.

By the end of this research, the author would like to find the answers to the following research questions:

1. How significant is the return to education in China?
2. How did China's return to education evolve in the last two decades?
3. What are the critical components of the human capital index in China?

4. How to establish a comprehensive quality-based human capital index?
5. How do different components contribute to the human capital index?
6. What are the features of human capital development in China?
7. How significant are the inequality gaps across provinces?
8. How are different determinants contributing to the human capital imbalance?
9. What are the impacts of education and health policies on human capital in China?
10. How do education and health policies affect human capital development in China?

The ultimate goal of this research is to uncover the imbalance issue of China's human capital development in the past ten years and to show what policy has retained its effectiveness for rebalancing the human capital disparities in China on a subnational level.

1.4. Research Methodology and Data

Various methodologies will be utilized to accomplish the research objectives and answer the research questions. As discussed in the background section, past studies have utilized the Mincer-type equation to estimate the return to education (Chen & Pastore, 2021; Kang & Peng, 2010; Mincer, 1974; Psacharopoulos & Patrinos, 2018; Xiu & Gunderson, 2013). Within the literature on the return to education, there are two separate directions: return to years of schooling and return to educational attainments. Both estimates can be derived from the derivative models of the Mincer-type equation (Guifu & Hamori, 2009; Otchia, 2021). In the meantime, to eliminate the endogeneity and robustness issues, we would also present a Lewbel IV approach (Lewbel, 2012) estimated results with the same conditions as basic Ordinary Least Square (OLS) regressed results. We select two different household surveys: the China Health and Nutrition Survey (CHNS) and the China Family Panel Studies (CFPS) (Institute of Social Science Survey, 2015), to demonstrate China's national return to education trend from 1993 to 2018. These two surveys have been widely used in previous research concerning China's development. The CHNS will focus on the national return to education from 1993 to 2015. The CFPS will first reflect the trend of return to education from 2010 to 2018 on the national level and then dive into the provincial level return to years of schooling in the same period.

As we have argued in the previous sections, the existing literature still lacks a quality-based comprehensive human capital index. We also see the great potential in World Bank's human capital calculation method. Since China only has a J-F method-derived human capital index, we decided to follow the World Bank's method as a prototype to provide an alternative to China's human capital studies. We would also adjust World Bank's methodology according to China's typical situation and data availability. More specifically, at the beginning of the calculation, we will use the return to years of schooling on China's provincial level as an upgrade to the World Bank's original constant number proxy. Secondly, the average education years in different provinces will be adjusted by the Best Chinese University Ranking Scores and relative college entrance exam scores presented by ShanghaiRanking Consultancy (ARWU, 2019) from 2015 to 2018.

Meanwhile, the health sub-index will also be reconstructed with the return to experience and life expectancy on the subnational level since life expectancy is one of the most informative factors in the health sector. A similar quality adjustment will also be implemented to life expectancy by incorporating the provincial-level residents' hospitalization ratio. The survival sub-index will also be calculated based on the mortality rate over the total population rather than the under five years old kids. The data will be collected from the China Education Statistical Yearbook and China Health Statistical Yearbook. Finally, to scientifically aggregate three sub-indexes for the final human capital index, we will replace the simple aggregating method used by the World Bank with a Principal Components Analysis. It can illustrate the specific factor loadings of each sub-index and each year which will not only support the final aggregation but also reveal the trends of each sub-index's contribution to human capital.

The imbalance of human capital development across China will be estimated with club convergence analysis and the Kaya-Zenga Index decomposition method. Compared to β-convergence and σ-convergence, human capital could be estimated with typical assumptions and premises on stationarity for controlling heterogeneity across areas and time (Coulombe, 2003; Coulombe & Tremblay, 2001). The club convergence analysis method with the regressed-based approach developed by Phillips and Sul (2007) is a more suitable choice for this research. Moreover, with a modified Kaya-Zenga Index (Mendoza et al., 2022; Wang et al., 2020), our human capital index can be decomposed into different dimensions, and we can also observe the contribution to the human capital imbalance of each dimension with overall sample and each convergent club's sample separately.

For rebalancing the human capital development in China, a reasonable model is critical to analyze the effect of different policies and funding from the education and health perspective. Learning from Lorenzoni et al. (2018) and Égert et al. (2020), an interaction model with policies and their related funding or spending has been established, which perfectly suits our research objectives. By dividing the categories of the policies and funding, the final model can interpret five different scenarios of the results: primary school and health, secondary school and health, vocational secondary school and health, universities and health, and an overall included baseline test. However, the independent policy effect of each scenario without funding and spending interactions is also necessary for examining the policy's effectiveness. We also implemented the predictive importance analysis developed by Sterck (2018, 2019a, 2019b). By combining two regression results in the same scenarios, the effects of education, medical, and health policies can be divided into different usage according to their effectiveness and importance. The rebalancing strategy can also be provided based on education and health spending from the public and private sectors.

Table 1-1 Research Design Summary

Research Objectives	Research Questions	Methodology	Data
1. To provide consistent estimates of the return to education in China in the past decades.	1. How significant is the return to education in China? 2. How did China's return to education evolve in the last two decades?	Mincer equation. Lewbel approach.	CHNS. CFPS.
2. To establish a comprehensive, quality-based human capital index for China.	3. What are the critical components of the human capital index in China? 4. How to establish a comprehensive quality-based human capital index? 5. How do different components contribute to the human capital index?	Human Capital Index. Learning Adjusted Years of Schooling (LAYS). PCA.	CFPS. China Statistical Yearbook. China Education Statistical Yearbook. China Health Statistical Yearbook. Best Chinese Universities Rankings.
3. To identify lagging regions based on the new human capital index.	6. What are the direction and features of human capital development in China? 7. How significant are the inequality gaps across provinces?	Club-convergence.	Human Capital Index was developed in Objective 2.
4. To reveal the imbalance issue of human capital.	8. How are different components contributing to the human capital imbalance?	Kaya-Zenga Index.	Human Capital Index was developed in Objective 2.
5. To assess the determinants of human capital imbalances.	9. What are the impacts of education and health policies on human capital in China? 10. How do education and health policies affect human capital development in China?	Spending interaction model. Predictive importance model.	Human Capital Index was developed in Objective 2. China Statistical Yearbook. China Education Statistical Yearbook. China Educational Finance Statistical Yearbook. China Health Statistical Yearbook.

Source: Author’s conception.

1.5. Significance of the Research

With the recognition of the existing literature, this research is designed to complete the missing pieces of human capital estimation and contribute to the research on human capital development in China with a more sustainable and balanced policy strategy.

The first contribution of this research is the study on the trend of return to education in China from the early 1990s to the late 2010s. By utilizing two longitudinal household surveys, our findings can be accepted with great significance since they reveal the details of changes in China's return to years of schooling and return to educational attainment. It compensates for the literature on the human capital in China in terms of return to education, and the length of the estimated trend can offer a better comparison study to the international cases, especially from the pre-2000 period to the post-2010 period.

The development of a sub-national human capital index is one of the most important contributions of this dissertation. As we have argued in previous sections, there are still several critical failings in the existing approaches. Although the World Bank compromises its human capital calculation method partly because of the international data accessibility, there are still serious defects in their approach, such as return to education, quality-based adjustment, and aggregation steps. On the contrary, the human capital index calculated by the China Center for Human Capital and Labor Research Center (CHLR) with the J-F method also lacks quality adjustment in education and health parameters. As an alternative to the Human Capital Index (HCI) developed by the CHLR, our research can provide a new benchmark for China's human capital research which can also be internationally synchronized with World Banks' findings.

As a result of the club convergence and Kaya-Zenga Index analysis based on our new human capital index, we can have an integrated comparison with Mendoza et al. (2022) as they used the HCI developed by the CHLR. Unlike their research design, our findings focus on the period after 2010, ranging from 1985 to 2018. However, the imbalance of human capital development on China's subnational level is quite different for pre-2000, post-2000, and post-2010 periods since the policy and social development stage varies over time. Therefore, this dissertation can offer a unique human capital imbalance research by focusing on the post-2010 period.

Turn to the policy and spending aggregated research on human capital. It has not been widely discussed in the literature, especially in China. Previous studies were more likely to highlight their findings and the contribution of human capital development to economic growth (Fraumeni et al., 2019; Heckman, 2005; Li et al., 2013; Mendoza et al., 2022). However, human capital was introduced as an aggregated indicator to reveal the intangible contributions of people's performance. It is necessary to clarify the determinants of human capital development. Although previous studies discuss the policy effect on human capital, even fewer of them are able to use an improved human capital index while covering determinants from different perspectives. It further motivated us to push this research forward. We try to give solutions and suggestions for rebalancing human capital development across China from education and health perspectives.

1.6. Research Limitations

It is not realistic to design research without any limitations. For this dissertation, we have made several compromises and have been unable to reach more targets by the end of the study period. Even though we are dedicated to establishing an integrated quality-based human capital index and the methodology itself is reasonable, the data we collected on China's subnational level is still far from perfect. The available household surveys strongly affect the return to years of schooling for different provinces, and it is hard to cover all the provinces within a stable duration. We have no choice but to approximate the return to years of schooling for those provinces. Life expectancy is also limited by the census and statistic yearbook since China only released provincial-level life expectancy data in 1990, 2000, and 2010 through the official channel. Most of the subnational life expectancy data we used in this research are interpolated from these three anchored years.

According to existing international research, the quality adjustment of education is still a theoretical attempt. At the same time, using Best Chinese Universities Ranking and its sub-scores as adjusted indicators may still need further tests to ensure its usefulness. A similar limitation also comes to the health quality adjustment since we have not seen such implementation in human capital research. Still, health quality is highly affecting productivity. More related research should be conducted to classify the feasibility of different health quality-related indicators.

The most regrettable limitation of this research is the economic analysis on the macro-level from the view of human capital. Although much research focuses on economic performance by analyzing human capital development, our unique human capital index may provide more effective economic policy recommendations. Moreover, since this dissertation emphasizes education and health policies in the first place, human capital could have been an excellent middle variable to study the impact of education and health policies on economic changes. These limitations may become our new proposals for future research.

1.7. Structure and Framework of the Dissertation

The dissertation is made up of seven chapters as follows:

Chapter 1: Introduction

Chapter 2: Literature Review

Chapter 3: Estimating the Return to Education in China: Evidence from longitudinal data

Chapter 4: Measuring Human Capital at Sub-national Level: A New Index for China

Chapter 5: Human Capital Imbalance in China: A Decomposition-based Convergence Analysis

Chapter 6: Assessing the Determinants of Human Capital Development in China: A Variance-based Decomposition Approach

Chapter 7: Conclusion

Besides Chapter 1 (this chapter), the following chapters will focus on different contents. Chapter 2 will mainly discuss the literature on return to education research, human capital research and its calculation evolvement, and human capital development in China. We will also review China's policy intentions on education and health perspectives from the central government's annual report.

Chapter 3 will begin the formal analysis by estimating the return to education in China. It will mainly discuss the trend of China's return to education in the past decades and provide an initial understanding of China's human capital development from the education perspective.

The comprehensive human capital research will begin its journey in Chapter 4. We can utilize the methods and findings from Chapter 3 to form a human capital index at China's subnational level. We will specifically discuss how to form an integrated quality-based human capital index step by step and select data from China to demonstrate the practical usage of the methodology. Meanwhile, the component analysis of this new human capital index can inform us of each component's contribution trend in recent years.

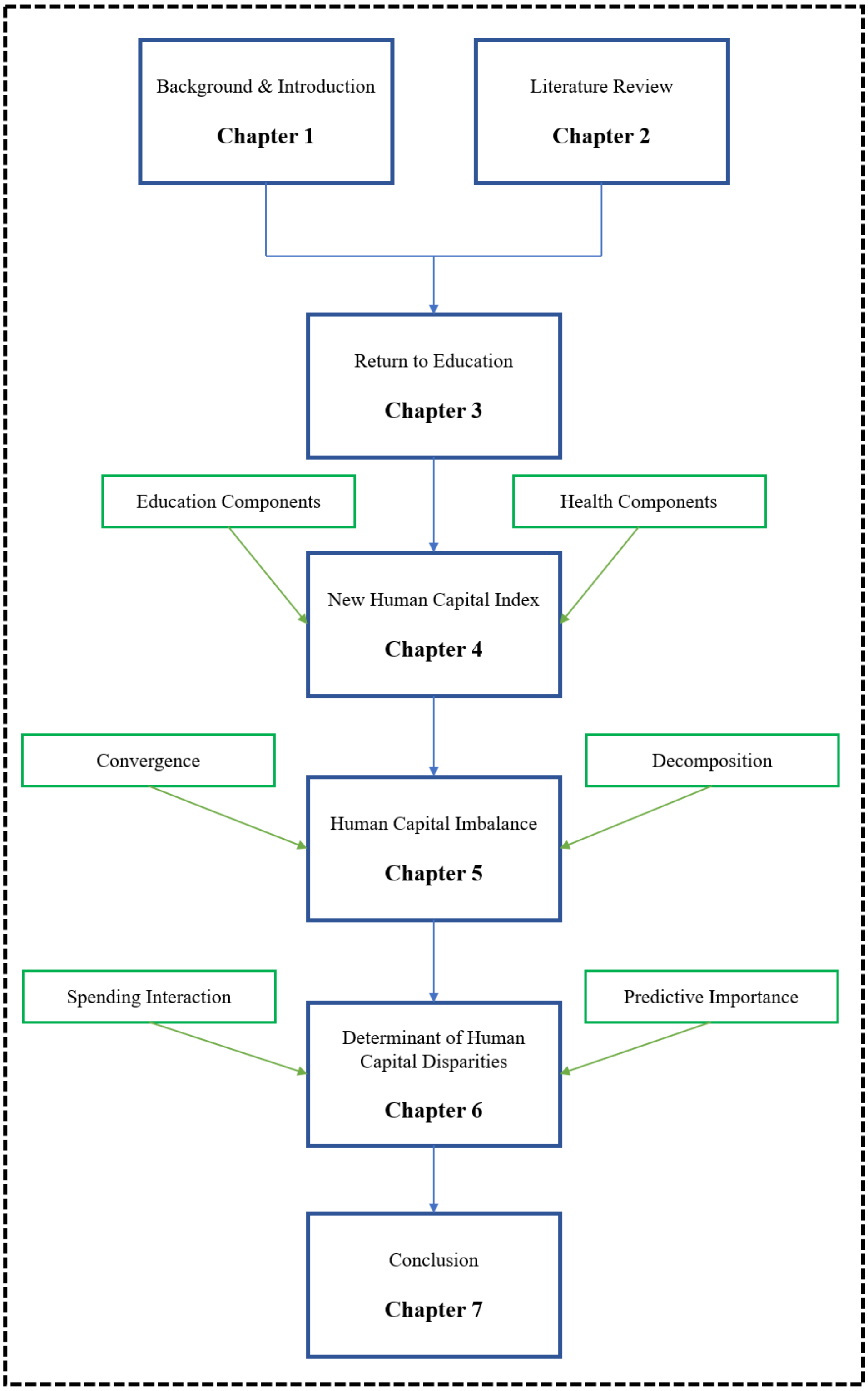
Implementing this improved human capital index in China makes the imbalanced research on China's subnational human capital development a possible target. Chapter 5 is designed to further understand China's human capital development imbalance across provinces using club convergence analysis. We will also use Kaya-Zenga Index to decompose the human capital index to investigate the contribution of education, health, and economic status to the inequality of the human capital index.

Chapter 6 will try to provide solutions to rebalance human capital development across China by investigating the effects of education and health policies. The spending interaction and predictive importance models are modified to accomplish the task. We will also discuss those policy factors at China's provincial-level by directly showing their aggregated data description.

Finally, the conclusion will present this dissertation's major findings and offer policy recommendations for China's central government education and health strategies. We believe the analysis-based policy suggestions can help China rebalance the human capital development in all the provinces and lead those undeveloped regions to a more sustainable and balanced future.

The following is a flowchart of this dissertation's structure (Figure 1-2) which graphically demonstrates the flow of this research.

Figure 1-2 Structure of the Dissertation



Source: Author’s creation.

Chapter 2 Literature Review

2.1. Introduction

Since there are a large number of findings across the literature on human capital research, we would like to discuss the fundamental approaches to understanding and calculating human capital. The traditional return to education literature will be discussed first. It can easily connect the relationship between the international and China's performances as a conventional proxy to observe human capital development from the education aspect. Second, we will investigate the methodologies to form a suitable human capital index in the literature and compare the advantages and disadvantages. Apart from these two parts, the literature on human capital status in China and how different policies have affected human capital development in China will also be discussed.

2.2. Review of Human Capital

2.2.1. The Definition of Human Capital

Back to the original discussion on the definition of human capital brought by Schultz (1961), he argued that even though people can acquire effective skills and knowledge, it cannot necessarily be recognized as a form of capital. However, suppose we define skills and knowledge as a kind of capital. They may occupy a substantial part of the deliberate investment outcomes and accumulate at a faster growth rate than conventional capital. Schultz (1961) also mentioned that three distinguished researchers had defined human beings as capital: Smith

(1776), who took all kinds of abilities of residents of a country as a form of capital; Thünen (1875), who argued about the concept of capital applied to man, will not degrade him or undermine his freedom and dignity, but without such applicable concept, it will be pernicious in wars; Fisher (1906) also clarified the capital concept with overall inclusive thoughts.

During the same period, Becker (1962) also interpreted similar thoughts on the definition of human capital. Unlike Schultz, he broadened the human capital investment, which should include schooling, skills training, medical care, vitamin consumption, and the ability to acquire information. It has built a firm conceptual foundation for human capital definition since then. However, even though Becker made such an interpretation of human capital, it is hard to include all these factors in estimating human capital investment.

Unfortunately, since the ideal structure of establishing a comprehensive human capital index according to Becker's original definition is hard to reach because of technical issues and data availability, literature has been using education proxies as human capital widely or exploring new methodologies by calculating people's lifetime income (Jorgenson & Fraumeni, 1989, 1992b) as a replacement (J-F method) until new methodologies and has been offered by the United Nations Development Programme (UNDP, 2016) and World Bank (2018, 2020). The UNDP came up with an alternative idea which is called the Human Development Index (HDI). They defined it as a measurement of human development, including healthy lives, education access, and a decent standard of living. Meanwhile, World Bank stuck to the original concept of human capital: knowledge, skills, and health that people accumulate over their lives are the primary sources. These latest findings didn't change the concept of human capital, but they have tried to follow the original definition and establish an ideal human capital index.

2.2.2. The Evolution of the Human Capital Determinants

According to the definition of human capital, we have learned that education is the most productive source of human capital accumulation. At the same time, health guarantees the human capital's longevity. However, the evolution of human capital research has been gradually extended. The effectiveness of different determinants, through quantity and quality evaluation, are the major focuses in its evolutionary path.

Education is the most important and earliest determinant that significantly impacts human capital. As knowledge and skills are transmitted through generations and times (Goldin, 2016), it can sustainably accumulate technologies and cultures for survival and living. Although education as one general concept is recognized as a major contributor to human capital productivity, the different categories of education can be quite different as human capital determinants. The modern formal education system consists of elementary, secondary, vocational, and tertiary education. These categorized periods are designed for different purposes. Elementary education determines the foundations of human capital; as more residents can access primary education, the bottom of the social pyramid can maintain a concrete labor supply with basic knowledge and skills. Secondary education, as a further step from elementary schools, is designed to screen teenagers' learning abilities. It should help people and society to understand their advantages and disadvantages for future productivity, which directly links to vocational and tertiary education. These two educational levels act much differently in human capital cultivation. Vocational education fosters more skilled labor, while tertiary education aims to increase the scale of cutting-edged and talented people in many aspects of development (Goldin & Katz, 1998; Tilak, 2003; Weisbrod, 1962). As one of the determinants of human capital, even though there are multiple stages through the education system, it keeps the goal and offers sustainable productivity to human capital. However, the education imbalance is hard to eliminate because of the quality disparities. The quality of education is one of the new concerns in human capital research in recent years. Multiple studies revealed that, as determinants of human capital, the same education level or years of schooling does not necessarily represent similar educational outcomes (Filmer et al., 2018). Educational quality affects the efficiency of knowledge transmission. It overwhelmingly changes human capital research by adding new dimensions.

Health, by definition, is a determinant that enlarges human capital in longevity. It concerns so many different scenarios of people from birth to death. Evidence has shown the health benefits of human capital accumulation in collaboration with education (Schultz, 2003). Extending human capital productivity, longer life expectation, and working sustainability are the main purposes of health investments, which require scientific nutrition intake, reasonable physical exercises, and proper mental health. As the foundation of people's long-term development, these elements of health determine the lower bound of human capital. Besides these individual concerns, public interventions are also critical since there is strong evidence from the existing findings suggesting that a well-built primary medical care system can reduce the mortality rate and lead to better public health status (Lee et al., 2007). However, quality issues should also be considered from the health perspective, as similar health status may not lead to the same level of productivity in real life.

Through the evolution of human capital determinants, quantity and quality issues are highlighting the overall effectiveness from education and health perspectives at the same time. The research on human capital should be designed with more patience and detail to reflect the general information of such a comprehensive concept.

2.2.3. The Measurement of Human Capital

Multiple options can be seen in the existing literature regarding how to measure human capital. These can be divided into four categories: Education parameter proxy, Cost approach, Income approach, and Indicator Approach. These four kinds of approaches are presented in the following Table 2-1. Together with the advantages and disadvantages, it offers integrated information about each approach. We will also extend the discussion to the details of the measurements and compare them in terms of their specific calculation process in this section.

Table 2-1 Approaches to Measure Human Capital

Approach	References	Data Requirements	Advantages and Disadvantages
Education Parameter Proxies: Use education data directly as a human capital variable proxy.	Average years of schooling (Barro & Lee, 1993, 2001, 2013, 2021) Return to Education (Heckman, 2005)	The survey, Census, Yearbooks, and administrative datasets.	(+) Straightly accessible and easy for calculation. (-) Far from informative and comprehensive.
Cost: An aggregated gross investment directly used for human capital development.	Eisner (1978, 1985); (1989); Gu and Wong (2015); Kendrick (1976)	School enrollment by different categories of samples; Direct spending on education or other human capital investments; Value of time cost by human capital; Deflators for nominal spending.	(+) Monetary calculation method with multiple sources of information. (-) Requires massive data accessibility. (-) Ignore the effectiveness and efficiency of the spending.
Income: Estimate peoples' future income and depreciate it to the current value as human capital.	Fraumeni et al. (2019); Jorgenson and Fraumeni (1989, 1992b)	School enrollment; Population; Earnings; Mortality rate.	(+) Monetary calculation method with comprehensive information. (-) Requires massive data accessibility. (-) Sensitive to the initial assumptions of future growth regarding earnings and education outcomes.
Indicator: Merge different weighted variables and form a human capital indicator	World Bank's Human Capital Index (World Bank, 2018, 2020) Human Development Index (UNDP, 2016)	The survey, Census, Yearbooks, and administrative datasets.	(+) Straightly accessible and easy for calculation. (+) Maintain enough information from various aspects. (-) Not a monetary calculation result.

Source: Collected by the author.

Note: (+) means advantages; (-) means disadvantages

Education parameter proxy is the most traditional way of estimating human capital as it only requires the least data scales, such as years of schooling (Barro & Lee, 1993, 2001, 2013, 2021). It was widely used in some studies for its convenience. However, it also reflects the issue of data shortages and a lack of understanding of human capital determinants.

To find a suitable method for aggregating determinants of human capital, some of the other approaches were established according to the literature's understanding of capital flows. The cost-based approach constructs the human capital estimates with depreciation methodology by tracing the nominal spending on all kinds of human capital components. Kendrick (1976) and Eisner (1978, 1985, 1989) have adopted a cost-based approach for expanding the economic evaluation with human capital investment. It incorporated human capital from education investments, job training, health inputs, geographic mobility, and child-rearing. However, the data limitation prevented the widespread use of such approaches and didn't include the effectiveness and efficiency of these investments in human capital growth. We only found that Gu and Wong (2015) have involved cost and income-based measurements in the formal educational investment studies for Canada as recent examples.

On the opposite side, the income-based approach engaged with a similar idea of nominal capital translation but regarded people's lifetime income's present value as the stock of human capital. It was introduced by Jorgenson and Fraumeni (1989, 1992b) and is widely used by different countries and organizations. By accounting for different population groups by age, gender, and educational attainment, Jorgenson and Fraumeni's approach estimates the stock of human capital separately using each group's earnings and survival rates across years. After depreciating all the future income into present value using a proper discount rate, it aggregates all the groups to estimate the regional human capital stock. The most famous and fully occupied version is the human capital panel database established by the CHLR. As they modified the J-

F method for China's local situation, a J-F method based on the human capital stock was provided (Fraumeni et al., 2019). They further incorporated the provincial-level population inflow and outflow data to adjust the impact of population movement. Because it's an income-based model, the components involved are distributed across different age groups, education categories, urban or rural areas, and other inputs. There are also cases in OECD (Liu, 2011) and World Bank (Lange et al., 2018) that deployed the J-F method for human capital estimation. However, the data requirements and calculation complexity still potentially block more nations and organizations from adopting it for their human capital analysis.

The upgraded methodology to the education parameter proxy is the indicator approach. It is a much more flexible way to create the human capital index for most cases but still the scientific explanations to some extent. For example, the UNDP (2016) created the HDI, we can see their index formation methodology as a particular type of concept for human capital estimation. The UNDP's HDI has three different dimensions: education, health, and standard of living. The arithmetic mean of expected and average years of schooling represents the education dimension. Health is reflected by life expectancy, while the standard of living uses GNI per capita. Their dimension index calculation is also suitable for index combinations (UNDP, 2016). It is not the only case. In 2018, World Bank launched a Human Capital Project and published a global human capital index (World Bank, 2018) annually. Their structure of building a human capital index is more complicated and involves different human capital indicators.

World Bank's international human capital index report in 2020 (World Bank, 2020) explained its calculation method thoroughly. They divided human capital indicators into three components. First is survival rate; under-five mortality rates represent survival from birth to school age. Second is education, which uses the expected years of school of a child before 18-

year-old and adjusts it by using World Bank Harmonize test scores to control education quality issues in different countries. The last one is health, combined with the adult survival rate and rate of stunting of a child under 5. We find strong evidence from World Bank's methodology that literature supports combining education and health factors for human capital research. Their impressive components selection also perfectly shows the importance of health variables. However, some slight weakness still attracts our attention as their selected indicators are related to economic performance or capital with a low correlation in the primary definition. Another paper under the same project modified this model (Kraay, 2019); the return to education was explained in the original equation. The return to the education they used here is a selected constant number: 0.08. They concluded the average return to education based on empirical studies. Still, this consistent return to education parameter cannot represent all the areas, especially in such a general model.

Another problem is that, although the health index is estimated, it simply calculated the return to height and un-stunted rate for another two constant parameters and multiplied in the equation. This method ignored the difference in health performance across regions, followed their quality-based education adjustment, and replicated that concept on health factors. If the quality-based adjusted schooling years are accepted, the same idea should also be recognized in calculating health performances.

Cost-based, income-based, and indicator approaches all attempt to involve education and health components in the estimation simultaneously. It is the foundation of making a comprehensive human capital index. Learning from the most traditional human capital research, years of schooling is a classical variable as a human capital proxy. Researchers know its shortages that, as a straightforward approach, it ignored the complex components of human capital. The solution is to estimate the return to education (Psacharopoulos, 1981) with the

Mincer-type equation (Mincer, 1974). By assessing the return to education, the economic factor can be related to education in the name of an individual's wage. It has become one of the most estimated indicators in human capital literature worldwide. There are generally two kinds of return-to-education measurements: the return to schooling years and the return to educational attainment. These two estimates reveal the education development issue from different directions. We can also see estimating the return to years of schooling in the income-based approach (J-F method) and indicator approach (World Bank).

Unfortunately, the education quality issue still prevents the researcher from estimating a more convincing result as people find out that the same average years of schooling in different areas will not necessarily offer the same level outcomes due to the education quality variances. One dominant solution in the literature is to adjust the years of schooling using testing scores (Filmer et al., 2018). It is one of the most popular approaches nowadays. A similar problem can also be found in human capital estimations regarding health perspectives. The different quality of health in different regions should also be considered since it affects the real human capital outcome in people's lives. The existing measurements do not deal with these quality biases at present.

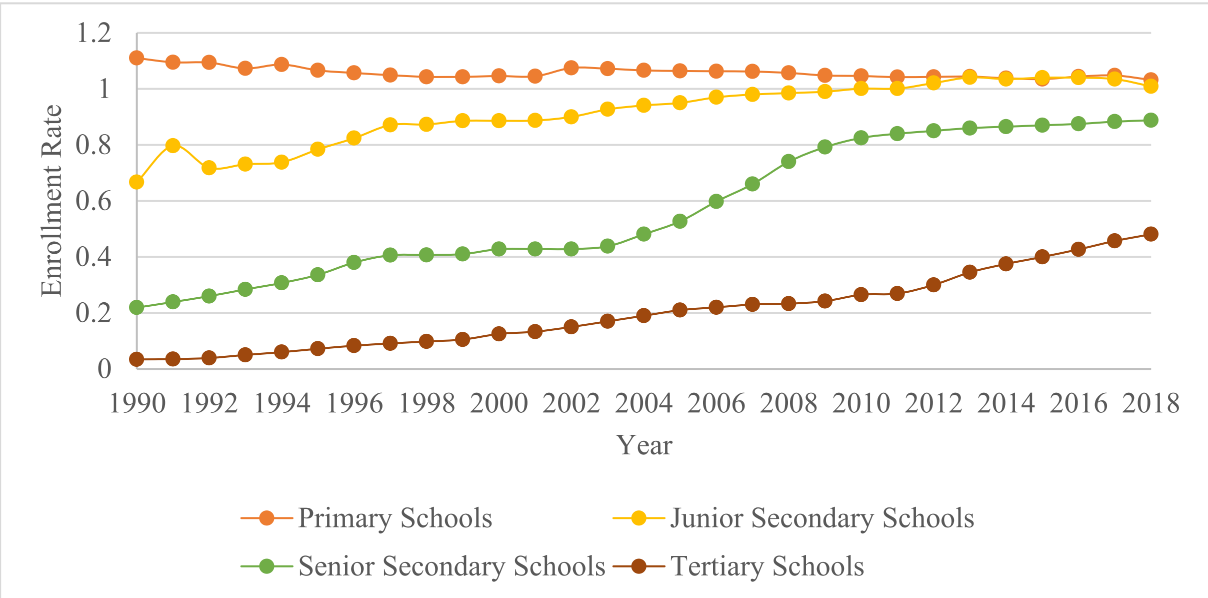
More relative discussion on the specific human capital measurements will be presented in Chapter four. We will also try to build our approach by adopting these existing methods based on China's datasets.

2.3. Human Capital Development in China

China's development has been so successful that attracted great attention in the last thirty years. Human capital development in China is also one of the major concerns among all kinds of related studies. This section will provide detailed information on China's human capital development in the past two decades. It will cover the trend of China's education, health, and other related impacts, which can be seen as the components of human capital.

As the dominant role of offering productive workforces in China, education has been attracting a variety of studies. In early times, when China faced barriers to education accessibility, the illiteracy issue was one of the biggest problems and was affected by the enrolment rate. China's large inflow of physical capital investment initiated the demand for skilled and educated labor, and such economic growth furtherly requires the abundance of higher education (Heckman & Yi, 2012). Figure 2-1 presents the trend of gross enrolment rate in different levels of schools in China from 1990 to 2018.

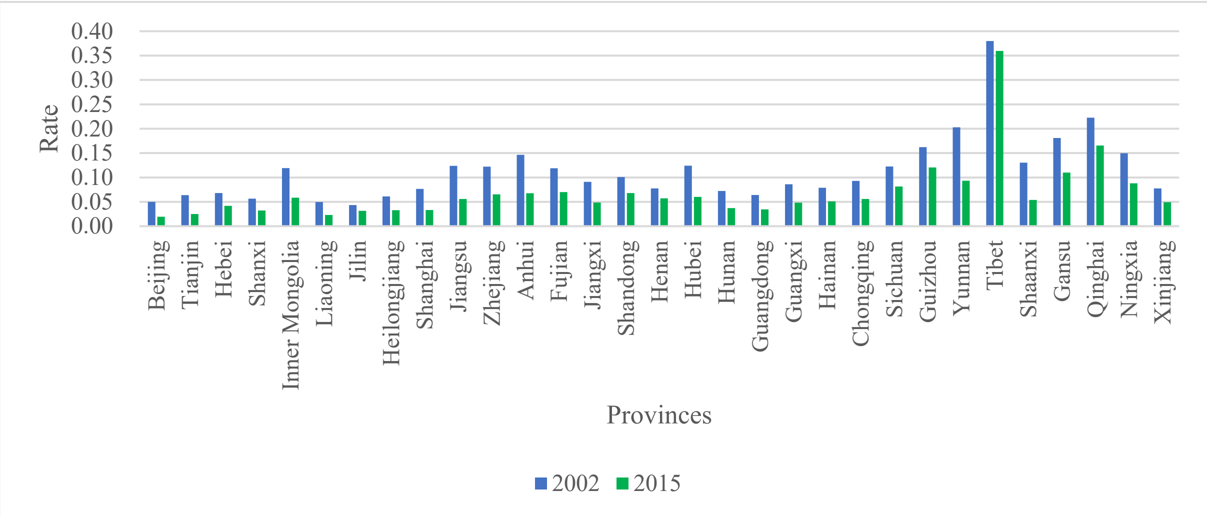
Figure 2-1 China's Gross Enrollment Rate in Different Levels of Schools



Source: Authors' creation using the data from China Education Statistical Yearbook (Ministry of Education of People's Republic of China, 2010-2019).

The structure of China's formal education system contains six years of primary school education (in some regions, it could be five years), three years of junior secondary school education (in some regions, it could be four years), three years of senior secondary school or vocational secondary schools' education, and tertiary education (college education and higher degrees). We can observe the steady trend of primary school gross enrolment rate in China from 1990 to 2018, while junior secondary school experienced a long-term growth from 70% to 100% of enrolment rate. It is an acceptable result since primary and junior secondary degrees have been regulated as compulsory education in China since 1986. Besides compulsory education, senior secondary schools had a slow increase before 2004 from 20% to 50% and boosted to 80% after 2008. Tertiary education remains the lowest enrolment rate for the whole time, but it still expands from 3.4% to nearly 50% within thirty years. On the contrary, from Table 2-2, we can see the general decline of the illiteracy rate across all the provinces in China from the early 2000s to the middle of the 2010s.

Figure 2-2 China's Illiteracy Rate Comparison Between 2002 and 2015



Source: Authors' creation using the data from China Education Statistical Yearbook (Ministry of Education of People's Republic of China, 2010-2019).

However, in terms of the reduced illiteracy rate, the imbalance among the provinces is still large. While the advanced regions with lower illiteracy rates were able to cut in half the overall proportion during this period, some undeveloped provinces such as Tibet, Qinghai, and Xinjiang still maintained a high illiteracy rate. Such cohort phenomenon indicates the inequality issue caused by economic development since the less changed provinces lack investment in education. Compared to the previous study by Heckman (2005), we can observe this disparity from the per-pupil perspective (Figure 2-3).

Figure 2-3 revealed the significant increase in per-pupil expenditure and per capita GDP from 2010 to 2018. According to Heckman (2005), the highest per-pupil expenditure in 2001 was 10000, which became the lowest in 2015. The per capita GDP presented similar changes in the comparison. Heckman (2005) highlighted three typical samples: Beijing, Shanghai, and Tianjin. The patterns can be easily concluded that Shanghai and Beijing had the best economy and per-pupil education expenditure, respectively. On the other hand, Tianjin was lower than Beijing and Shanghai but performed better than other provinces. The rest of the provinces shared a low per-pupil expenditure in the early 2000s.

The whole structure of the distribution did not change much after nearly two decades. Figure 2-3 illustrates the similar patterns of per-pupil expenditure to per capita GDP across China compared to the findings from Heckman (2005). However, as highlighted in the figure, Tibet has almost the same per-pupil expenditure level compared to Tianjin after 2015 but with quite a low per capita GDP. It revealed the efforts of China's support to strengthen the overall education investment in the undeveloped provinces. Still, such intention may not easily be transferred to local human capital performance as it is designed to be.

Figure 2-3 Per Pupil Expenditure vs. per capita GDP

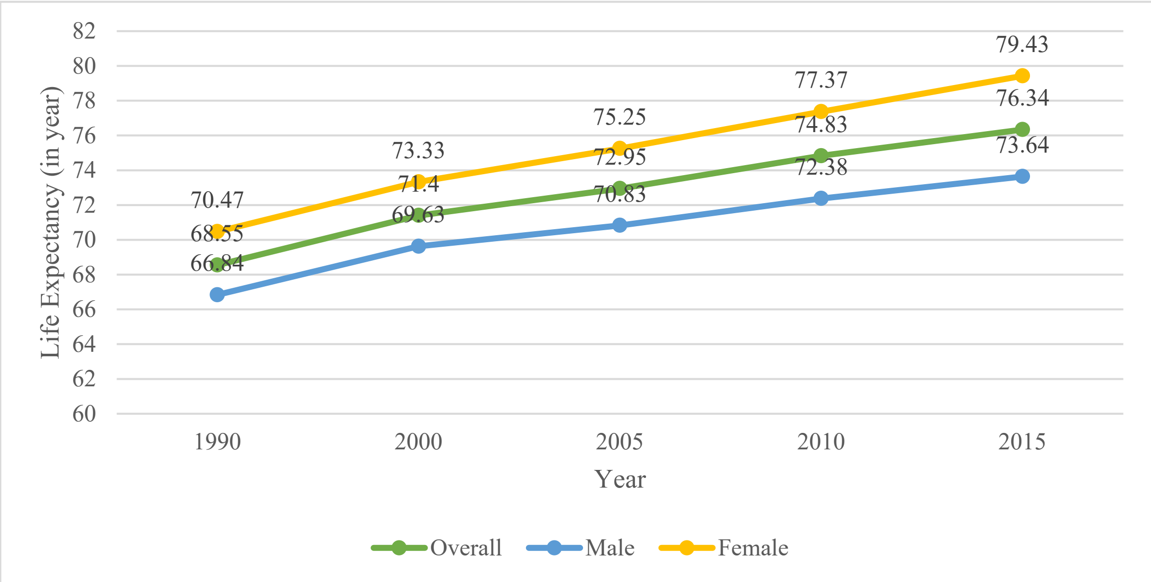
Source: Author's calculation using the data from China Statistical Yearbook (National Bureau of Statistics of China, 2010-2019) and China Educational Finance Statistical Yearbook (Department of Finance et al., 2010-2019).

Apart from the education perspective, the trend of health-related factors is also devoted to the major human capital changes across China. Within the enormous health factors, life expectancy is one of the most aggregated variables representing the overall health status of individuals in regions.

In 1990, China's overall life expectancy was 68.55, 66.84 for males, and 70.47 for females. Ten years later, in 2000, the overall life expectancy increased to 71.4, with males' at 69.63 and females' at 73.33. Males' life expectancy also surpassed 70 in 2005 at 70.83, while females got

75.25, and overall life expectancy reached 72.95. In recent decades, the overall life expectancy in China has grown from 74.83 in 2010 to 76.34 in 2015. This trend is also presented in Figure 2-4. It is easy to observe that females' life expectancy has kept the highest position in the past thirty years, and the overall trend is sustainably growing. We may conclude that China's human capital is promoted significantly in terms of health.

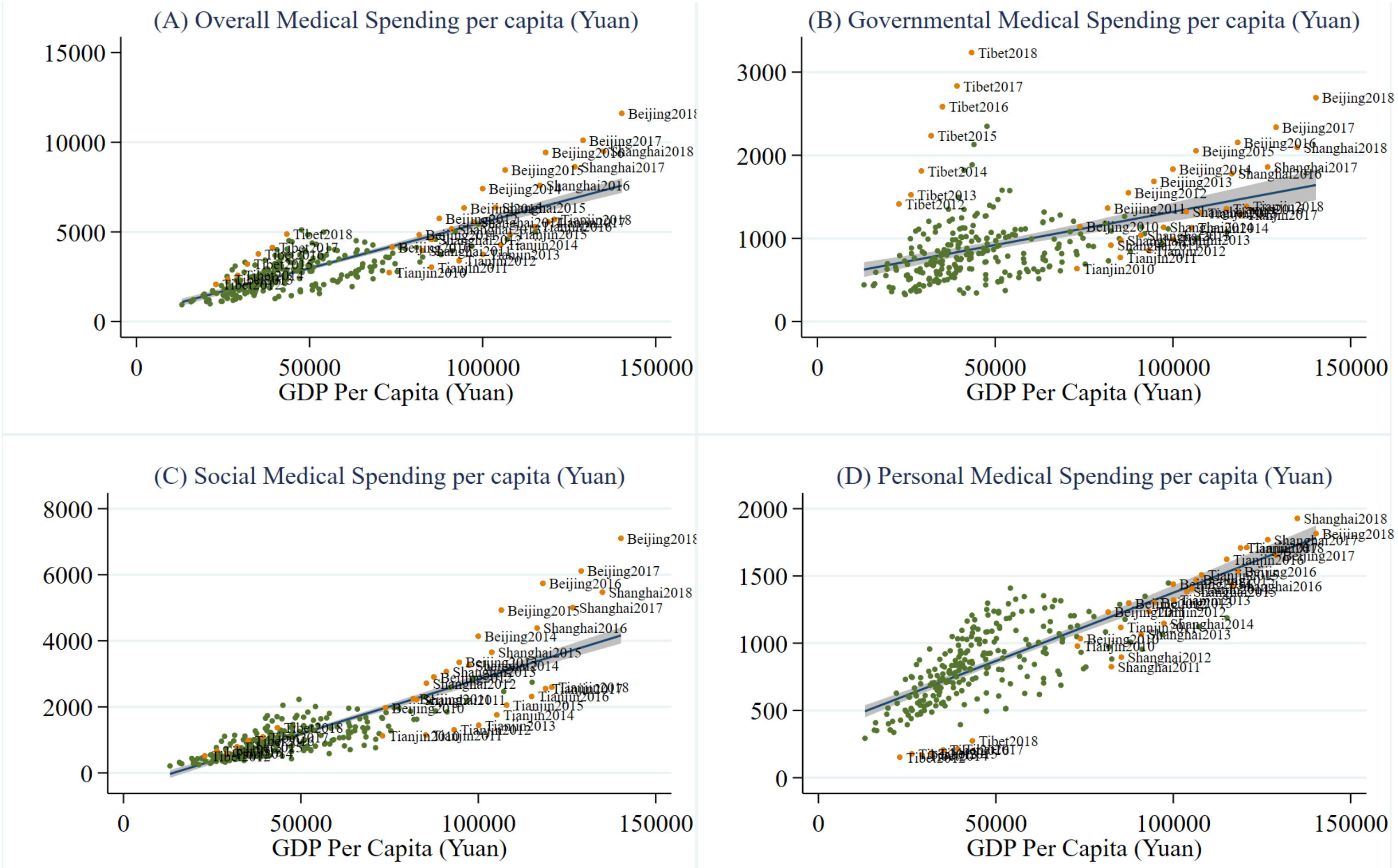
Figure 2-4 Trend of Life Expectancy in China from 1990 to 2015



Source: Authors' construction using the data from China Statistical Yearbook (National Bureau of Statistics of China, 2010-2019).

In a more detailed view of China's health sectors' development, we provide Figure 2-5 to show the correlation between medical spending and GDP per capita. It is divided into four per capita categories representing overall medical, governmental, social, and personal medical spending. These four graphs demonstrate the increasing trend of medical spending across China regardless of all personal perspectives. Their difference also indicates that higher medical spending generally happens in better economic conditions.

Figure 2-5 Provincial Medical Spending per capita vs. GDP per capita (2010 to 2018)



Source: Authors' construction using the data from the China's Health Statistical Yearbooks (Ministry of Health of the People's Republic of China, 2010-2019).

However, the exception appears in Tibet, as they experienced the sharpest growth in governmental medical spending per capita from 2010 to 2018, outperforming Beijing and becoming the highest. On the contrary, Tibet's personal medical spending per capita occupied the lowest outlier trend, which cannot even catch up with the major groups with the same GDP per capita. This further raises concerns about the unequal development of China’s human capital accumulation in the education and health sectors.

The inequality issue of China’s human capital development has been raised for a long time. From an education perspective only, even though China has been experiencing fast growth in its real rate of return to education (Heckman, 2005), the interregional migration restriction has served to the rise of inequality since labor cannot move between rural and urban areas freely at that period. However, the long-term policy on fostering access to education can reduce the inequality issue in China’s human capital development. Holding a similar conclusion, Fleisher et al. (2010) remarked the opening strategy in China, which resulted in spectacular economic growth, has unfairly benefited China’s human capital development. According to their analysis, the marginal product contributed by higher than primary degree labor forces are much higher than those under primary schooling. Human capital can positively affect total factor productivity. However, they also found that as the household registration system placed fewer limitations on rural-urban migrations of highly educated workers, the benefits of increased investment in human capital to western regions may get lower because of the brain-drain phenomenon. From the view of education policy, the education evolution didn’t seem to catch up with the human capital development and market demand during China’s transition from a low-income to a middle-income country (Li et al., 2017). It explained that though China started the wide implementation of primary education for almost all children after the 1980s, such education was only adequate for fostering the labor force in the early manufacturing sectors. While the economy gradually switched the demand for high-skill, high-wage, and innovation-based labor forces, the lack of highly educated human capital started to drag the overall development as decentralized control of tertiary education in urban areas, and centralized compulsory and pre-tertiary education in rural regions should be raised accordingly to rebalance the human capital development in central educational policies.

Still, human capital research moved to another stage when a comprehensive human capital index could be provided for analysis. Over time, human capital research from 1985 to 2014 highlighted China's regional distribution and dynamics issues (Fraumeni et al., 2019) based on the J-F methodology estimated human capital index (presented by the CHLR). It confirmed that those previous education-based human capital measures underestimated the regional disparity issues. During the early period (1985 to 1994) of China’s “Reform and Opening” strategy, human capital across China experienced a low speed of growth. After 1995, it began to get faster in the eastern area of China. The human capital development gap between east and west China enlarged, and the regional imbalance became substantial. They also admitted that education contributed the largest proportion to human capital’s quality growth in labor forces while urbanization made the heaviest incentives for quality growth of the population. On the contrary, the population aging issues deflated the human capital quality, and its negative effect worsened after 1995.

On the provincial level research in China, the convergence analysis done by Mendoza et al. (2022) demonstrated a far more imbalanced human capital development trend across China from 1985 to 2016. They used the same human capital index presented by the CHLR, so their findings on China’s human capital disparities pushed an important step forward. Mendoza et al. (2022) concluded that there had been no overall convergence group in China in the past thirty years, which is against the education-based human capital convergence analysis results in the literature. Meanwhile, the estimated subgroups as different convergent clubs proved that China is still in the midst of human capital development disparities issues. The eastern and capital regions outpaced the central and western provinces, while urban areas performed far beyond rural regions in China.

2.4. Review of China's Policy Intentions

Policy intentions can reflect the focus of the development strategy. As human capital development requires great implementation of education and health policies, we would like to look through the policies' priorities and intentions from these two categories in China. From China's State Council Government Work Report between 2005 to 2018 (Li, 2014-2018; Wen, 2005-2013), we selected the policy narratives on education and health and summarize them into direct explanations by year as additional evidence. We believe that with the proper understanding of China's annual policy summary on education and health-medical perspectives, our final policy analysis and suggestions can provide a strong foundation.

2.4.1. Education Policy Intention

Education policies are first discussed in this section. To simplify the original policy narrative, we summarized them into different targets by year. Table 2-2 summarizes some of the main movements of educational policies and intentions in China. More specific educational policies will be interpreted in the following paragraphs and presented in the Tables in Appendix A.

Table 2-2 Summary of Main Education Policy Intentions in China

Education Policy Intentions	Year	Covered Grades	Covered Ranges
Accelerate the construction of modern distance education projects	1996	Tertiary Education	Nationwide
Promote the healthy development of private education.	1997	All	Nationwide
Reform teaching contents to alleviate the burden on students	2000	Primary & Secondary	Nationwide
Strengthen the financial management and supervision of schools' fees.	2006	All	Nationwide
Exemption of tuition and fees for compulsory education students	2006	Primary & Junior Secondary	Western rural regions
Improve the quality of tertiary education with key disciplines	2006	Tertiary Education	Nationwide
Improve the coverage of vocational education and training networks.	2007	Vocational Education	Nationwide
Establish a sound national scholarship system	2007	Vocational & Tertiary	Nationwide
Full exemption of compulsory education tuition and miscellaneous fees	2008	Primary & Junior Secondary	Nationwide
Gradually implement free secondary vocational education	2009	Vocational Education	Poor Families
Strengthen the construction of preschools' education	2010	Pre-schools	Nationwide
Ensure one hour of school physical activity per day	2011	Primary and Secondary	Nationwide
Coordinate the regional education and the autonomy of universities	2012	All	Nationwide

Source: Author's collection using the contents from China's central government work reports (Li, 2014-2018; Wen, 2005-2013).

In 2005, the education policies from China’s central government work report focused more on compulsory education (see Table A2-1 for details). By strengthening mandatory education coverage and exempting tuition and miscellaneous fees, China determined to raise the quality and quantity of compulsory education in rural areas. While compulsory education in China represents primary and junior secondary schools, China also mentioned higher education’s quality and vocational education’s expanding development. Students’ burden was also considered in 2005 as the old teaching contents could not fit the requirements of those days. At the same time, China’s government further claimed to improve funding systems, the enrolment process, and even schools’ financial management with proper supervision. They also encouraged private education investment as supplementary to the whole education system.

One year later, in 2006, the central government's view further strengthened compulsory education in lagging areas by providing better national financial support (see Table A2-2 for details). In western regions, exemptions were planned to be fully covered in tuition and miscellaneous fees, and state financial protections were offered. The rise in public funding to renovate rural primary and secondary schools’ facilities and compensate teachers’ salaries was also guaranteed. Colleges and universities were more likely to be highlighted with quality improvement.

For 2007 and 2008, free compulsory education coverage expanded nationwide across lagging regions. Furthermore, vocational education’s development was also highlighted in terms of quality and quantity. Policies were also founded to establish national scholarship programs for vocational schools and universities. Free education was even implemented to mitigate teacher resource shortages by supporting teacher-training universities in 2007. Simultaneously, teachers’ salaries and allowance systems were also improved in 2008.

Cooperation between industries, enterprises, and schools is recommended for higher education with a specific mechanism, and the university enrolment ratio in central and western provinces is continuously raised. These measures could potentially strengthen the quality of higher education and rebalance the inequality between eastern and western education outcomes. We also observed that private education was encouraged and regulated from 2008.

Extending the previous education policy was treated with more public funding for compulsory and vocational education. Free vocational education was concentrated on supporting rural areas and started with students with poor backgrounds. Universities were guided to adjust their majors and curricula, which are critical to match the required education quality market. Moreover, the effort has also been implemented on school buildings and environmental safety issues since a severe earthquake disaster in 2008.

Starting in 2010, pre-primary education became one of the major concerns of the central government policy intentions. Meanwhile, autonomy has been discussed in higher education institutions on management and enrolment decisions. Other than these two new focuses, other education policies stayed with their previous trend and continued to expand. The propensity to help rural areas was still highlighted.

The post-2010 period can be divided into two parts, and the year 2013 is the dividing point since China's central government experienced a significant leadership change in that year. We can observe the continuity of these education policies' intentions across two periods.

Before 2013, main education policies maintained the same direction as the pre-2010 period, with more extensive support for compulsory and vocational education in rural areas with tuition-free policy and more concerns about pre-primary and other exceptional education development. Starting in 2011, the burden of mandatory degree students was also mentioned to be reduced with different strategies while it was necessary to spare time for students' daily physical exercises. The students' nutrition improvement program was launched in rural regions in 2012 regarding the student's health concerns. In the meantime, school bus and campus safety issues were also highlighted for students' safe and soundness. The democratic management of the different degrees of schools was further discussed as schools' autonomy attracts further attention to education outcomes and quality. For education equity, the central government educational funding allocation strategy for compulsory education in western, rural, remote, ethnic areas, and weak urban schools was presented to solve the educational imbalance issue.

The educational policy narratives in the official work report 2013 did not cover much. However, it still focused on the balance, equity, and quality of the different levels of education. Compulsory and vocational education were specially mentioned in the limited phrases. Moving to the post-2013 period, the overall education policy narrative coverage gradually returns to the pre-2013 scale. Education equity issues had become more concentrated in the central government's policy intentions in 2014. Several new measures began to be implemented while existing policies' continuity was ensured.

In 2014 and 2015, we can observe that the main concerns didn't change much in these two years, with comprehensive policies directed to preschool, compulsory, vocational, and higher education, respectively (See Table A2-10 and A2-11 in the Appendix A). However, we can also see more policy propensities to support central and western regions in 2015. They were influenced by counterpart support policy in higher education, and the admission rate tilted to west and central areas. Meanwhile, the standardization of compulsory schooling was implemented to improve the average quality of primary and secondary education. The transformation of local-based undergraduate universities to application-oriented colleges may help more students make better social contributions.

From 2016 to 2018, education policies started to have a unified trend, meaning that education funding to rural and urban areas started to be counted under the same conditions and rules (See Table A2-12 to A2-14). Meanwhile, the tuition fee exemption strategy was first introduced to high school education and began with poor students in 2016. We can also find that besides the application-oriented transformation of the universities, the innovative abilities of higher education were highlighted, which potentially concerns the colleges' autonomy and self-management strategy.

The education policy intentions in 2017 and 2018 remained excellent in policy continuity compared to the previous years. The overall incentives to help rural and less developed areas' education highlighted the importance and necessity of education equity in China. With a wide coverage range from primary education to high school and vocational schools, tuition fees, miscellaneous fee exemption, and living expenses subsidies and scholarships fundamentally reduce the cost of proper instruction.

The overall trend of the educational policies' intentions from 2005 to 2018 illustrated a powerful and dynamic adjustment to China's education system. The initial idea was to expand the educated population by gradually reducing the education cost and balancing the rural and urban areas' inequality issues, which may help narrow the gap between east coastal provinces and western provinces. Multiple policies were separately involved in supporting fostering and accumulating teachers to mitigate resource shortages and increase quality. The quality issues of education also concerned the student outcomes related to market demand and schools' autonomy. Several issues were triggered within the education development, such as the increasing burden on young students and the additional need for pre-primary education. According to social incidents, the campus and facilities issue represents another part of concerns in education policies that may affect students' health and safety. The performance of private capital in the education sector should also not be forgotten, as it became crucial for the quality and quantity development of education in China.

2.4.2. Medical and Health Policy Intention

Simultaneously, we selected the same period's medical and health policy narratives compared with education policies. We can also observe the changes in these official medical and health policies intentions from the same State Council Government Work Report. Similar to the education policies, we will provide a summarized description (Table 2-3) to demonstrate the major changes in China's health and medical policies from 2005 to 2018.

Since 2005, China has continuously invested in completing a disease prevention and control system and a synergetic medical treatment system for public health emergencies. Health infrastructures and a pilot program for the rural cooperative medical system were introduced in rural areas. Meanwhile, community health services in urban areas were also brought up as a pilot reform plan. Besides, the government also attempts to improve and standardize the medical services charges and drug purchase sale orders in medical institutions. Rural health services have been further expanded to counties, townships, and village levels with a "Rural Health Services System Construction and Development Plan" in 2006. China invested more than 20 billion Yuan in renovating health centers and hospital facilities in the counties and villages in the following five years. In the meantime, central and local financial subsidies to rural individuals' cooperative medical care insurance plans have started to increase. Again, the promotion of urban communities' medical and health services system was seriously treated with more investment and innovations. The standardization of medical services and drug production were also mentioned. Furthermore, the regulation of medical and pharmaceutical behaviours of hospitals and doctors was introduced to improve the quality of medical services and control general medical costs. Finally, the importance of preventing and controlling highly infectious human diseases was mentioned in the same year.

Table 2-3 Summary of Main Health and Medical Policy Intentions in China after 2005

Health and Medical Policy Intentions	Year	Covered Regions
The full completion of the disease prevention and control system	2005	Nationwide
Promote the pilot of the new rural cooperative medical system	2005	Rural Regions
Pilot reform of the urban medical service system with community health services	2005	Urban Regions
Launch the "Rural Health Service System Construction and Development Plan"	2006	County – Township - Village
Implement measures to prevent and control major infectious diseases	2006	Nationwide
Build a rural drug supply and supervision network	2007	Rural Regions
Launch the pilot of basic medical insurance for urban residents for major diseases	2007	Urban Regions
Expand the pilot of basic medical insurance for urban residents to 50% of cities	2008	Urban Regions
Fully implement the new rural cooperative medical system	2008	Rural Regions
Carry out public hospital reform pilot plan	2008	Nationwide
Gradually abolish the mechanism of using drugs to subsidize medical care	2009	Nationwide
Support social capital to set up medical and health institutions with equal terms	2010	Nationwide
Integrate the basic medical insurance system for urban and rural residents	2016	Nationwide

Source: Authors' collection using the contents from China's central government work reports (Li, 2014-2018; Wen, 2005-2013).

In 2007, the target of promoting a new rural cooperative medical system in 80% of the villages and counties was set up. The health services networking through county, township, and village levels was also focused on quality concerns. Drug supply channels and supervision strategies were expanded to reduce medical and health burdens on citizens in lagging regions. Official financial support to the central and western provinces was still critical. Urban areas were piloting basic medical insurance for significant diseases. At the same time, universal prevention and treatment strategies have been expanded to 15 infectious diseases with vaccination and immunization plans.

The policy in 2008 demonstrated a more extensive medical insurance system for urban and rural areas coverage, while 50% of the urban cities and 100% of rural countries implemented the public medical insurance system. The detailed urban and rural medical services frameworks were further strengthened as rural regions' county-township-village "3-tier" health service network and urban areas' community medical foundation were emphasized. The major infectious diseases immunization program was also expanded. A national essential drug and supply guarantee system was established to ensure medical safety and price control. There were also two new policy intentions in this year's work report. One is to foster more general nurses and doctors and encourage highly qualified personnel services at the grassroots level. Another is the public hospitals' pilot reform plan, which was first mentioned.

A more extensive coverage ratio of urban and rural medical insurance to 90% was set up for the following three years in 2009. The national drug system started to offer the national essential drugs catalog, aiming to reduce the public's healthcare costs burden. Also, the number of primary healthcare services was highlighted, as 2.9 million township health centers were on the task list that year while the gradual equalization of essential public health services was required. The public hospital reformation piloting program focused on the management system to explore a more effective form between hospitals and the government. Moreover, it was said that the medicine-subsidized medical care mechanism in the hospital compensation method should be gradually abolished, and try to establish a negotiation, quality monitoring, and evaluation system for a healthier medical service.

The post-2010 period focuses on expanding existing strategies according to the previous plan, such as basic medical insurance coverage and financial and medical subsidy standards. Also, the national essential drug system was introduced to more state-run primary healthcare institutions for the unified distribution of essential medicines. The large-scale training program to foster suitable medical workers was continuously implemented in 2010. Requirements on improving the compensation mechanism to medical institutions and medical job payment were involved. An efficient collaboration framework between community clinics and hospitals was carried out in the medical treatment system according to their functional distinctions. As for the public hospital reform pilot program, China's central government insisted on perseverance in providing basic medical care for the public good. Service quality, medical costs, and the relationship between doctors and patients were also emphasized. One new policy was founded in 2010, supporting social capital involvement in medical and health institutions with an equal environment to public hospitals.

In 2011 and 2012, medical and health policy directions from the central government of China stayed its stability and continuity compared to the pre-2010 period. The national essential drug system, rural and urban public medical insurance strategy, collaboration between different tiers of medical institutions, and public hospitals' reform pilot plan remained their expansions. The infectious diseases supervision and social capital involved in the medical services sector were also highlighted. Meanwhile, to deal with the doctor resources shortages and inequality issues, a multi-point practice system for doctors which can encourage the reasonable movement of doctors among various medical institutions and the opening of clinics at the grassroots level was suggested in 2011.

As mentioned in the education policies reviews, The newly elected central government committee members started their governance in 2013. The overall policy continuity has been ensured. The major medical and health policies from 2013 to 2015 maintained a similar intention and expanded speed. We can observe the stable growth of the national essential drug system and public medical insurance coverage ratio. The long-term effort to reform public hospitals and make an effective coordinative system among different tiers of medical institutions was still the top priority. Two solutions were provided to reduce medical resources shortages: offering equal policy and regulatory environment to medical care institutions run by social capital. The second is encouraging doctors to work flexibly in multiple medical institutions in different tiers and even establish community clinics using social capital.

One major change in medical policy happened in 2016. The previous strategy divided public medical insurance into urban residential and rural village cooperative categories. However, to ensure the cross regions' medical insurance payment and national network system functions, the integration plan of two types of public insurance system were launched in 2016. Simultaneously, a more substantial compensation policy for the medical professions was founded to protect and mobilize their enthusiasm. Also, the training program is accelerating to foster more medical practitioners and pediatricians. These policies continued to 2017 and 2018, as more medical subsidies to insurance, medicines, and medical professions were implemented.

To conclude the medical and health policy intentions from 2005 to 2018, we can observe that, even though the central government leadership experienced the update in this period, policy continuity and directions are greatly ensured. Multiple medical and health issues have been targeted with top-priority policies. The public insurance strategy for urban and rural areas, the public hospitals' reform and autonomy propensity, the drug and medicine essential supply, medical professions, and practitioner foster and encouragement, three tiers of hospitals strategy, and social capital involvement in the medical care market, these significant policies intended to provide an equal and sustainable health development to the whole country for both rural and urban areas. We will look further at the specific factors among these medical resources and health imbalance issues in our human capital research policy research.

Chapter 3 Estimating the Return to Education in China: Evidence from longitudinal data

3.1. Introduction

The return to education is perhaps the most studied topic in economics and education. Since the seminal work of Mincer (1974), previous research has documented a positive marginal monetary return of years of schooling. Psacharopoulos and Patrinos (2018) have shown that the returns to education increased after 2000, compared to the pre-2000 period. Meanwhile, the evidence from Psacharopoulos and Patrinos (2018) also demonstrated that the global trend over time returns to schooling decreases by 0.2% for every additional year of education. This phenomenon may cause by the demand for skills outpacing the supply growth.

Recent evidence also suggests that the return to education in lower- and middle-income countries are experiencing higher estimates than in higher-income countries, especially tertiary education. While most of the existing studies relied on cross-section data, questions have been raised about the credibility of these estimates for policymaking. For instance, Patrinos (2016) points out the importance of considering the demand change in estimating the returns to schooling. Therefore, this paper leverages one of the most extended longitudinal datasets for developing countries to assess how the returns to education evolve.

As a crucial case for its large population, China has a fast-growing economy, stabilized society, and proactively implemented development policies. In 1986, the Compulsory Education Law of the People's Republic of China was launched from the education case. It firstly built up the foundation of education rights for every citizen. To adjust the education system more reasonably, the Compulsory Education Law had its first revision in 2006. The main idea is to balance education resources in different areas. Furtherly, reduce the household burdens on education expenditure, and expand the range of the definition of the student's learning objectives, which means basic knowledge is taught in the school. Comprehensive abilities like physical, art, and manner education are required in the overall development. Undoubtedly, a suitable and widely covered education structure is one of the keys to the country's long-term growth.

On the other hand, with the most acknowledged development over the past 40 years, people gradually accepted new life patterns in China. There are already numerous studies on China's modern development paths and how different impacts of those essential investments from public and private were promoting economic growth. Given China's unique environment and policy implementation, it will be an experience for the world to understand China's household education investment preference, the returns to education, and other related factors crucial to individual outcomes. This study sets out to investigate two specific objectives. First, we shall document the changes in the returns to education in China over a long period between 1993 and 2015 using the years of schooling and educational attainment. Second, we shall review critical government policies and external factors and explain how they relate to the changes in the returns to education in China. These crucial factors are forging China's human capital development, requiring more empirical studies for better understanding and future planning.

To assess the trend of the return to education in China more accurately, a better understanding of China's achievement in the education sector should be one of the minimum requirements. Since the consistent education investment from the government and individuals poured into the education industry, the gross enrollment rate of primary schools has been maintained at 100% since 1990. The junior secondary school raised from less than 70% to 100% during the past 30 years. Besides China's compulsory school levels, senior secondary levels increased more than 60% of the gross enrollment rate to 80%. Concerning college degrees, a share beyond 40% of the gross enrollment ratio reflected a considerable leap from nearly zero starts in 1990. These incredibly fast-growing enrollment rates in different education degrees were not useless. The share of illiterate people in every province in China declined sharply, even in the most rural area (See Chapter 2: Figure 2-3).

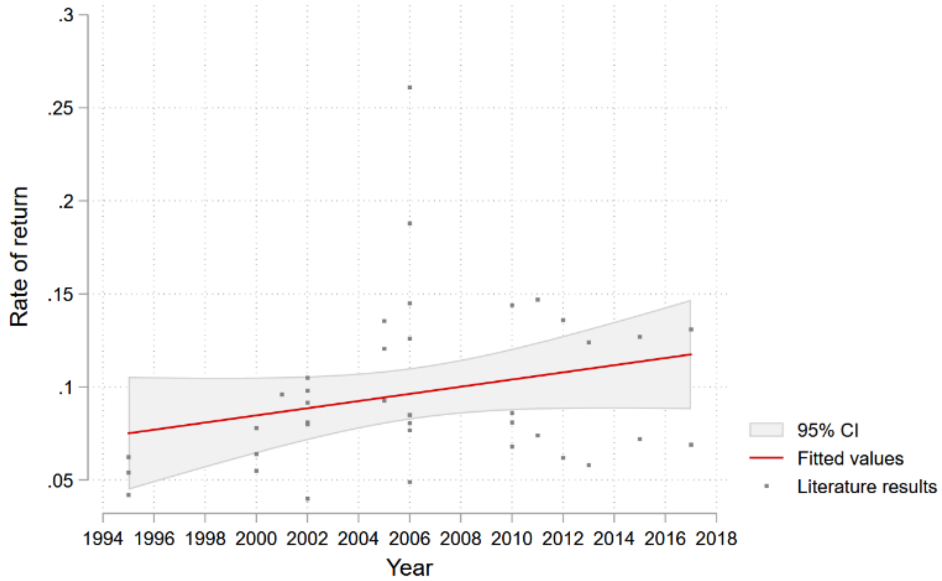
The overall findings in this chapter demonstrate an uprising trend in return to years of schooling. At least one continuous significant boost began in the late 1990s and peaked in 2006. Although the returns to years of schooling in China after 2011 show a slight decrease, it is still reasonable to admit the long-term education policy's contribution, including China’s eighth curriculum reform for compulsory education period started in 1999 and public funds growth to stimulate vocational education before 2010. The returns to education are still very high compared to the early 2000s. Our findings are robust to different estimation methods, such as the Lewbel approach, a heteroskedasticity-based estimating method.

Meanwhile, we have added control variables such as gender and work unit type to extend the results. We also show that the returns to higher educational attainment grew faster than fundamental education during the whole period, but vocational education became more popular after 2011. The rest of this chapter is organized as follows: The detailed literature review on return to education will be provided in section two; the methodology will be explained in section three, and data description will be given in section four; section five will present the main results; section six will discuss the findings while concluding remarks will be highlighted in section seven.

3.2. Literature Review

Return to education usually consists of two aspects: return to schooling years and return to educational attainment. In most studies, the return to years of schooling attracted more attention in the literature. The year of schooling means the overall duration of one’s education, while educational attainment represents an individual's highest degree. First, we shall discuss previous studies on the returns to years of schooling. According to research based on 705 worldwide estimates, the private rate of return to an extra year of education was 8.8 percent from 1950 to 2014. The return to education is highest in Latin America and Sub-Saharan Africa, while the Middle East and North Africa get the lowest outcomes, according to Psacharopoulos and Patrinos (2018). In China, the return to education has also been widely studied. The mincer-type equation possibly covered most of the papers on this topic. They used various datasets and estimations methods to find significant results in those years. We have summarized the existing evidence on China's returns to education in Figure 2-1. These estimates were collected from 12 different studies published between 2003 and 2021. We can see that the overall trend of return to years of education increases over time according to several different estimated results, just like the literature expected. In the 1990s, the return to years of schooling in China rose from at least 4% nationally (Xiu & Gunderson, 2013) to 5% (Kang & Peng, 2010). In the 2000s, these returns increased to more than 8% (Kang & Peng, 2010) on average. It can reach a 14% level after 2010 (Chen & Pastore, 2021). However, Figure 3-1 also shows that the rates of the returns to education years can be quite different even in the same year. This situation is mainly due to various datasets and methodologies.

Figure 3-1 Estimated Return to Education Years in China from Literature



Source: Authors' construction based on the literature review.

Besides the literature which focuses on estimating the return to the years of schooling, various studies have focused on educational attainment. Regarding the results of Psacharopoulos and Patrinos (2018), their estimation shows that higher education levels may not necessarily bring better personal or social returns. Furthermore, primary education always gives the highest return from low-income to high-income counties, and secondary or tertiary levels reflect similar results in the private sector. While social returns to educational attainment appeal more to the primary level, higher levels give the lowest coefficient. They explain that higher education costs more and increases investment, hence the lower returns. However, they also believe that spending on human capital will continue to return as a good investment if utilized efficiently. The finding above is quite different from some other studies. From Melianova et al. (2021), the return to a vocational degree is lower than university from 1994 to 2018. Also, the study focuses on China, as Fu and Ren (2010) estimated in their work using the urban groups of the regression. Higher educational attainment did have higher returns.

These former studies on return to education have already credited education's inevitable contribution. It is evident that better-educated people have better chances and can make better choices, both in traditional farming and those advanced jobs in the urban area (Yang, 2004). However, as one of the major economies and societies in Asia, the increase in the return to education in China was lower than in other transitional economies, which means further development of China's return to education was expected (Guifu & Hamori, 2009). Also, the return to education is not the same in the various sectors, and China's labor market has segmented views on wage determination (Xing, 2008). However, the age structure has been experiencing a population aging issue, negatively affecting human capital development (Fraumeni et al., 2019).

It further reminds us that even the overall return to education in China has gradually caught up with the average performance worldwide. External and internal issues still complicate the dynamic balance between human capital performance and education investment. We believe further research is needed on China's case. Understanding the education's internal impact status is essential since each country's development won't necessarily share the same path. This chapter will provide more support and clarify the understanding of China's human capital development on the education side.

3.3. Methodology

Return to education study has a widely accepted estimation approach: mincer type equation (Mincer, 1974). The equation (3-1) below is the structure of the mincer-type equation for the return to schooling years OLS estimation. It was formally adopted by Guifu and Hamori

(2009).

$$ln\,Y_i = a + \beta X_i' + \gamma S_i + \varepsilon_i \quad (3\text{-}1)$$

$ln\,Y_i$ is the natural logarithm of an individual's annual wage, X_i' denotes the schooling years. S_i represents all the other control variables, such as age, experiences, and gender. ε_i is the error term that is expected to have the condition of $E[\varepsilon_i] = 0$.

Following previous studies, we estimate equation 3-1 using the OLS method. The OLS estimation with the Mincer-type equation has proved to be one of the methods in the research of return to education. However, a double-check solution is still crucial for the robustness test of the original OLS results. This part of the research would focus more on the factors' general influence.

Commonly, instrument variables will be used to correct the effect of endogeneity issues. However, the difficulty of utilizing the instrumental variables method is finding the proper instruments that need the correlated relationship with the main factor and orthogonal to the whole approach's residuals. Such instrument variables may not be provided in the database. To solve this problem, Lewbel (2012) developed a suitable way for estimating the impact on an outcome variable even when the traditional instrument cannot be found.

The Lewbel approach can be described as follow:

$$Y_1 = X'\beta_1 + Y_2\gamma_1 + \varepsilon_1 \quad \varepsilon_1 = \alpha_1 U + v_1 \quad (3\text{-}2)$$

$$Y_2 = X'\beta_2 + Y_1\gamma_2 + \varepsilon_2 \quad \varepsilon_2 = \alpha_2 U + v_2 \quad (3\text{-}3)$$

Y_1 are wages, Y_2 is education, U denotes the unobserved factors, and v_1 and v_2 are the idiosyncratic errors. The whole approach will become convincing if the following conditions are achieved:

$$E\left(x_{\varepsilon_j}\right) = 0,\ j = 1,\ 2 \tag{3-4}$$

$$\text{cov}(Z, \varepsilon_1\varepsilon_2) = 0 \tag{3-5}$$

According to Lewbel (2012), the identification is achieved by limiting the correlations of $\varepsilon\varepsilon'$ with X. The model will still be unidentified with standard homoskedasticity assumption, which means $E\left(x_{\varepsilon_j}\right)$ is a constant matrix. The identification goal can be accomplished only if heteroskedasticity is related to some elements X to some extent. In an overall simultaneous structure, if $\text{cov}(X,\ \varepsilon_j^2) = 0$, j = 1, 2 and $\text{cov}(Z, \varepsilon_1\varepsilon_2) = 0$ for observed Z, then it should be able to identify the structural parameters. Here the variable Z may be a subset of X, so no information outside the model specified above is required. However, if conditions (4) and (5) hold, together with the heteroskedasticity of ε_j. The identification can be completed whether Z is or isn't a sub-vector of X.

These conditions are standard assumptions for the test, and the only difference is that it requires heteroskedasticity in ε. The Lewbel approach can use traditional instruments with TSLS to estimate the IV regression in the conventional way (Mishra & Smyth, 2015). Furthermore, the initial test of Lewbel's approach showed a good result in Engle curve estimations. The household expenditure on a specific good or service varies with household income, compared to the regular instrument variable approach using income. Supported by this evidence, even if conventional IVs are not utilized or are not strong enough in the dataset, the Lewbel approach can efficiently provide consistent estimates.

Moreover, to estimate the returns to educational attainment, we use the following specification as in Otchia (2021):

$$\ln Y_i = X_i'\gamma + \sum_{j=0}^{6} \beta_{ij} U_{ji} + \varepsilon_i. \tag{3-6}$$

Here, U_{ji} represents the dummy variables of the highest level of education attained by individuals i in each survey year. This specification assumes a non-linear function between education and earnings and allows us to estimate the returns to educational attainment from no formal education level to Master's and higher degrees. In addition, we can also evaluate the marginal effect of each education degree. The margins of each additional degree of educational attainment can reflect the return to education with more detailed results and offer overtime changes in the human capital demand from society from the educational attainment distributions.

3.4. Data Description

Two different household surveys are utilized to estimate the return to education. The CHNS datasets are founded and collaborated between the Carolina Population Center at the University of North Carolina and the National Institute for Nutrition and Health at the Chinese Center for Disease Control and Prevention (CCDC) internationally. It is one of the most suitable datasets that can provide an extended period of samples and is widely used in health, nutrition, and household planning policies with comprehensive research. People can study the household level of Chinese society's transformation. The survey used a multistage, random cluster process within seven days to draw the sample, including 7,200 households with over 30,000 individuals in 15 provinces and municipal cities. The datasets serve as longitudinal data; its latest data was issued in 2015. We utilize the data from 1993 to 2015 to show the trend.

This study also uses the CFPS (Institute of Social Science Survey, 2015). It was funded by the Chinese government and edited by Peking University in 2008. This survey data is a great alternative that is suited for this research. Since it can provide widely covered and high-quality data from 2010 to 2018, it is thus very useful for estimating the return to education for almost every province. It contains 16,000 households with all family members, but the data from some western provinces, such as Ningxia and Xinjiang, were insufficient for the provincial-level analysis. We use geographic location similarity to offer these provinces a relevant result. We obtained each educational attainment population in each region and year from China Statistical Yearbook for the second part. The years of schooling of different degrees have been set as follows: College education and higher equals 16 years, senior secondary school is 12 years, junior secondary school is nine years, elementary school is six years, and illiterate for 0 years.

This research utilizes eight waves of the CHNS data and five years of the CFPS data to demonstrate the return to education trend. These different years of samples can provide a dynamic view of social improvement in China from pre-2000 to the late 2010s.

Table 3-1 CHNS Data Description (1993 to 2015)

Variable	Year	1993	1997	2000	2004	2006	2009	2011	2015
Ln Wage	Mean	7.5421	8.4013	8.6711	8.9931	8.8469	9.1208	9.6373	10.270
	S.D	0.7127	0.7058	0.7111	0.7576	1.1351	1.3244	1.2844	1.0644
Years of schooling	Mean	6.7119	6.8930	7.4858	7.9604	8.1288	8.2655	9.0639	10
	S.D	3.9574	3.8596	3.7492	3.6724	3.9718	3.7823	3.9748	3.8095
Age	Mean	36.310	37.394	38.301	42.026	43.108	43.817	44.291	43.986
	S.D	12.747	12.565	12.407	11.567	11.231	11.646	11.434	11.737
Experience	Mean	25.392	25.888	26.177	29.643	30.787	31.695	31.950	31.950
	S.D	16.667	16.668	16.485	15.323	15.147	15.072	15.193	15.728
Gender	Mean	0.4977	0.4955	0.4970	0.4962	0.5008	0.5003	0.5175	0.5113
	S.D	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.4997	0.4998
Work Unit Type	Mean	1.7670	1.7729	1.8155	2.3086	2.1654	2.1223	1.9780	1.6216
	S.D	0.5580	0.5340	0.5550	1.0615	1.0150	1.0217	1.0389	0.9287

Note: S.D = Standard Deviation.

Source: Author’s calculation using the data from the CHNS (1993-2015).

Table 3-2 CFPS Data Description (2010 to 2018)

Variable	Year	2010	2012	2014	2016	2018
Ln Wage	Mean	9.7486	9.5265	9.9203	10.020	10.239
	S.D	0.6883	1.2793	0.9729	1.0687	0.9688
Schooling Years	Mean	6.6152	7.0365	7.8846	8.1428	8.3548
	S.D	4.8915	4.8026	4.6372	4.6947	4.7542
Educational Attainment	Mean	1.6468	1.8609	2.0076	2.0145	1.8953
	S.D	1.3595	1.3259	1.3005	1.3799	1.4059
Age	Mean	42.809	41.491	42.001	42.378	43.279
	S.D	14.187	14.699	14.826	14.868	14.950
Experience	Mean	30.190	28.461	28.117	28.849	29.482
	S.D	16.641	17.124	17.316	17.789	17.845
Gender	Mean	0.5167	0.5011	0.4978	0.4976	0.5044
	S.D	0.4997	0.5000	0.5000	0.5000	0.4999
Work Unit Type	Mean	0.7041	1.2003	0.3554	1.0611	1.0749
	S.D	1.4113	1.7086	1.1122	1.5005	1.4756

Note: S.D = Standard Deviation.

Source: Author's calculation using the data from the CFPS (2010-2018)

We restricted our sample to individuals over 15 and under 70 years old. Table 3-1 and 3-2 present the summarized statistics. The gradual increase in the samples' average annual wage and schooling experience is easy to observe. The data shows that the average age started from 36 in 1993 to 43 in 2018. Males (Male = 0, female = 1) maintained a more significant number than females in the samples before 2006 and got less after 2009 from the CHNS data. While the CFPS data shows, samples with more females in the early 2010s and Males caught up later in 2014. But in general, the gender scales are equalized on both sides. Four types of work units are obtained (Government and public services = 1, State/Township/Province/City/County-owned enterprise = 2, Domestic private company = 3, and Enterprise owned by foreigners, overseas Chinese, and joint venture = 4). A similar work unity type categorization was deployed in the CFPS data which is reflected in Table 3-2. It is easy to find out that public sectors may have accounted for a larger sample ratio.

3.5. Results

The overall results are divided into three sections. The first part is the results of the return to schooling years, and then followed by the second part is the return to educational attainment and its marginal effect. The third section is the robustness test for the former estimation using the Lewbel IV approach. Each of these three parts will contain two different surveys (CHNS and CFPS) with two estimation periods: the CHNS datasets will show the results from 1993 to 2015, while the CFPS will focus on the period from 2010 to 2018. These two periods can offer a macro understanding of China's education performance over the past three decades.

3.5.1. Return to Years of Schooling

First, the correlation between log wage and schooling years without controlling for other factors is presented in Table 3-3 and Table 3-4. As Table 3-3 is the estimated result based on the CHNS datasets, the trend of the return to schooling years reached its peak in 2011 and experienced a sharp fall in 2015.

Table 3-3 OLS Result of Return to Years of Schooling in China from 1993 to 2015

	1993	1997	2000	2004	2006	2009	2011	2015
	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage
Years of schooling	0.015***	0.026***	0.054***	0.096***	0.144***	0.163***	0.173***	0.109***
	(3.39)	(5.05)	(12.34)	(16.44)	(23.27)	(25.32)	(31.30)	(20.73)
Constant	7.413***	8.167***	8.145***	8.021***	7.495***	7.610***	7.880***	9.093***
	(168.46)	(153.04)	(175.66)	(122.23)	(106.07)	(101.62)	(115.56)	(140.80)
Observations	2,748	2,448	2,573	2,224	3,232	3,521	5,010	4,833
R-squared	0.005	0.014	0.058	0.161	0.231	0.208	0.264	0.138

Note: *** p<0.01, ** p<0.05, * p<0.1. The values in parentheses are confidence levels.

Source: Author's calculation using the data from the CHNS (1993 to 2015).

With an overlap interval from 2010 to 2014, verifying the return to schooling years in this same period is possible by having baseline estimation using the CFPS datasets. Table 3-4 directly shows a similar decrease trend between 2010 and 2014 compared to the CHNS baseline results. Furtherly, we can see a rebound after 2014, which returns to 0.081 in 2018. One thing that has to be mentioned here is that the overall scale of the return to years of schooling estimated by the CFPS is lower than the CHNS. I assume that the sample base differences cause this. Since the CFPS is determined to collect the data around all the nations, which contains 31 provinces, autonomous regions, and municipalities, the CHNS data only includes twelve regions of China. Although there are different levels of economic and geographic samples among these 12 regions, they still cannot represent the nationwide samples.

Table 3-4 OLS Result of Return to Years of Schooling in China from 2010 to 2018

	2010	2012	2014	2016	2018
	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage
Years of schooling	0.128***	0.080***	0.058***	0.062***	0.081***
	(65.20)	(35.55)	(22.05)	(15.91)	(36.30)
Constant	7.839***	8.850***	9.358***	9.348***	9.410***
	(437.20)	(392.92)	(331.08)	(221.57)	(372.74)
Observations	23,255	15,546	9,246	4,965	10,471
R-squared	0.157	0.081	0.060	0.055	0.125

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$. The values in parentheses are confidence levels.

Source: Author's calculation using the data from the CFPS (2010 to 2018).

The further regression between Log wage and schooling years with other factors controlled is demonstrated in Table 3-5. Although the overall trend of returns to education years across these eight waves is increasing, it is worth noting that the estimates in the 1990s were lower than 3% and only 5.1% in 2000, and the returns after 2000 reached a whole new level. In 2006, 2009, and 2011, the return to the years of schooling maintained the status of around 10%. But the estimate in 2015 decreased back to the same level as in 2004. These results match other research to the same degree. In detail, it is lower than the results we're focusing on in urban China (Zhang et al., 2005) but close to the same survey estimates (Guifu & Hamori, 2009). The R-Squared in the earlier waves is not very large but corroborates with preview literature which studied the returns to education on the CHNS data (Guifu & Hamori, 2009). Interestingly, we see significant variations in R-square across waves, meaning that our explanatory variables, including education, are becoming more important in explaining wages. Similar to

Psacharopoulos and Patrinos (2018), we also show that the returns to education years before 2000 were much lower than the world average but caught up with the same level after 2000.

Table 3-5 OLS Result of Return to Years of Schooling in China from 1993 to 2015

	1993	1997	2000	2004	2006	2009	2011	2015
	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage
Years of schooling	0.017***	0.029***	0.051***	0.080***	0.105***	0.110***	0.127***	0.080***
	(3.85)	(5.40)	(10.98)	(12.55)	(14.77)	(14.79)	(21.67)	(14.46)
Age	0.056***	0.049***	0.037***	0.043***	0.076***	0.096***	0.125***	0.088***
	(6.99)	(5.01)	(4.74)	(4.17)	(6.52)	(7.41)	(10.43)	(8.35)
Age-squared	-0.001***	-0.001***	-0.000***	-0.001***	-0.001***	-0.001***	-0.002***	-0.001***
	(-5.93)	(-4.24)	(-4.08)	(-3.96)	(-6.98)	(-8.23)	(-11.30)	(-9.34)
Gender	-0.143***	-0.178***	-0.159***	-0.149***	-0.276***	-0.390***	-0.344***	-0.328***
	(-5.81)	(-6.91)	(-6.22)	(-4.80)	(-7.61)	(-9.92)	(-11.82)	(-11.74)
Work unit type	-0.019	0.052*	-0.069**	-0.134***	-0.217***	-0.269***	-0.159***	-0.096***
	(-0.63)	(1.91)	(-2.55)	(-6.11)	(-9.54)	(-10.70)	(-8.59)	(-5.22)
Constant	6.308***	7.146***	7.598***	7.709***	7.245***	7.343***	6.800***	8.350***
	(37.88)	(36.50)	(45.18)	(33.61)	(27.91)	(24.35)	(26.85)	(35.68)
Observations	2,748	2,448	2,573	2,224	3,232	3,521	4,953	4,751
R-squared	0.062	0.056	0.096	0.205	0.284	0.274	0.333	0.202

Note: *** p<0.01, ** p<0.05, * p<0.1. Age, gender, and work unit type are controlled. The values in parentheses are confidence levels.

Source: Author's calculation using the data from the CHNS (1993 to 2015).

On the other hand, the rest of the individual factors in the model also show the expected results. The age and age-squared coefficients show that potential earnings are higher with age growth. It started at 5% in the pre-2000 period and dropped to 3.7% in 2000. However, age has gradually increased and peaked at 12.5% in 2011 and slightly fell to 8.8% in 2015. Meanwhile, the Age-squared variable presents a negative coefficient through the estimation, meaning the marginal effect from the age to the wage decreases. In other words, the borderline relationship between age and wage is an inverted U curve. Individuals' salaries grow throughout their lifetime, but the growth rate will rise early and get slower after a certain point. Males are still taking advantage of females' workforces in job markets. The gap was narrowed down after 2009, but 30% of the wage gap still stayed in front of females. From the macro view, the types of those samples' work unit variables have an odd trend that public services or non-private-owned enterprises seem to offer more wages after 2004.

The result derived from the CFPS data shows that Table 3-6 is established following the same structure as Table 3-5. The only thing that has been changed here is that the work unit types have remained in the estimation function. At the same time, return to schooling years illustrated a valley shape from 2010 to 2018, which confirmed the decreasing trend between 2010 to 2014 again. Other controlled variables interpret a slightly different story. The effect of age peaked in 2014 with a correlation of 0.163, but the Age-squared factor reflected the same inverted U curve of age’s marginal impact on wage level. The gender gap in individuals’ wages is more significant in the CFPS datasets, which maintained -0.4 after 2012. This implies that market-driven income distribution is not working well on gender balance.

On the contrary, while the CHNS estimation shows the adverse effects of private and foreign enterprises on the wage level, the CFPS data demonstrated a completely different story. It is strongly supported that samples working for private and foreign sector companies have higher returns than those in government or public sectors. This divergence may have two possible explanations. The major one is the dataset’s differences, as we discussed previously. The differences in the nationwide range samples cannot be ignored when some typical variables reacted divergently. Simultaneously, the supported reason may have been that the newly accounted region’s open market policies positively affected the individual wages of private and foreign sectors, and the bias can be fixed. However, this positive trend does not seem secure as the year pass. It gradually decreased from 0.253 to 0.046 in 2014 and bounced back only to 0.095 in 2018.

Table 3-6 OLS Result of Return to Years of Schooling in China from 2010 to 2018

	2010	2012	2014	2016	2018
	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage
Years of schooling	0.096***	0.088***	0.038***	0.061***	0.076***
	(46.87)	(39.21)	(13.30)	(14.93)	(32.65)
Age	0.101***	0.056***	0.163***	0.105***	0.095***
	(21.81)	(12.22)	(27.06)	(12.50)	(18.29)
Age-squared	-0.001***	-0.001***	-0.002***	-0.001***	-0.001***
	(-21.71)	(-9.95)	(-26.20)	(-12.60)	(-18.70)
Gender	-0.571***	-0.396***	-0.417***	-0.432***	-0.415***
	(-31.31)	(-20.42)	(-18.04)	(-14.75)	(-23.96)
Work unit type	0.253***	0.150***	0.046***	0.058***	0.095***
	(51.11)	(26.38)	(7.47)	(5.09)	(13.54)
Constant	6.082***	7.387***	6.425***	7.555***	7.690***
	(61.48)	(75.93)	(54.05)	(44.10)	(71.35)
Observations	23,255	15,401	11,846	4,965	10,471
R-squared	0.267	0.172	0.116	0.131	0.221

Note: *** p<0.01, ** p<0.05, * p<0.1. Age, gender, and work unit type are controlled. The values in parentheses are confidence levels.

Source: Author's calculation using the data from the CFPS (2010 to 2018).

Apart from age, some other existing research would also like to control for experience since it can highlight more connections to individuals' wages. By general definition, experience is one's age minus years of schooling and initial six years. It is typically utilized for the working duration, which will not generate an overlap period with years of education. Although some cases may mix formal schooling with working experiences, separating these two periods should reflect a more reasonable estimation result.

Table 3-7 and 3-8 are the return to schooling years controlled with experience and experience-squared using the CHNS and the CFPS datasets, respectively. The fundamental model is the same as the previous age-controlled results: having a mincer-type equation measured with the OLS approach. Table 3-7, based on the CHNS data, shows a higher starting point and a lower peak of return to schooling than its age-controlled result. But the trend of the return to schooling year is similar. Meanwhile, most of the experiences' coefficients are lower than age factors. It is acceptable because the age variable contains schooling years by default.

Table 3-7 OLS Result of the Return to Years of Schooling in China from 1993 to 2015

	1993	1997	2000	2004	2006	2009	2011	2015
	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage
Years of schooling	0.026***	0.034***	0.054***	0.079***	0.091***	0.093***	0.105***	0.063***
	(5.12)	(5.58)	(10.57)	(11.15)	(10.87)	(10.87)	(15.47)	(10.23)
Experience	0.032***	0.030***	0.022***	0.022***	0.030***	0.034***	0.043***	0.034***
	(7.72)	(5.98)	(5.54)	(4.42)	(5.40)	(5.67)	(8.63)	(7.14)
Exp-squared	-0.044***	-0.049***	-0.034***	-0.041***	-0.073***	-0.085***	-0.112***	-0.092***
	(-5.65)	(-4.54)	(-4.27)	(-4.11)	(-6.55)	(-7.49)	(-11.14)	(-9.60)
Gender	-0.140***	-0.177***	-0.155***	-0.144***	-0.257***	-0.360***	-0.308***	-0.305***
	(-5.67)	(-6.85)	(-6.10)	(-4.66)	(-7.10)	(-9.15)	(-10.62)	(-11.04)
Work unit type	-0.022	0.050*	-0.071***	-0.135***	-0.226***	-0.281***	-0.166***	-0.098***
	(-0.74)	(1.86)	(-2.66)	(-6.15)	(-9.90)	(-11.15)	(-8.86)	(-5.26)
Constant	6.995***	7.749***	8.059***	8.318***	8.498***	8.957***	8.953***	9.844***
	(78.84)	(75.13)	(82.53)	(61.84)	(54.04)	(51.14)	(66.28)	(74.52)
Observations	2,748	2,448	2,573	2,224	3,232	3,521	4,953	4,751
R-squared	0.060	0.058	0.097	0.206	0.284	0.271	0.333	0.205

Note: *** p<0.01, ** p<0.05, * p<0.1. Age, gender, and work unit type are controlled. The values in parentheses are confidence levels.

Source: Author's calculation using the data from the CHNS (1993 to 2015).

Other Variables like gender and work-related factors share similar results to the age-controlled version of the estimate. It furtherly confirmed the trend evaluated by the CHNS samples is solid. Extended by the CFPS-based estimates, Table 3-8 also shows the controlled OLS result with the experience variable. We can find more significant numbers in return to schooling years this time, but the falling-rising trend in the period is still striking. The correlation between experience and wage is also lower than the age-controlled estimation, and the coefficient from 2010 to 2014 matches the CHNS results perfectly. The other factors remain consistent with the age-controlled version, which shows enormous gender inequality and positive private employers' wage effect.

Table 3-8 OLS Result of the Return to Years of Schooling in China from 2010 to 2018

	2010	2012	2014	2016	2018
	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage
Years of schooling	0.097***	0.098***	0.054***	0.067***	0.072***
	(40.08)	(38.64)	(18.55)	(13.67)	(25.69)
Age	0.043***	0.034***	0.035***	0.038***	0.030***
	(18.58)	(14.34)	(13.15)	(9.19)	(12.86)
Age-squared	-0.068***	-0.041***	-0.073***	-0.077***	-0.066***
	(-18.71)	(-9.76)	(-14.00)	(-9.44)	(-14.41)
Gender	-0.553***	-0.389***	-0.433***	-0.408***	-0.388***
	(-30.10)	(-20.04)	(-21.44)	(-13.96)	(-22.26)
Work unit type	0.262***	0.152***	0.016***	0.057***	0.095***
	(52.52)	(26.89)	(2.66)	(5.00)	(13.32)
Constant	7.553***	8.080***	9.265***	9.048***	9.226***
	(160.19)	(166.88)	(185.14)	(100.01)	(170.12)
Observations	23,255	15,401	9,246	4,965	10,471
R-squared	0.262	0.173	0.133	0.119	0.207

Note: *** p<0.01, ** p<0.05, * p<0.1. Age, gender, and work unit type are controlled. The values in parentheses are confidence levels.

Source: Author’s calculation using the data from the CFPS (2010 to 2018).

The CHNS estimation reveals that return to education almost tripled in China and maintained a level of 9% from 1993 to 2010. However, the marginal effect shrunk quickly from 2011 to 2015. This trend also suits the findings from Asadullah and Xiao (2020). Luckily, the return to schooling years after 2014 started its recovery, supported by the results of the CFPS-based estimation. The possible reason for this widespread phenomenon is that the former boosted demand from the market reached a balance point, and the rate of return to schooling years fell back to an average level.

Meanwhile, the education system and market demand are transforming, and it took several years for this relationship to generate new opportunities and suitably educated labor forces. It can also explain the fact that the strategic policy initiative in China: "Supply-Chain Reform" and the "Made-in-China 2025" Plan (Chen & Pastore, 2021). These visions should become the new engine of the market and social development and strengthen the demand for necessary education again at the same time.

3.5.2. Return to Educational Attainment

In this session, I expand the analysis of the returns to schooling by moving on to the return to educational attainment. Since heterogeneity may exist in different educational attainment levels, I provide results for each degree, with no education (illiterate) as the reference. Contents will be presented following the order, like a return to years of schooling sessions. Table 3-9 is derived from the CHNS database, while Table 3-10 refers to the CFPS. Moreover, as the marginal effect between degrees can highly affect educational acceptance in society, Figure 3-2 and Figure 3-3 are estimated academic attainment margins' line graphs based on the CHNS and the CFPS datasets, respectively.

Table 3-9 Return to Educational Attainment by Different Degrees (1997 to 2015)

	1997	2000	2004	2006	2009	2011	2015
	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage
Age	0.048***	0.045***	0.042***	0.067***	0.112***	0.090***	0.070***
	(4.60)	(4.82)	(3.34)	(4.60)	(7.19)	(6.53)	(5.48)
Age-squared	-0.001***	-0.001***	-0.000***	-0.001***	-0.001***	-0.001***	-0.001***
	(-3.82)	(-4.14)	(-2.79)	(-4.40)	(-7.28)	(-6.59)	(-5.78)
Gender	-0.183***	-0.172***	-0.162***	-0.299***	-0.436***	-0.334***	-0.318***
	(-7.60)	(-7.45)	(-5.12)	(-7.99)	(-10.59)	(-11.69)	(-11.32)
Primary	0.208**	0.197***	0.356**	0.276**	0.249**	0.434***	-0.140
Degree	(2.53)	(2.70)	(2.40)	(2.45)	(2.03)	(3.54)	(-1.01)
Junior High	0.198**	0.271***	0.656***	0.729***	0.692***	0.697***	0.138
	(2.51)	(4.05)	(4.60)	(7.10)	(6.05)	(6.12)	(1.10)
Senior High	0.284***	0.472***	0.865***	1.028***	1.160***	1.122***	0.335***
	(3.39)	(6.95)	(6.07)	(9.86)	(10.34)	(9.93)	(2.64)
Vocational	0.339***	0.548***	1.092***	1.387***	1.489***	1.377***	0.441***
	(3.89)	(7.73)	(7.66)	(13.59)	(13.49)	(12.09)	(3.45)
University	0.396***	0.667***	1.298***	1.669***	1.725***	1.732***	0.734***
	(4.30)	(9.04)	(8.91)	(15.76)	(15.58)	(15.64)	(5.92)
Master or	0.314	1.037***		1.789***	1.949***	2.187***	1.029***
Higher	(0.87)	(3.67)		(18.04)	(15.01)	(15.01)	(6.59)
Constant	7.475***	7.663***	7.549***	7.230***	6.936***	7.584***	9.251***
	(36.98)	(41.45)	(27.62)	(25.14)	(21.69)	(27.19)	(35.23)
Observations	2,704	3,007	2,173	3,041	3,275	4,671	4,387
R-squared	0.057	0.091	0.179	0.231	0.219	0.247	0.132

Note: *** p<0.01, ** p<0.05, * p<0.1. The values in parentheses are confidence levels.

Source: Author's calculation using the data from the CHNS (1993 to 2015).

The return to educational attainment trend shown in Table 3-9 demonstrates various historical changes at different levels. While age and gender factors remained the same in the OLS estimated return to years of schooling, it can assure us of a convincing return to educational attainment results. The primary degree returns ascended before the early 2000s, dropping down until 2011. Junior high school returns rose before 2006 and maintained their level, while senior high and vocational school returns peaked in 2009 and sharply decreased in 2015. University and higher degrees also experienced their shrinking phases after 2011. Comparing the coefficients across different degrees, we can find the incremental trends among all the categories. It further proved that higher education degrees could provide better returns for individuals.

Table 3-10 below is the expanded results of the return to educational attainment using the CFPS data. Similar to the previous CHNS estimates, the coefficient of all kinds of degrees fell between 2010 and 2014, and two secondary degrees were even lower in 2016. According to the result, these reverted trends headed back to the rising mode in 2018. We can also see the same incremental effects and the upgrade in educational attainment. Other factors also remain similar to the return to schooling years estimation.

For the period these two tables have covered, we can see more precisely the changes in return to education. Although the coefficient number differences caused by the original data's sample scale variation cannot provide consistent results between 2009 to 2015, the trend in the overlapping periods can still verify each other. The overall trend directly shows the uprising feature of the returns to educational attainment during the period, where primary, vocational, university, and higher degrees maintained continuous ascending status. It is also clear that university and higher education degrees have better returns on average. However, in secondary and lower degrees, their returns decreased in 2006. The delayed impact of market demand for higher educated workforces may cause this phenomenon. Also, we could find that people could receive higher returns in wages after entering society if they sustained to upgrade their diploma. This finding is not solid with the international research by Psacharopoulos and Patrinos (2018) but proved similar to the study from Fu and Ren (2010).

Table 3-10 Return to Educational Attainment by Different Degrees (2010 to 2018)

	2010	2012	2014	2016	2018
	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage
Age	0.103***	0.067***	0.095***	0.105***	0.094***
	(22.27)	(13.86)	(17.14)	(12.42)	(18.81)
Age-squared	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(-22.14)	(-10.08)	(-17.47)	(-12.62)	(-19.24)
Gender	-0.585***	-0.386***	-0.461***	-0.444***	-0.447***
	(-32.01)	(-19.00)	(-22.83)	(-15.19)	(-26.61)
Primary Degree	0.414***	0.376***	0.176***	0.190**	0.228***
	(14.15)	(8.11)	(3.26)	(2.34)	(5.92)
Junior High	0.700***	0.834***	0.378***	0.285***	0.383***
	(25.89)	(19.83)	(7.71)	(3.77)	(10.47)
Senior High	0.968***	0.997***	0.452***	0.421***	0.539***
	(30.00)	(22.52)	(8.81)	(5.22)	(13.77)
Vocational	1.523***	1.452***	0.768***	0.684***	0.886***
	(41.96)	(29.42)	(14.32)	(7.86)	(21.98)
University	1.906***	1.508***	0.931***	0.949***	1.185***
	(42.93)	(24.54)	(16.19)	(10.78)	(28.26)
Master or Higher	2.323***	2.156***	1.170***	1.338***	1.501***
	(19.27)	(13.54)	(6.26)	(9.26)	(15.51)
Constant	6.097***	6.752***	7.944***	7.755***	7.974***
	(61.70)	(61.09)	(68.32)	(42.26)	(76.95)
Observations	23,255	14,004	9,136	4,965	11,406
R-squared	0.275	0.199	0.147	0.138	0.230

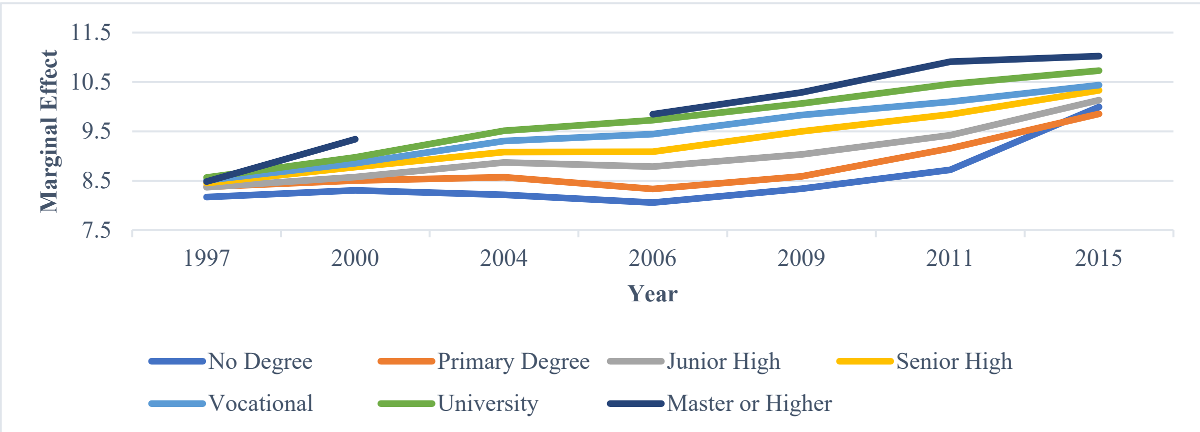
Note: *** p<0.01, ** p<0.05, * p<0.1. The values in parentheses are confidence levels.

Source: Author's calculation using the data from the CFPS (2010 to 2018).

Apart from investigating the return to educational attainment, the marginal effect of each degree may attract more attention. Since this research assume that the sample's education attainment should be precise and no half-degree exists, I believe that margins of the return to educational attainment can reflect more exact outcomes with the trends. Figure 3-1 presents the marginal effects of the education variables throughout the whole different eight years with CNHS data. Compared to the return to educational attainment, degrees' margins seem to experience the reverted performance. On the one hand, in fundamental education degrees, people with no degree to secondary school degrees can obtain a better margin if they could upgrade one more level in most cases. The surpassing of the illiterate margins to primary degrees is phenomenal, but this abnormal situation requires further cross-test with the CFPS data.

On the other hand, higher education like university and Master's degree graduates' returns rises less than those essential degrees. It reflected that although the return to education in the same period may drop because of the economic environment, fundamental education is still a necessary investment for most people. Even higher degrees couldn't bring as better margins as before. These typically educated individuals can still have higher margins than those with lower degrees. Also illustrated in Figure 3-1, the margins trend higher than senior high degrees were increasing continuously. Typically, vocational degree education as one of the critical workforce providers shows a very long-term growth during the whole period, though its numbers were lower than the university level.

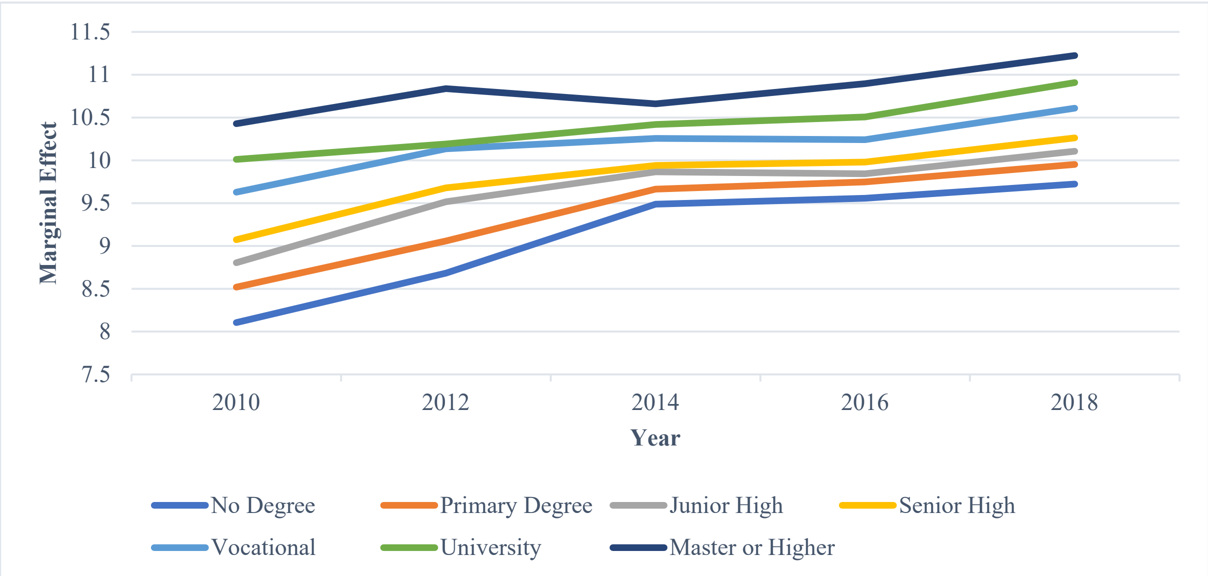
Figure 3-2 Marginal Effect of Educational Attainment (By Degrees, 1997 to 2015)



Source: Author’s construction using the regression result from Table 3-9.

Extended estimation with Figure 3-2, the margins result from 2010 to 2018 generally can fit the trend of Figure 3-2 as each degree's number from 2010 to 2014 is similar. However, for the illiterate groups' margin in Figure 3-2, though it reached the 9.5 level in 2014 and 2016, 10 is still a far-off line, as Figure 3-2 reflected. This gap between the two estimations suggests that the valid margin return to educational attainment for samples with no degrees may remain low for its performance. The gradual growth of the margin from illiterate to graduate degrees shows the same phenomenon as the return to educational attainment coefficients. As for the growth rate, higher levels of education had flatter curves, while lower education was rising faster before 2014. The overall shape of Figure 3-2 demonstrates a convergent trend across these degrees. There was a significant turning point in 2014, and the illiterate margin kept the disparity between university degrees lower than two.

Figure 3-3 Marginal Effect of Educational Attainment (By Degrees, 2010 to 2018)



Source: Author's construction using the regression result from Table 3-10.

By combining the two figures, we can see the general overview of the trend of return to educational attainment margins in the past two decades. Starting at a low point of around 8.5 in 1997 for all kinds of academic degrees, China's return to educational attainment margins didn't grow that fast for most types except for Master's and higher education. To the market demand in the early 2000s, only a few individuals could obtain a degree from a university, which let those most knowledgeable people find their opportunities easily in the development of China society. Meanwhile, as the manufacturing sectors expanded quickly after 2000, China started to require more average educated labor forces who were expected to understand basic techniques and skills. It has triggered the increase of education degrees margin after 2006. Potentially, this continuous uprising trend urged more individuals to invest in higher education. However, it also expanded the highly educated population, which squeezed the growth space of the education margins for this group after 2014. Understanding these results again affirms the long-term return on the education investment is crucial. But policies' designs for keeping education and development's sustainable healthy balance are also necessary.

3.5.3. Robustness Test

As the previous methodology section has interpreted, the robustness test of all the estimations involves the Lewbel approach, which can further extend the instrument variable model with generated IV. In the following tests, I present four tables to show the Lewbel approach estimation results on two different datasets, with the return to years of schooling and educational attainment, respectively. For the CHNS tests, the Lewbel approach's features of generated IV are utilized because of the lack of real instrument variables. Simultaneously, the CFPS database provides the parents' education degrees of most samples, which allows me to implement true IV with the same Lewbel approach.

Table 3-11 Lewbel Results of the Return to Years of Schooling from 1993 to 2015

	1993	1997	2000	2004	2006	2009	2011	2015
	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage
Years of schooling	0.019**	0.059***	0.061***	0.111***	0.130***	0.138***	0.189***	0.129***
	(2.14)	(2.59)	(3.62)	(5.20)	(5.50)	(5.46)	(4.29)	(2.82)
Age	0.056***	0.045***	0.036***	0.041***	0.073***	0.093***	0.121***	0.087***
	(6.86)	(5.76)	(3.88)	(3.70)	(6.28)	(7.55)	(6.98)	(9.12)
Age-squared	-0.001***	-0.000***	-0.000***	-0.000***	-0.001***	-0.001***	-0.002***	-0.001***
	(-5.68)	(-4.23)	(-3.26)	(-3.40)	(-6.03)	(-8.41)	(-6.57)	(-8.53)
Gender	-0.142***	-0.167***	-0.155***	-0.139***	-0.253***	-0.366***	-0.299***	-0.306***
	(-4.80)	(-5.33)	(-5.51)	(-5.00)	(-5.68)	(-9.01)	(-4.69)	(-5.51)
Work unit type	-0.016	0.084*	-0.052	-0.089**	-0.173***	-0.216***	-0.060	-0.019
	(-0.58)	(1.80)	(-1.42)	(-2.07)	(-3.48)	(-3.40)	(-0.60)	(-0.18)
Constant	6.287***	6.866***	7.469***	7.261***	6.880***	6.921***	5.796***	7.532***
	(40.90)	(22.45)	(28.92)	(18.04)	(18.41)	(12.85)	(6.77)	(8.63)
Observations	2,748	2,448	2,573	2,224	3,232	3,521	4,953	4,751
R-squared	0.061	0.041	0.094	0.191	0.279	0.270	0.311	0.181
Sargan test	0.00491	0.702	0.180	0.366	0.453	0.127	0.270	0.610

Note: *** p<0.01, ** p<0.05, * p<0.1. The values in parentheses are confidence levels.

Source: Author's calculation using the data from the CHNS (1993 to 2015).

Table 3-11 is the Lewbel approach results of the CHNS-based return to years of schooling from 1993 to 2015. Numbers show that most coefficients have larger scales, consistent with literature findings (Chen & Pastore, 2021; Mishra & Smyth, 2015). We can also see the overall return to years of schooling trend rose in the early 2000s and dropped around 2009. The Sargan test initially assumed a weak instrument variable effect but was rejected in most years.

Move on to Table 3-12, which are the results of the Lewbel approach on return to years of schooling for the CFPS data. The larger coefficient in each year is also significant. Surprisingly, the trend shows more fluctuations in return to schooling years since the result in 2014 reached the highest point across all years. However, we can also see a negative R-squared in 2014. This didn't mean that the model was wrong, as we involved the Lewbel approach for using instrumental variables to confirm that OLS results are convincing. Fortunately, the Sargan test results also supported the strong IV effect in the model, which assures the OLS result in the previous sections is acceptable.

Table 3-12 Lewbel Results of the Return to Years of Schooling from 2010 to 2018

	2010	2012	2014	2016	2018
	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage
Years of schooling	0.139***	0.129***	0.174**	0.122*	0.145***
	(21.65)	(21.81)	(2.44)	(1.84)	(4.61)
Age	0.148***	0.060***	0.089***	0.107***	0.107***
	(14.46)	(12.17)	(6.45)	(10.99)	(9.59)
Age-squared	-0.002***	-0.000***	-0.001***	-0.001***	-0.001***
	(-12.32)	(-7.83)	(-4.57)	(-8.92)	(-9.49)
Gender	-0.616***	-0.386***	-0.422***	-0.417***	-0.402***
	(-21.44)	(-18.48)	(-7.74)	(-12.93)	(-10.03)
Work unit type	0.208***	0.208***	-0.004	0.075***	0.106***
	(26.04)	(31.33)	(-0.31)	(3.08)	(5.09)
Constant	4.964***	6.560***	6.520***	6.692***	6.553***
	(26.18)	(53.80)	(8.56)	(6.70)	(12.00)
Observations	8,752	12,989	6,715	4,965	5,164
R-squared	0.269	0.201	-0.089	0.088	0.155
Sargan test	0.909	0.507	0.0919	0.177	0.126

Note: *** p<0.01, ** p<0.05, * p<0.1. The values in parentheses are confidence levels.

Source: Author's calculation using the data from the CFPS (2010 to 2018).

Table 3-13 and 3-14 are the return to educational attainment robustness tests. Looking into the details of these two tables, though the educational attainment variable is not divided into different degrees this time, the trend across two decades can still be seen as a solid result of the

OLS estimates. The positive coefficient of educational attainment constantly supports the rising demand for higher-educated workforces. The fluctuation happened during the middle of the 2000s and 2010s, but this rise and fall can still be seen due to the short-term mismatch between market changes and the education system. Age and age-squared factors also indicate that older people were supposed to receive larger wages, but the growth rate gradually declined.

Table 3-13 Lewbel Results of Return to Educational Attainment from 1997 to 2015

	1993	1997	2000	2004	2006	2009	2011	2015
	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage
Educational attainment	0.166***	0.318***	0.535***	0.248*	0.260**	0.399	0.499***	0.129***
	(4.65)	(3.24)	(2.73)	(1.83)	(2.04)	(1.22)	(2.61)	(2.82)
Age	0.093***	0.027***	0.045***	0.096***	0.100***	0.122***	0.130***	0.087***
	(5.02)	(3.11)	(3.44)	(6.03)	(4.10)	(5.74)	(9.99)	(9.12)
Age-squared	-0.001***	-0.000**	-0.000***	-0.001***	-0.001***	-0.002***	-0.002***	-0.001***
	(-4.97)	(-2.16)	(-3.54)	(-6.45)	(-5.63)	(-7.34)	(-7.53)	(-8.53)
Gender	-0.226***	-0.163***	-0.168***	-0.332***	-0.434***	-0.400***	-0.443***	-0.306***
	(-10.37)	(-4.21)	(-4.91)	(-6.01)	(-7.27)	(-4.47)	(-6.95)	(-5.51)
Work unit type	6.420***	7.294***	6.564***	6.807***	7.083***	6.618***	6.369***	-0.019
	(19.78)	(42.00)	(10.63)	(15.34)	(8.43)	(4.15)	(10.33)	(-0.18)
Constant	6.287***	6.866***	7.469***	7.261***	6.880***	6.921***	5.796***	7.532***
	(40.90)	(22.45)	(28.92)	(18.04)	(18.41)	(12.85)	(6.77)	(8.63)
Observations	3,188	3,591	2,318	3,500	3,833	5,498	5,656	4,751
R-squared	0.093	-0.008	-0.059	0.297	0.283	0.370	0.270	0.181
Sargan test	0.923	0.580	0.804	0.217	0.238	0.204	0.214	0.610

Note: *** p<0.01, ** p<0.05, * p<0.1. The values in parentheses are confidence levels.

Source: Author's calculation using the data from the CHNS (1993 to 2015).

The most important thing is that we can see significant test results for most years, like the former test on return to schooling years. P-value of the Sargan test in Table 3-13 and 3-14 present results beyond 0.05. The generated IV for the CHNS samples or real IV from the CFPS datasets suggests a strong effect of the IV model, confirming the original estimation's robustness.

Table 3-14 Lewbel Results of Return to Educational Attainment from 2010 to 2018

	2010	2012	2014	2016	2018
	Ln Wage	Ln Wage	Ln Wage	Ln Wage	Ln Wage
Years of schooling	0.464***	0.433***	0.455***	0.363***	0.407***
	(27.78)	(9.97)	(2.85)	(4.41)	(5.50)
Age	0.103***	0.075***	0.101***	0.111***	0.107***
	(20.46)	(4.31)	(14.08)	(12.41)	(14.29)
Age-squared	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(-19.74)	(-3.29)	(-11.16)	(-10.71)	(-15.91)
Gender	-0.565***	-0.385***	-0.448***	-0.427***	-0.456***
	(-27.88)	(-9.94)	(-13.79)	(-15.68)	(-15.89)
Work unit type	0.226***	0.228***	-0.004	0.080***	0.109***
	(37.29)	(9.12)	(-0.41)	(6.30)	(10.18)
Constant	5.873***	6.310***	6.966***	6.925***	7.081***
	(51.87)	(14.64)	(13.11)	(19.04)	(20.28)
Observations	19,068	12,989	6,634	4,965	5,632
R-squared	0.267	0.183	0.031	0.100	0.176
Sargan test	0.560	0.122	0.0892	0.321	0.213

Note: *** p<0.01, ** p<0.05, * p<0.1. The values in parentheses are confidence levels.

Source: Author’s calculation using the data from the CFPS (2010 to 2018).

3.6. Discussion on Return to Education in China

The research on return to education in China has demonstrated a positive trend in the returns to schooling using two indicators: years of schooling and educational attainment. However, several aspects of these findings need discussion. As a complex and continuously evolving society, China needs a modernized and demand-driven education system to develop different areas accurately. First, we found that the returns to education are not stable in recent years.

Several reasons triggered this fast boost of returns to education, given that the coefficient almost tripled from 2000 to 2011. The Chinese government created many incentives to strengthen education policy and delivery from the supply side. As early as 2002, China introduced a social market education institution intending to decentralize decision-making (budget, curriculum, etc.) and increase the privatization of public schools (Fan & Popkewitz, 2020). For instance, China introduced the eighth wave of curriculum reform in 1999. Unlike the former curriculum reforms, this eighth wave rebuilt China's education system from the basic concept. Students can receive a more balanced and flexible learning style that aims to understand how to learn and keep a positive attitude. The eighth wave of curriculum reform developed a better and positive relationship between student and teacher and innovative approaches to the education system (Cui & Zhu, 2014). It also reduces the mismatch between the education system and labor market demand with better education quality. Another essential factor is government expenditure on education, which increased to highlight the quality of education. Existing data show that public spending increased from 2.56% of GDP in 2000 to 4.28% in 2012. The most direct effect is that the student-teacher ratio has a different trend in each degree after 2005. It first appears at primary and secondary school levels, which means more teachers are available in the entire education system. The vocational degree's student-teacher ratio increased before 2010 and sharply decreased immediately. From the college part, it remained at the level of 17 and slightly increased after 2007. These trends match the return to educational attainment results and support the explanation of the improving education quality (National Bureau of Statistics of China, 2010-2019).

From the demand side, explanations could also be derived from the market demand for skills growth, as partially illustrated in our findings on the returns to educational attainment: the gradually opened market and a positively developing social environment demand higher-educated labor in China. In the meantime, China's industrialization and reform strategy introduced foreign direct investment worldwide. Under these circumstances, the service sector and industry greatly demanded post-secondary degree graduates in the late 1990s and early 2000s (Xiaohao et al., 2013). The market demand for qualified personnel by different kinds of enterprises and manufacturing and technology sectors projected the benefit to the need for education, promoting the return to education growth in the estimation after China participated in the WTO in 2001 (Ding et al., 2009).

Second, we also found that the trend in the returns to education weakened after 2011. Several hypotheses may explain this decline. One of the possible reasons is that the high expansion of the demand for highly educated labor in quantity costs the general quality decline of the graduates (Asadullah & Xiao, 2020). Another reason might be the structural change in the industry. China launched several innovation-oriented policies after 2010, aiming to strengthen the comprehensive ability of the domestic industries as the other growth engine (Zilibotti, 2017). These strategic changes firmly pushed China's domestic market and may take responsibility for the structural mismatch to the former education target.

Taken together, these findings are consistent with former studies in the literature. Lewbel estimates indicated significant results with IV in the model (Mishra & Smyth, 2015). The sharp increase in the returns to education since the 1990s driven by economic reform is similar to other transition economies (Zhang et al., 2005). Gender inequalities still exist, and the wage gap is getting more significant over time. Knowledge-intensive works are more popular than skill-intensive works, but due to the structural changes, skill-intensive jobs may receive higher expectations in future development. Public services seemed to be a better choice for the graduates since China has its unique hybrid economic system. But after the CFPS's estimation from 2010 to 2018, an open market may offer more opportunities to the private sector.

Educational attainment margins also imply a similar conclusion.

From the return to education research on China with the whole country's samples, it starts to hold concerns about the samples' range. As mentioned earlier, the CHNS data's estimation may be biased by its limited range of provinces. At the same time, the CFPS provided a better, more integrated foundation on the whole sub-national level of China. The complexity of China's national human capital development needs more profound evidence from provincial-level understandings.

3.7. Conclusions

This study, as we designed it, aims to demonstrate the trend of returns to education in China in the past two decades. By utilizing the CHNS longitudinal data with Mincer and Lewbel approach, we estimate the return to years of schooling and educational attainment, respectively. Since former studies on returns to education in China, the literature focused on one or two specific years or generated results on-trend. Still, it did not simultaneously estimate returns to education years and attainment. This study is a good supplement to the literature and carries out several solid conclusions.

On the one hand, the overall trend shows that the eighth curriculum reform significantly upgraded the return to years of schooling in the 2000s. The market demand was also gradually fulfilled by quality-improved educational attainment. On the other hand, controlled variables on gender, work issues, and estimation of academic attainment margins reflected external and internal impacts on China's human capital development.

Externally, we observed the influence of the gender gap issues, which are still generating inequality problems. We also see the private sector market and large companies' advantages and market preference for knowledge-intensive labor. The internal impact uncovered by education margins shows positive trends during educational attainment growth. We see improvements in higher education that generate more margins on wages and more opportunities to accept the vocational degrees offered by the fast-developing market. Although long-term returns to education may not remain the same in the future, the positive effect of sustainable education investment from various sources shouldn't be ignored.

We realize that human capital development in China needs more comprehensive studies like education investment distribution and health factors. Our future study will focus on provincial-level human capital research by estimating education policy, health issues, and economic influences. These perspectives will help us understand and project future macro policy development in China from the human capital side.

Chapter 4 Measuring Human Capital at the Sub-national Level: A New Index for China

4.1. Introduction

The discussion on forming a useful human capital index has gone on for decades. Some early studies focused on the contributions to human capital accumulation. Education researchers gradually utilized education factors such as average years of schooling, return to education, or student test scores as proxies to represent the human capital performances in some regions. Meanwhile, when health and medical researchers tried to establish cross-studies between human health and development, they selected life expectancy as a representative from their point of view. However, scholars have known from the beginning that human capital should not be measured with any one-dimensional proxies as they may generate biases in the overall human capital performances in a certain area. After decades of exploration, several well-designed solutions have been introduced to the literature. However, we can still find shortages and weaknesses when we attempt to push our research into China's human capital development research. To provide more aggregated human capital research on China's subnational level, we originally established our human capital index based on China's provincial level.

We have learned to establish a comprehensive human capital index. Critical components should be emphasized with great caution. Following the World Bank (2018, 2020) method, we can easily find a proper framework to target the sub-indexes in China. However, we should also avoid the shortages mentioned in the World Bank methods (Kraay, 2019). We also need to involve quality-based measurement from education and health perspectives. As Filmer et al. (2020) highlighted: schooling is not the same as learning. Although there is already a J-F method estimated human capital index that has been created for China introduced by the CHLR team, we would still like to use this new index-based method to provide a supplementary human capital index on China's subnational level.

This chapter begins with the primary issue of human capital measurement by providing new attempts at fixing shortages of existing methodologies and offering an aggregated index-based human capital calculation approach. The rest of the chapters shall be arranged thus. A literature review on human capital measurements will be given in section two. Section three mainly discusses the methodology for establishing this new subnational human capital index. Section four will offer the essential data description of all the data utilized and how we pre-process them. Overall results, components contributions, and the final selection of the human capital index will be explained in section five. Section six will provide an integrated discussion, discuss limitations, and conclusions.

4.2. Literature Review

As we mentioned in the introduction, there are several solutions to human capital measurement. Schultz (1961) and Becker (1962) presented the idea of human capital by highlighting the importance of intangible capital effects. Calculating various investment channels for humans was a considerable step for economists to understand social development differently. Motivated by his valuable work, much research has focused on evaluating human capital for a specific region.

On the one hand, the lifetime income estimation methodology (J-F method) established a comprehensive model containing the most crucial components in human capital research with easily understandable results. However, we also meet the barriers to finishing the process and replicating the model in many scenarios. The J-F method requires enormous data sources and a complicated calculation process as a lifetime income model. It may also weaken the correlation between human capital performance with economic indicators with its procedure. From the existing literature, there is always a dilemma between the ease of calculation and informative results, from the recent OECD (Égert et al., 2020) study to the World Bank's attempts with their Human Capital Project (World Bank, 2018, 2020). They all have advantages in developing several ideas and estimating the human capital index. However, there is always part of the methodologies compromised in the result. This paper may not directly fix this issue, but it is still possible for us to push this solution one step forward.

On the other hand, learning from the HDI created by the UNDP (2016), we choose life expectancy as the leading representative of the health sector. However, many studies argue that the quality of education can affect the schooling years in different regions (Filmer et al., 2020). According to the Learning Adjusted Years of Schoolings (LAYS) studies, students' test scores can reflect the quality difference among regions which can be used to create score rankings and formulate LAYS. The human capital index published by World Bank has also implemented the same idea to adjust education years for each country according to global student test scores. We agree with this idea, and we start to push this concept further by considering the quality of the health sector in different regions, which can affect human capital's real productivity in the health dimension. There is also a potential problem in the existing human capital index final calculation from each sub-index to the aggregated index. Since the World Bank and the UNDP multiply each sub-index to finish the final calculation, we want to use the principal component analysis to weigh the education, health, and survival index. We believe that it can offer a more reasonable human capital index.

For this section of the dissertation, we want to demonstrate the human capital measurement approaches by providing specific solutions to motivate human capital research. The literature discussed above can represent the most advanced solutions.

4.3. Methodology

Two parts of the methodologies will be explained explicitly in this section. The new method we established for calculating the human capital index will be discussed first, and the club convergence approach will be stated right behind.

The existing method in the literature for human capital index calculation mainly agrees with the three dimensions as the main components: education, health, and survival index. According to World Bank's Human Capital Project, these sub-indices can be estimated separately.

4.3.1. Education Index

$$\ln Y_i = \alpha_1 + \beta_1 S_i + \varepsilon_i \tag{4-1}$$

This is also a Mincer-type equation (Mincer, 1974) for Y_i denotes natural logarithm individual wages and S_i represents the schooling years. This equation is targeted to derive each province's household datasets' return to schooling years from 2010 to 2018. β_1 is what we will reserve for further calculation since it represents the result of the return to schooling years.

Next, each province's average years of schooling will be calculated through equations 4-2. The provincial-level statistical yearbook can offer the source data. The overall samples are based on a 1% census according to the definition of yearbooks.

$$Average\ Yeas\ of\ Schooling(AYS)_{i,t} = \frac{\sum_{i,t}^{n} Population_{i,t} \times Yeas\ of\ Schooling_{i,t}}{\sum_{i}^{n} Population_{i,t}} \quad (4\text{-}2)$$

By multiplying the population and years of schooling in each degree, each province's aggregated years of schooling can be calculated. Then subtract these aggregated years of schooling by the total population for each year, and the average years of schooling for province i and year t could be recorded. However, the concept of LAYS was suggested by Filmer et al. (2020), which World Bank also utilizes. Similar education-quality-based years of schooling adjustment indicators should also be used. By implementing the Best China University Rankings provided by ShanghaiRanking Consultancy (ARWU, 2019), the comparable idea of LAYS can be calculated through the following equation 4-3:

$$R_i^b = \frac{L_i}{L_b} \quad (4\text{-}3)$$

Specifically, R_i^b represent the ratio of the education quality per year for province i over benchmark province b. L_i denotes each province's education quality scores while L_b stand for the benchmark province in that year. This means that the highest ratio will be one, and all the R_i^b will lay between 0 and 1. According to Best China University Rankings, the education quality here for each province can be divided into two categories: universities' overall ranking scores and the standardized students' test scores for college entrance exams for each university. The details of these two adjusted scores for each province will be specified more precisely in the following data section.

With the generated ratio for adjusting years of schooling, the education quality-adjusted years of schooling could also be presented as:

$$Adjusted\ AYS = Average\ Years\ of\ Schooling\ *\ R_i^b \tag{4-4}$$

By simply multiplying two variables, the adjusted AYS is ready for the final calculation of the human capital subindex on education. Equation 4-5 shows the step.

$$I_{Education} = \mathrm{e}^{\beta_1(Adjusted\ AYS - 12)} \tag{4-5}$$

Following the similar idea of the World Bank's human capital calculation, we also subtracted proper years of education benchmarks for 12 years since China's child should averagely obtain 12 years of education by age 18.

4.3.2. Health Index

In the case of the health dimension, we replicated a similar approach to education. Here you can see the whole computing process with all the equations.

$$\ln Y_i = \alpha_2 + \beta_2 E_i + \beta_3 E_i^2 + \varepsilon_i \tag{4-6}$$

$$\theta = \frac{1 - Residents'\ Hospitalization\ rate}{1} \tag{4-7}$$

$$Adjusted\ Life\ Expectancy\ =\ Life\ Expectancy \times \theta \tag{4-8}$$

$$I_{Health}\ =\ \mathrm{e}^{\left(\beta_2(Adjusted\ Life\ Expectancy - 85) + \beta_3(Adjusted\ Life\ Expectancy - 85)^2\right)} \tag{4-9}$$

Using each province's life expectancy across the years, we can multiply it with the regressed return to experience from the same household survey. You can see Y_i denotes natural logarithm individual wages and E_i denotes the experience of individuals. Similarly, we managed to offer a health quality adjustment approach as the counterpart to the previous education-quality-based adjustment because of the health quality disparities. The residents' hospitalization rate of each province across years is involved here to set the adjustment factor, and θ is the generated health quality ratio (equation 4-7). The health factor I_{Health} is estimated with the same form and with an 85-year-old benchmark of life expectancy.

4.3.3. Survival Index

The final subindex of the human capital index is the survival rate. Unlike the World Bank, which can collect under 5-year-old mortality rates, China's subnational mortality rate under 5 is not accessible to us. As a replacement, we calculate the survival rate with the following equation 4-10:

$$I_{Survival} = \frac{1 - Mortality\ Rate}{1} \tag{4-10}$$

We used the overall mortality rate for the population, which contains the child's and adults' survival in one variable. Although all the sub-indexes are now provided, we still have to decide how to merge them for an improved human capital index for China's subnational level.

4.3.4. Discussion on Aggregating the Final Index

As required, several available approaches aggregate those three sub-indexes into the human capital index. The most straightforward example is the World Banks' example (Kraay, 2019), as they multiply three sub-indexes together. Another example of merging the sub-indexes is the UNDP's HDI, which calculated the components' geometric mean. These two methods only differ in the geometric mean approach, while the main body of the index combination has multiplied them. In our opinion, they all ignored the contribution of each sub-indexes to the final merged index.

By understanding the shortages and potential bias of the existing approach in the literature, we decided to run a principal component analysis for three sub-indexes. The different factor loadings for components can let us know the proportion of their contributions and help us merge them together into the final human capital index by weight.

$$Component\ Index_i = I_{Health} \times \gamma_{i1} + I_{Education} \times \gamma_{i2} + I_{Survival} \times \gamma_{i3} \quad (4\text{-}11)$$

$$Human\ Capital\ Index = \frac{\sum_{i=1}^{n} Component\ Index_i \times Component\ Proportion_i}{Cumulative\ Ratio_n} \quad (4\text{-}12)$$

The final aggregation process follows equation 4-11 and 4-12. The component index denotes principal components, and γ represents the component loadings for each sub-index. Component proportion and cumulative ratio stand for the overall contribution of the estimated principal components.

The calculation method will present the human capital index as an absolute number, which means the final index is not harmonized between 0 and 1. By definition, this new human capital index is a standardized income generated by education, health, and survival status. By remaining the absolute index numbers, the development of each province can be demonstrated, and the relative gaps will also be reflected.

4.4. Data

The data for estimating the human capital index is collected through different sources. There are three dimensions in total, as we can see. However, we can define two categories from the data's property: Household survey data and macro data. Household data are used for regressing return to schooling years and return to experience. The macro data are those education and health variables that can be found through the official websites and China statistical yearbook. Further, this section will also discuss the quality-based adjusted schooling years and health demand for pre-processing from its raw datasets.

4.4.1. Data Description

First, we utilized a household survey to estimate the return to years of schooling. The CFPS, funded by the Chinese government and led by Peking University, is one of the suitable choices here. Since it can provide the most comprehensive and high-quality data after 2010, we can estimate the return to education and return to experience for almost every province in 2010, 2012, 2014, 2016, and 2018. But some western provinces were not available due to data shortages. We interpolate data to provinces with missing values by using their geographical location neighbouring's similarity.

For the second part, we obtained educational attainment populations in each province for each year from China Statistical Yearbook. The years of schooling of different degrees have been set as follows: College education and higher equals 16 years, senior secondary school is 12 years, junior secondary school is nine years, elementary school is six years, and illiterate for 0 years. As for the education quality adjustment indicator, the data are collected from Best China University Ranking from ShanghaiRanking Consultancy. They provide consistent rankings with a similar ranking method from 2015 to 2019. After 2020, since the calculation rules have changed, it is forcing us to use the ranking data from 2015 to 2019. For data before 2015, we did a simple regression using the data from 2015 to 2019. We traced it back to 2010 for each province.

Meanwhile, the Best China University Ranking can provide us with two ranking scores related to education quality issues. One is the ranking score for each college's comprehensive performance, and another is the sub score of the college students' entrance exams relative to yearly scores. Although this student's college entrance exam relative score is a part of the overall Best China University Ranking score, it is more correlated to the education quality since the test scores are the foundation of this indicator. The LAYS originally required the test score of different regions.

The health dimension used the return-to-experience regression result from the CFPS dataset and required provincial macro data from various statistic yearbooks. Life expectancy is the key variable in this dimension since it denotes a province's expected length of age and working experience. We also collected it from China Statistical Yearbook, as it is the most widely accepted official macro dataset released by the Chinese government. However, due to the subnational level's life expectancy only getting collected every ten years, we can only use the existing data in 1990, 2000, and 2010 for each province and did another regression to project the life expectancy from 2010 to 2018. As for the health quality adjust indicator, we involved the residents' hospitality rate in each province since we assume that a higher hospitality rate indicates lower health quality in the area. In standard situations, individuals who stay in the hospital for treatment or operation cannot be seen as productive. Lastly, we collect the survival rate from the China statistic yearbook using the overall mortality rate.

Table 4-1 Basic Data Description

Variable		Mean	Std. dev.	Observations
Return to Years of Schooling	overall	0.076511	0.024154	Observations = 279
	between		0.008444	Provinces = 31
	within		0.022676	Time (Years) = 9
Average Years of Schooling	overall	8.982295	1.123447	Observations = 279
(Without any adjustment)	between		1.116978	Provinces = 31
	within		0.224494	Time (Years) = 9
Best Chinese Universities Ranking Score	overall	6.915826	1.757707	Observations = 279
Adjusted Years of Schooling	between		1.723284	Provinces = 31
(With all listed colleges)	within		0.453086	Time (Years) = 9
Best Chinese Universities Ranking Score	overall	5.356182	1.969647	Observations = 279
Adjusted Years of Schooling	between		1.972015	Provinces = 31
(Top 3 colleges in each province)	within		0.320269	Time (Years) = 9
Best Chinese Universities Ranking Score	overall	5.110224	2.109826	Observations = 279
Adjusted Years of Schooling	between		2.113361	Provinces = 31
(Top 1 college in each province)	within		0.337042	Time (Years) = 9
College Entrance Exams Relative Score	overall	5.972829	2.185627	Observations = 279
Adjusted Years of Schooling	between		2.18471	Provinces = 31
(Top 3 colleges in each province)	within		0.375974	Time (Years) = 9
College Entrance Exams Relative Score	overall	6.216781	2.249309	Observations = 279
Adjusted Years of Schooling	between		2.260617	Provinces = 31
(Top 1 college in each province)	within		0.309936	Time (Years) = 9
Projected Life Expectancy	overall	76.12654	3.12761	Observations = 279
	between		3.034856	Provinces = 31
	within		0.914678	Time (Years) = 9
Return to Experience	overall	0.027319	0.003597	Observations = 279
	between		0.003519	Provinces = 31
	within		0.000957	Time (Years) = 9
Return to Squared Experience	overall	-0.07692	0.001894	Observations = 279
	between		0.001852	Provinces = 31
	within		0.000507	Time (Years) = 9
Residents' Hospitality Rate (%)	overall	14.12853	3.687948	Observations = 279
	between		2.761244	Provinces = 31
	within		2.489157	Time (Years) = 9
Mortality Rate (‰)	overall	6.010717	0.773788	Observations = 279
	between		0.733665	Provinces = 31
	within		0.275631	Time (Years) = 9

Source: Author's calculation using the data from the CFPS, China Statistical Yearbook, China Health Yearbook, and Best Chinese Universities Ranking.

Table 4-1 shows the basic description of all the possible data we will discuss in this section. Some of them are the middle outcome during the calculation process, which needs further discussion. We can first build a general idea of all the variables from this basic data description. The return to schooling years is 0.07 on average, which is a reasonable number according to the research on China’s return to education. A more significant standard deviation can be observed within the provinces than between, which indicates the changing trend of the return to education for provinces is more fluctuated. You can also see six different average years of schooling in the table. They are a series of mean variables for estimating the education quality-adjusted years of schooling. The first one is the original average years of schooling, representing the nominal annual years of schooling in different provinces. Three Best Chinese Universities Ranking scores adjusted years of schooling variables are behind the original data. They are calculated from the entire listed university's average ranking score for each province, the top three universities' average ranking scores in each province, and the top one university in each province.

Meanwhile, we also calculated two different college entrance exams' relative scores adjusted for average years of schooling, which involves the top three and top one universities’ students' college entrance exams comparable scores separately. The data description shows a descending trend from the original average years of schooling to the adjusted years of schooling. The lowest mean in the top one university is ranking score-adjusted average years of education. Higher standard deviations are observed between provinces in all six variables, indicating unequal education resources distributed across the provinces.

We obtained these six different years of schooling for three reasons: First of all, we are interested in the changes between the original average years of education and the adjusted variables. Second, the overall average methods may bias the adjusted indicator because of the different scales of the Best Chinese Universities Rankings in each year and province. The actual rankings in 2015 show fewer universities, while more and more universities and colleges are listed after 2017. Finally, universities' comprehensive rankings scores may also be recognized as an education quality alternative to testing scores. As for how to correctly choose these six different middle variables, we will raise the discussion in the pre-processing data section.

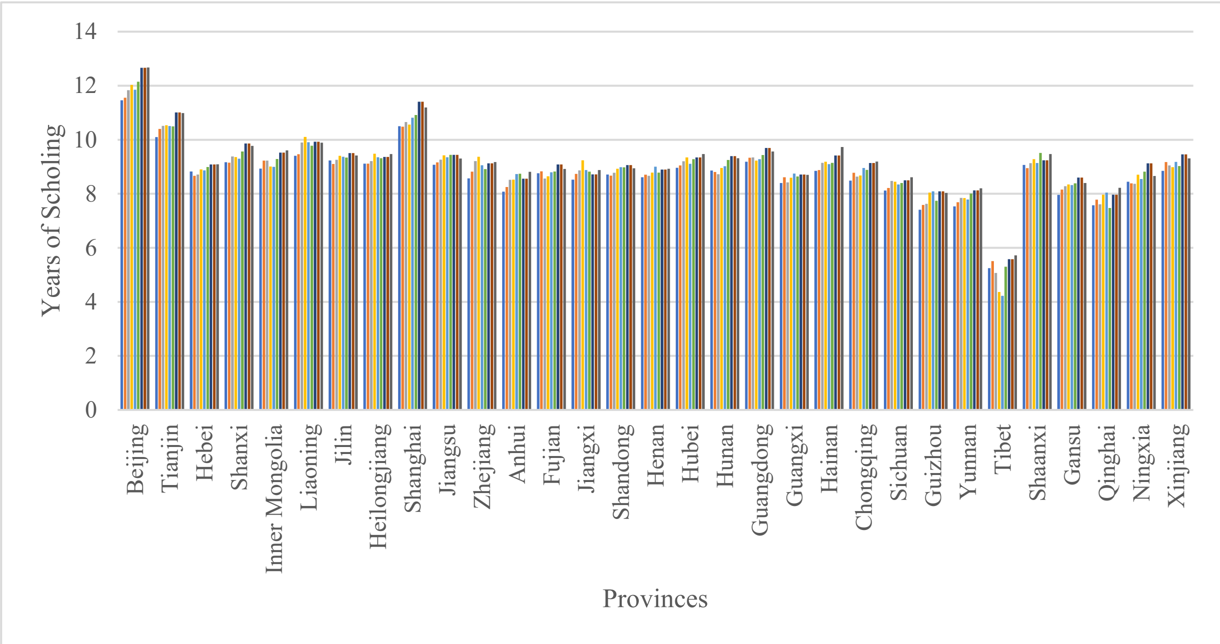
The life expectancy shows a 76-year-old as the mean value of all the provinces, while the standard deviation indicates the variance between provinces is more prominent than their changes. A 0.027, the return to experience shows a bit lower level than the overall regression result, demonstrating up to 0.04 in 2010. But it still makes sense because of China's unbalanced provincial development. Standard deviation also supports the same idea. On health quality indicators, the residents' hospitality rate shows that 14% of residents never see a doctor in the hospital and stay for concerning treatments or operations. The final variable is the mortality rate, the raw data for calculating the survival rate and average 6‰ mortality rate shows a normal level in total. But the standard deviation reflects a giant variance between provinces, pointing to the same unbalancing problem across regions.

4.4.2. Data Pre-processing

One of the essentials of data pre-processing is to decide which adjusted average years of schooling should be used to calculate the human capital index. Meanwhile, all three sub-indexes should be calculated in this section, for we need to estimate their contributions in the final index.

In what follows, we will present bar charts to show the trend of different average years of schooling for six categories.

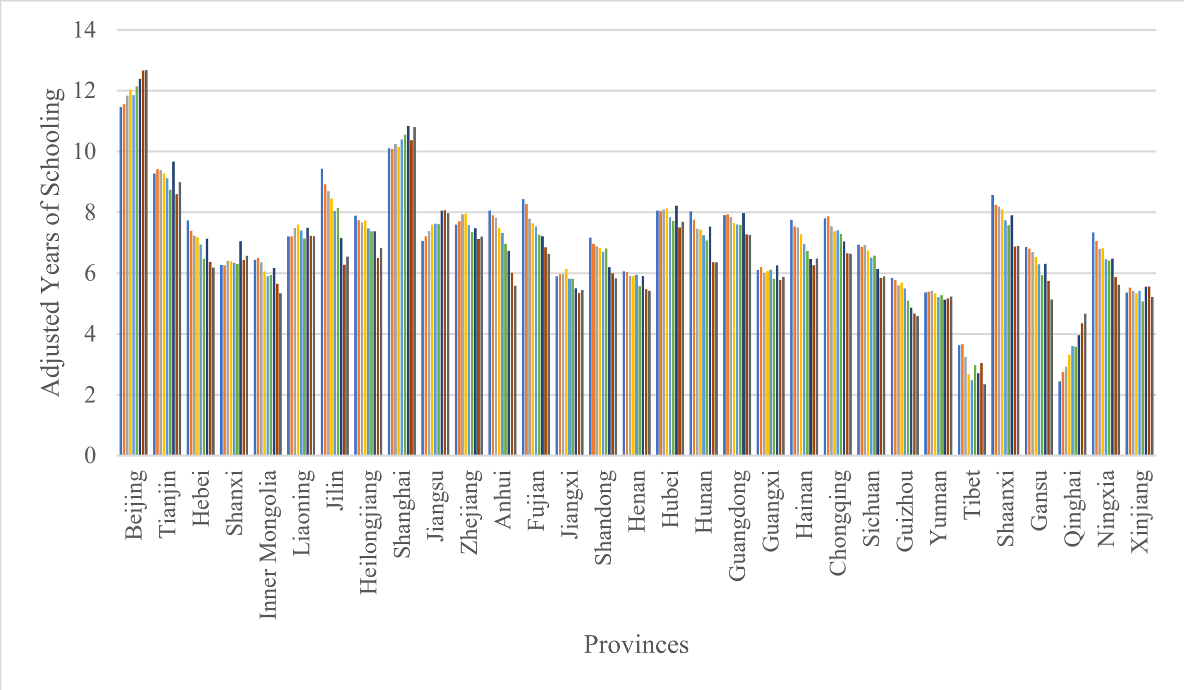
Figure 4-1　Average Years of Schooling (2010 to 2018)



Source: Author's construction using the data from China Statistical Yearbook (National Bureau of Statistics of China, 2010-2019).

The original average years of schooling illustrated in Figure 4-1 show an overall increasing trend in most provinces from 2010 to 2018. Only Tibet appears to have decreased sharply in 2013 and 2014 but bounced back to its previous growth pattern after 2015. Meanwhile, we can observe Beijing as the most advanced area with high years of schooling. Tianjin and Shanghai are right after Beijing as they both show higher performance than other provinces but only lower than Beijing.

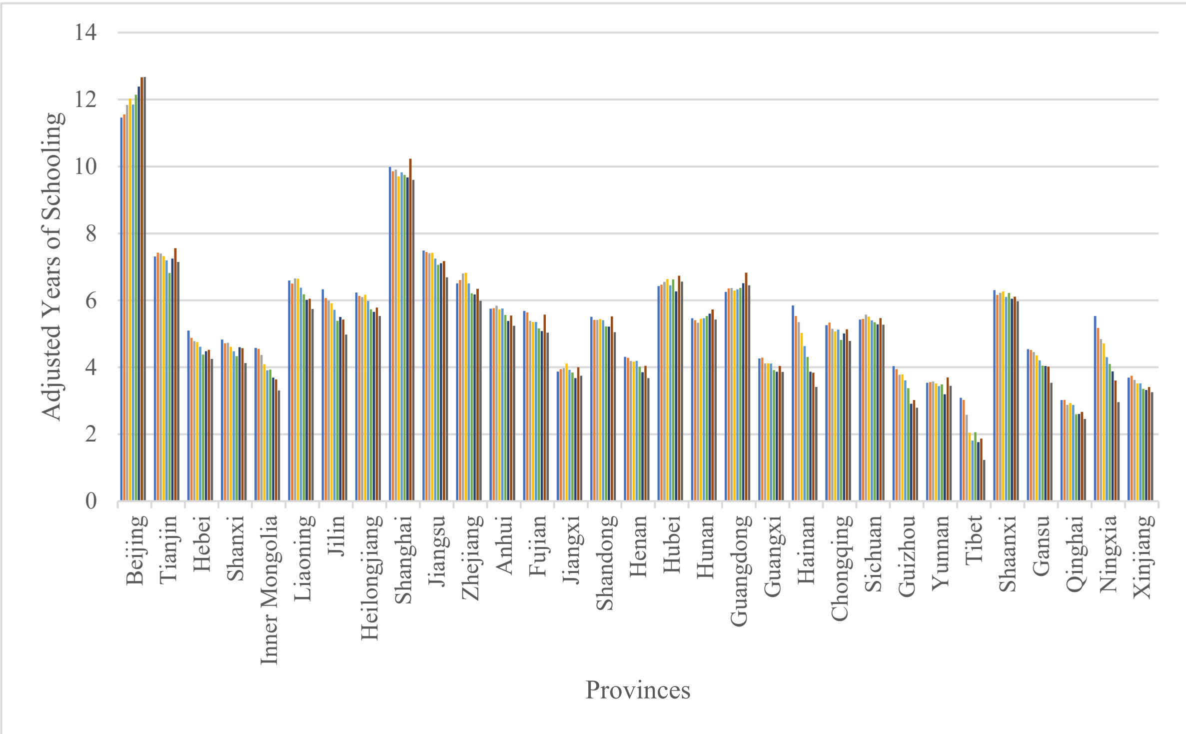
Figure 4-2 Best Chinese Universities Ranking Score (All listed Schools' Average)



Source: Author's construction using the data from China Statistical Yearbook (National Bureau of Statistics of China, 2010-2019) and Best Chinese Universities Ranking (ARWU, 2019).

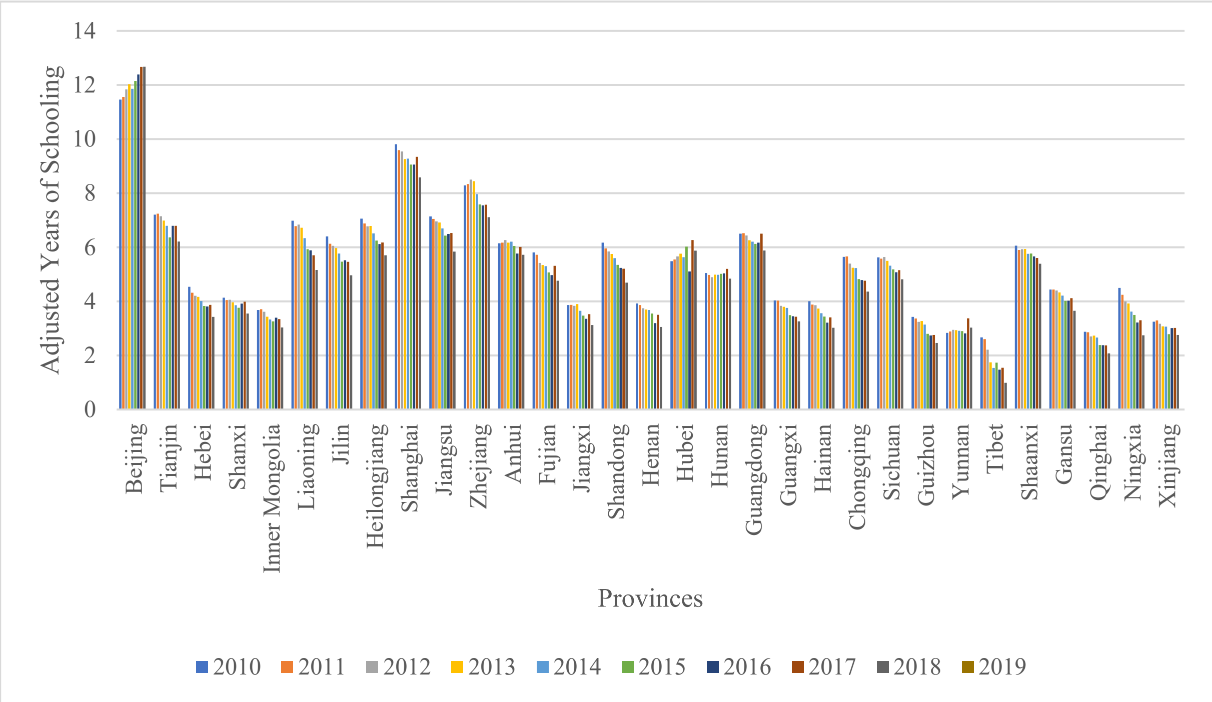
The all-listed universities ranking average scores adjusted for average years of schooling reflected a very different trend from the original data. While Beijing maintained its trend because of the highest scores over time, only Shanghai, Jiangsu, and Qinghai still show a rising trend of years of schooling during the same period. Most provinces are decreasing under this adjustment, which is unreasonable compared to reality. We have been concerned about this because the original Best Chinese Universities Ranking sizes changed from 2015 to 2018. With more universities and colleges involved in the list, the overall average for all the listed colleges is lower across the same period. The projection on the adjusted indicator before 2015 will enlarge this bias, generating a negative correlation during the years. Therefore, most of the provinces show decreasing trend under this circumstance. We can decide not to use this biased result in the subsequent calculation step, and we still have two approaches to deal with this comprehensive university ranking scores. As we can see from the data description (Table 4-1), we chose the top three and top one universities' ranking scores as an indicator of average years of schooling adjustment. Figures 4-3 and 4-4 are the visualized data.

Figure 4-3 Best Chinese Universities Ranking Score (Top Three Schools' Average)



Source: Author's construction using the data from China Statistical Yearbook (National Bureau of Statistics of China, 2010-2019) and Best Chinese Universities Ranking (ARWU, 2019).

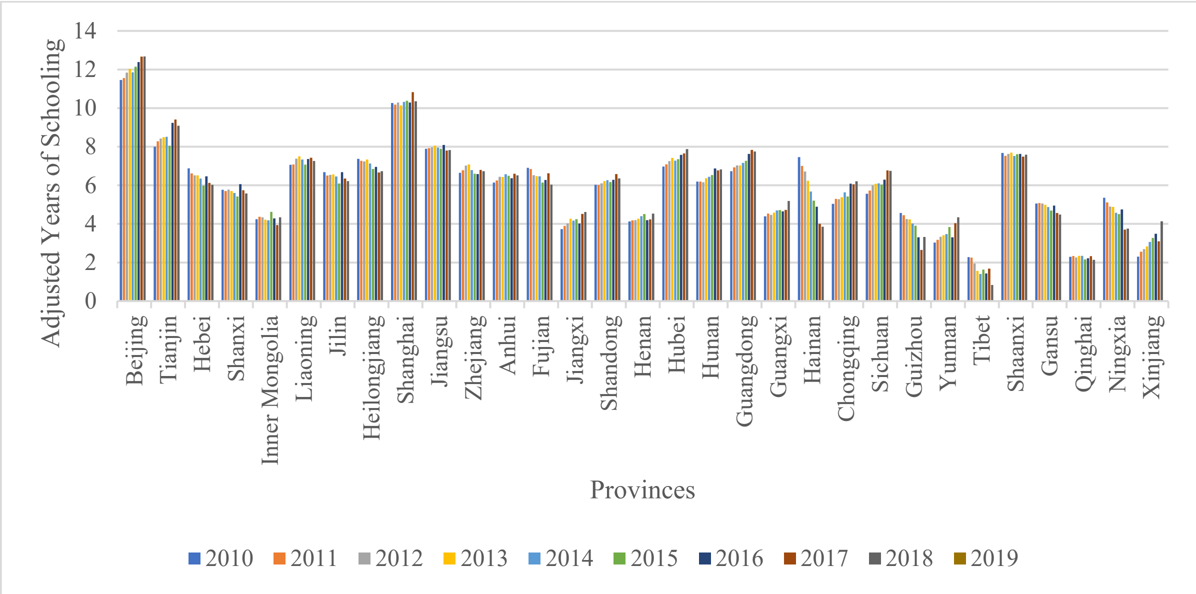
Figure 4-4　Best Chinese Universities Ranking Score (Top One Schools' Average)



Source: Author's construction using the data from China Statistical Yearbook (National Bureau of Statistics of China, 2010-2019) and Best Chinese Universities Ranking (ARWU, 2019).

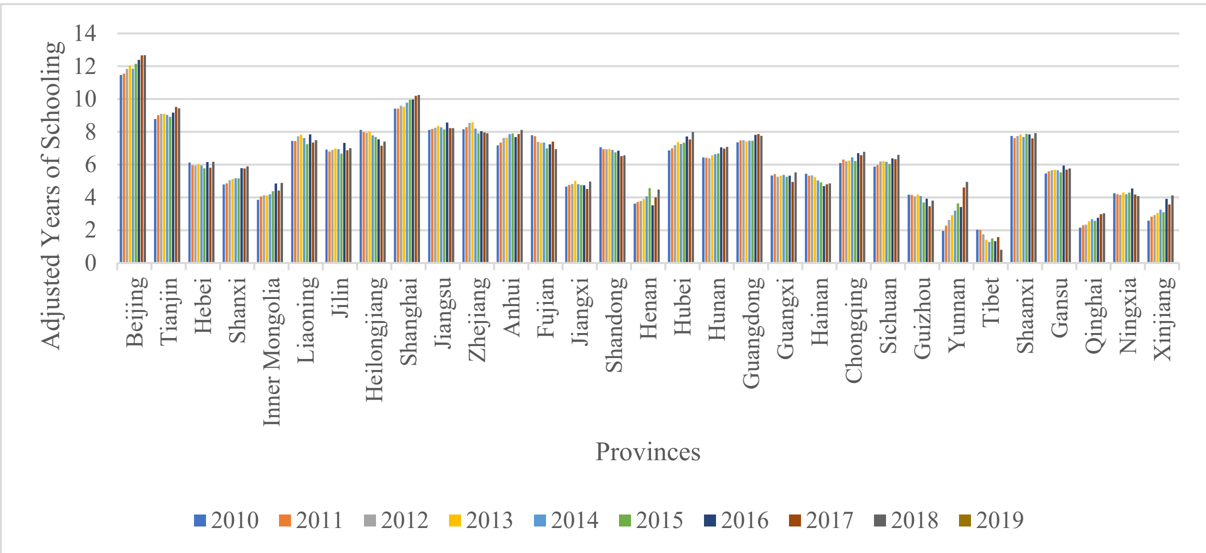
These two figures show that university ranking scores may offer a more significant gap for education-quality-based adjusted years of schooling in our human capital research. The top three and top one universities' average ranking scores adjusted for average schooling years generate a more descending trend among the provinces. Despite Beijing's top performance all around the time, no other areas experienced a steady incremental development from 2010 to 2019. Only a few provinces, such as Hubei, Hunan, Guangdong, and Yunnan, maintained flats for the duration. In contrast to the ranking score adjustment, the college entrance exam relative scores in the following figures seem to be more reasonable in the way of adjusted years of schooling trends for provinces.

Figure 4-5 College Entrance Exams Relative Scores (Top Three Schools' Average)



Source: Author's construction using the data from China Statistical Yearbook (National Bureau of Statistics of China, 2010-2019) and Best Chinese Universities Ranking (ARWU, 2019).

Figure 4-6 College Entrance Exams Relative Scores (Top One Schools' Average)



Source: Author's construction using the data from China Statistical Yearbook (National Bureau of Statistics of China, 2010-2019) and Best Chinese Universities Ranking (ARWU, 2019).

Figure 4-5 and Figure 4-6 demonstrate a more reasonable adjusted average education years in each province within the period. Descending trend is not the major pattern across the provinces anymore, and more than half of the cases are at least maintained their steady status. The difference between these two figures is still the sample size. Since the overall sample size's average result is biased, we directly use the top three and top one university student relative entrance exam scores for further computation. The biggest difference in the outcome is that, with the top 3 schools contained, the gap between the highest and lowest level of education is more diminutive than standardized by only the top one university. The top universities' variance may trigger this in different provinces related to the group effect. Advanced universities in coastal and capital regions are far more densified than in western, northern, and some central provinces. Some provinces like Tibet, Qinghai, and Ningxia can only count as one or two schools in the overall list, but the gap between their top universities to other provinces like Beijing and Shanghai is too large to be compared. In the meantime, their top universities can only represent their upper bound of education quality in those advanced provinces around the capital or coastal areas. The actual student ability is far lower than that limitation. To conclude the choice from these different adjusted average years of schooling variables for human capital index formation, we decide to utilize the top three universities' college entrance exams' relative scores as education-quality-based years of schooling indicator.

Table 4-2 Data Description of Pre-processed Variables

Variable		Mean	Std. dev.	Observations
Education Sub-index	overall	0.799251	0.090177	Observations = 279
(Average Education Years)	between		0.065975	Provinces = 31
	within		0.062486	Time (Years) = 9
Education Sub-index	overall	0.619167	0.128986	Observations = 279
Adjusted Years of Schooling	between		0.098516	Provinces = 31
(Top 3 colleges ranking score)	within		0.08492	Time (Years) = 9
Education Sub-index	overall	0.648726	0.135532	Observations = 279
Adjusted Years of Schooling	between		0.105861	Provinces = 31
(Top 3 entrance exams score)	within		0.086515	Time (Years) = 9
Education Sub-index	overall	0.660202	0.137275	Observations = 279
Adjusted Years of Schooling	between		0.108554	Provinces = 31
(Top 1 entrance exams score)	within		0.08602	Time (Years) = 9
Health Sub-index	overall	0.58123	0.11771	Observations = 279
Adjusted Life Expectancy	between		0.107763	Provinces = 31
(Residents' Hospitality Rate)	within		0.050763	Time (Years) = 9
Survival Sub-index	overall	0.993989	0.000774	Observations = 279
	between		0.000734	Provinces = 31
	within		0.000276	Time (Years) = 9

Source: Author's construction using the data from China Statistical Yearbook (National Bureau of Statistics of China, 2010-2019) and Best Chinese Universities Ranking (ARWU, 2019).

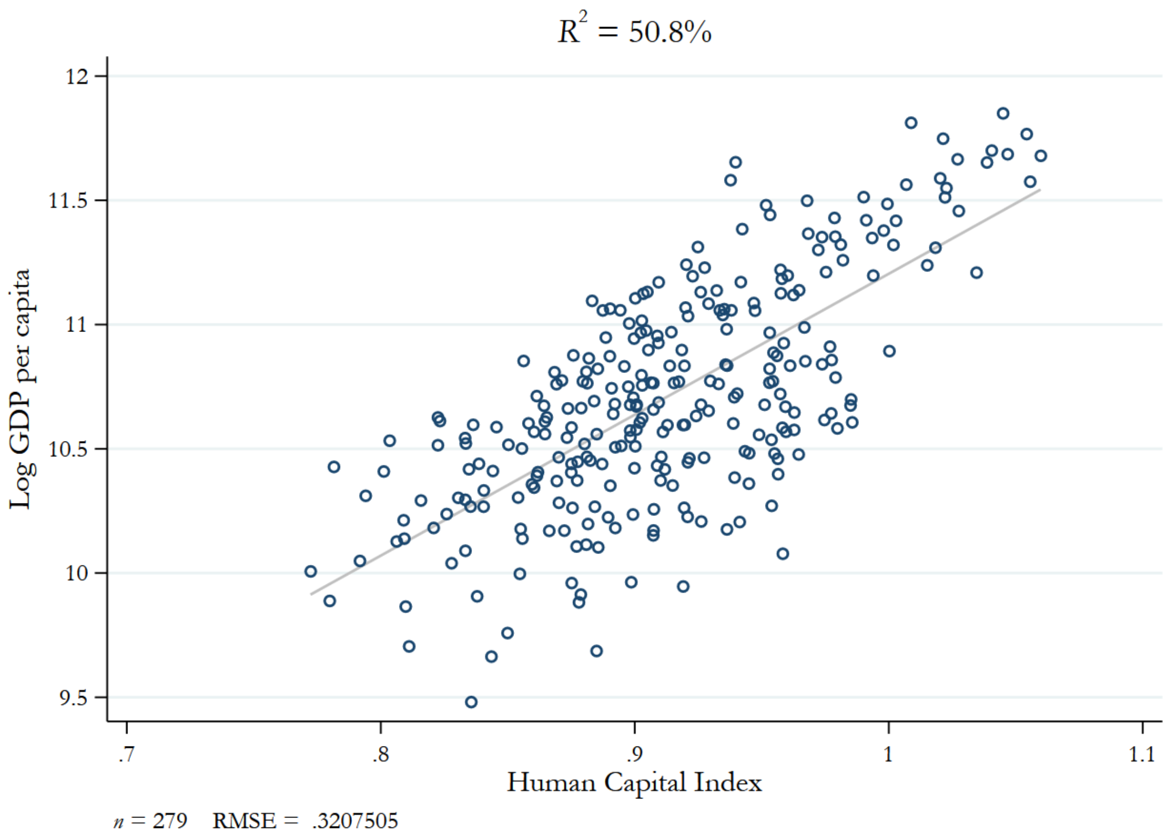
After properly discussing the pre-processing, we can summarize all the final variables in Table 4-2. It shows all the sub-index we can use to form the last human capital index at China's provincial level. The next section will specifically discuss the human capital index we created.

4.5. Results and Discussions

4.5.1. Final Selection of the Human Capital

After properly discussing the different appearances of the human capital index (Details can be seen in Appendix B), we can finalize our choices with one selection as a formal decision. Because of the quality-based measurement, we need to abandon the original average education years as components in the calculation. We have seen that it did not show better correlations to an economic indicator. Secondly, although the college ranking scores adjusted human capital index can demonstrate a higher correlation to GDP per capita, the abnormal gaps and fluctuations across provinces cannot convince us of a suitable choice.

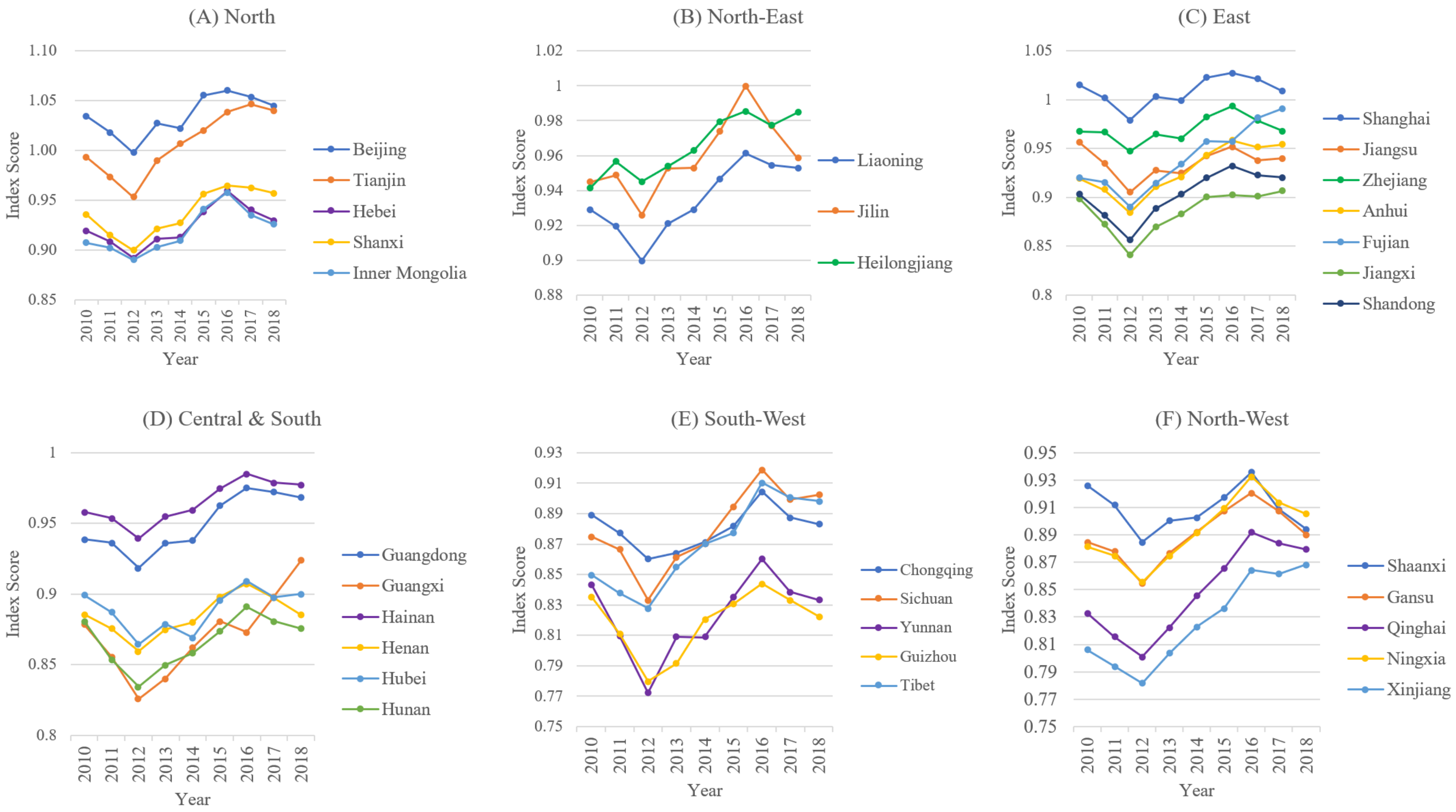
Figure 4-7 Log GDP per capita vs. Human Capital Index



Note: n means sample size. RMSE means Root Mean Square Error.

Source: Author's construction using the data from China Statistical Yearbook, Best Chinese Universities Ranking, and the newly created Human Capital Index in this chapter.

Figure 4-8 Human Capital Index Trends from 2010 to 2018



Source: Authors' construction using the data from the Human Capital Index created in this chapter.

We used the top three average score versions as our formal human capital index. From Figure 4-7, you can see a significant relationship between this new human capital index and log GDP per capita. The details of the human capital index trend are provided in Figure 4-8.

4.5.2. Human Capital Index Description

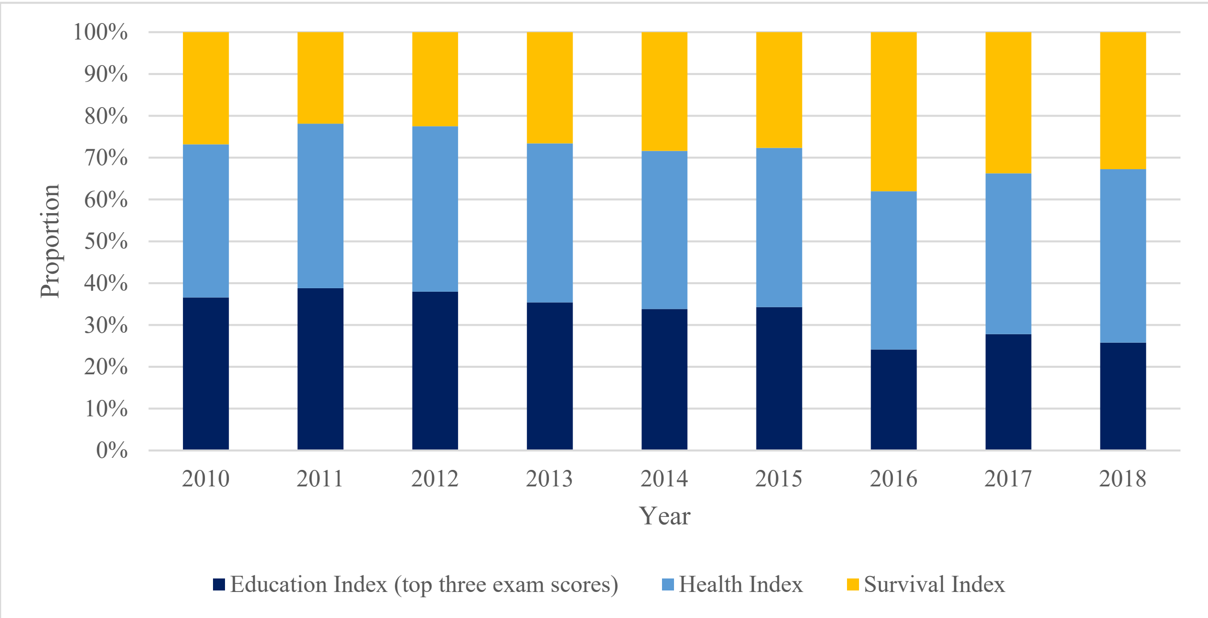
We divided all 31 provinces into six groups according to China's administrative geographical zones. A common trend shared by most of the provinces is that the twist and turns occurred in 2012 and 2016. The main reason for such changes in the human capital accumulation trend could result from several different reasons, such as the impact of economic cycles, financial crisis and recovery, and policies related to human capital cultivation. We would not specifically discuss the reasons behind such changes in this paper but reserve them for future research.

However, we can still see the difference among different provinces. Beijing, Tianjin, and Shanghai hold the best human capital performance in this period, while Guizhou, Yunnan, Qinghai, and Xinjiang are on the opposite side. We can also see a very common pattern in all the groups. Several provinces have always hugely outperformed the rest of the group members. From the view of development, it usually happens because of the combined effect. Since human capital is more likely to choose to flow to those cities and areas which have more opportunities, it can drastically accelerate the process of urbanization and industrialization. Within such a pattern, there are also two different results, divergent and convergent development for a certain geographical group. The divergent trend may have happened in the north and southwest groups, while the northwest group is more likely to have a convergent effect.

4.5.3. Key Components of Human Capital Development

We have already obtained three dimensions for calculation from our human capital index formation process. However, these components may not be constantly productive with the same ratio. According to the aggregating methodology, each component index has its factor loadings through the Principal Components Analysis (PCA) calculation process. The integrated human capital index will be decomposed into component contributions separately by estimating their factor loadings each year. Figure 4-9 shows the trend of the three components' different contributions over time.

Figure 4-9 Trend of Components Contributions to Human Capital Over Time



Source: Author's construction using the PCA results from the Human Capital Index, created in this chapter.

From this figure, we can learn that, although education is admitted as the engine of human capital development and accumulation, it still contributed to the same level as health before 2012 in China. However, the clear trend of educational contributions decreasing after 2013, especially the sharp drop between 2015 and 2016, attracts more attention. We can also observe the increasing contribution of the survival index in the same period while the health index is basically maintaining its proportion of the contributions over time. It implies that the contribution of education to human capital accumulation decreased after 2015. However, health and survival are still widely demanded as they are the foundation of lives' long-term existence.

One of the possible reasons for the decline of education contributing to human capital development could be the transitional social requirement for an educated workforce. It is also the same effect we have found in return to education studies, which demonstrated the reduction of return to years of schooling around 2014. The contribution from the education index declines because of the delay effect. Another evidence supporting this phenomenon is that fewer students are enrolled in primary and secondary schools. The student-teacher ratio is also decreasing, and the number of secondary schools and the college admission rate has declined since 2015 (Guo et al., 2019).

On the contrary, rising survival and health indices contributions generate more curiosity. China's universal two-child policy was implemented in 2015, requiring more resources to help parents and families look after their new-borns. In 2016, China started to consider combining maternity insurance and basic medical insurance while cutting the maternity insurance rate to reduce business costs and enhance business vitality. Meanwhile, the poverty-eliminating policies are right under the critical point between the "12th Five-year-plan" and to "13th Five-year-plan" in 2016. Government and fundamental administrations are offering more resources and policy incentives to help poverty areas by strengthening the income level. While education is one of the long-term supportive factors, more health resources and infrastructures have started to help these areas sustain healthy development.

4.6. Conclusions

This chapter mainly explored the new method of measuring an improved human capital index at China's provincial level. By discussing the advantages and biases of the different choices of other existing methodologies and our calculation barriers, we provided an education and health quality double-based human capital index. And since it followed the basic idea of the World Bank's methodology, we can also expect further modification and implementation for extending the international comparison research on human capital with China's case.

The whole process of establishing such human capital index involved several sources of data and calculation methodology. As we expected, a specific return to years of schooling for each province annually can derive a more realistic education performance in the view of human capital research. So is the same as the return to working experience based on life expectancy. In the meantime, quality-based adjustment for education and health is also critical since they reflect the true outcomes instead of the nominal data. Finally, utilizing the principal components analysis helps us aggregate the sub-indexes with the dimensionality reduction method, which is more scientific than simple multiplication calculation.

For the main contribution of this chapter, the newly established human capital index illustrated a good correlation to GDP per capita provincially. Its components' contributions are also discussed, showing greater demand for health and survival, while education contributions are getting lower in China from 2010 to 2018. The trend of human capital development at China's subnational level is diversified but with some typical patterns from 2010 to 2018. This paper is the beginning of our whole series on China's human capital research, and we are devoted to providing more analysis and findings in the following chapters.

Chapter 5 Human Capital Imbalance in China: A Decomposition-based Convergence Analysis

5.1. Introduction

The recent literature on the subject have discussed quite a lot on China's geographically unbalanced human capital development issues. Mendoza et al. (2022) highlighted the significant challenges to China's sustainable human and economic development. We can also see the direct evidence from the CHLR's human capital index, which shows great gaps in human capital development across China, especially between urban and rural areas. Since China's geographical status determined the original unequal chances between eastern and western provinces, the fast growth in modern China after 2000 has forwardly enlarged the unbalancing effects. However, China and its "Five-year Plan" strategy have always been dedicated to helping restructure the industry by forcing the industrial up-gradation and making policies incentives to move supply chains from municipalities to the neighbouring undeveloped area.

On the one hand, it can help develop new markets and social impact locally. On the other hand, it can also reduce the overpopulation issues in municipal cities. Meanwhile, China's poverty-eliminating program also attracts massive attention. This program aims to offer support to rural areas through different channels. It contains universal fundamental education and local student nutritional lunch program, vocational skills training, infrastructure establishment, and paths between local products and markets in urban areas. From these different strategies in recent decades, we would like to make a more specific investigation into the human capital development inequality issues in China after 2010.

The main method used in this part of the research is convergence analysis. Convergence analysis, developed by Phillips and Sul (2007), can examine the cross-sectional variance ratio of human capital. It can further identify the subgroups among the samples and generate different clubs, reflecting the gaps between other areas. To push this inequality analysis forward, we will also use the convergence results on the original human capital index for a decomposition analysis by calculating a Kaya-Zenga index used by Wang et al. (2020) and Mendoza et al. (2022). It can help us clarify policy incentives' directions, potentially rebalancing the human capital index across China.

Finally, the human capital index we would like to use in this analysis will be the one we selected from Chapter 4. It will help us generate a convincing result from convergence analysis and the Kaya-Zenga index. The following sections in this chapter will be organized: Section 2 will mainly discuss literature findings. Section 3 will focus on methodology explanations, while section 4 will provide a quick view of the human capital index original data. Section 5 will be the main results of club convergence and the Kaya-Zenga index analysis. The conclusion will be presented in section 6.

5.2. Human Capital and its Convergence Analysis in China

There are several types of convergence research on human capital using different concepts. As we have already learned from the literature, using β-convergence and σ-convergence, human capital can be estimated with typical assumptions and premises on stationarity for controlling heterogeneity across areas and time (Coulombe, 2003; Coulombe & Tremblay, 2001). However, implementing the variance ratio with the econometric method developed by Phillips and Sul (2007) allows us to illustrate the development of human capital over time and explore the transition process of human capital at China's subnational level (Mendoza et al., 2022). the model developed by Phillips and Sul can endogenously separate regions into groups that converge to various dynamic equilibria, such as convergence clubs, when overall convergence cannot be achieved within the panel datasets.

The major contribution of the previous studies on China's provincial human capital developments focuses more on regional differences with aggregated data. By comparing the coastal and western areas, urban and rural areas, and within-regions unbalanced human capital accumulation, the internal heterogeneity issue was examined through provinces' human capital disparities (Fleisher et al., 2010; Fraumeni et al., 2019; Li et al., 2014). Using the J-F method to calculate the human capital index (created by the CHLR), Mendoza et al. (2022) argued no overall convergence in human capital per capita and labor forces across all 31 provinces in China from 1985 to 2016. But subgroups' effect has been demonstrated. While several megacities remain at their top level of human capital development, most provinces are still significantly lagging. Several western provinces are even worse, showing an opposite trend with diverging patterns. The club convergence result provided by Mendoza's team warned that China's recent policy targets related to human capital may have been out of reach and exposed potential threats. To make a more specific and targeted analysis, this research is designed to focus on the club convergence result in the recent decade, which can reflect more issues within the middle of China's economic transition. Since we utilized our own human capital index from Chapter four, it can generate different convergence results compared to Mendoza's and provide us with more targeted findings related to human capital development contributors. A more general picture of the human capital imbalance in China can be illustrated by decomposing these contributors, such as education, health, and the economy.

5.3. Methodology

Three parts of this chapter's methodology will be explained in this section. Firstly, the original convergence hypothesis will be described. Secondly, we will present the club convergence analysis's main steps. Lastly, the Kaya-Zenga index's decomposing method will be discussed in detail.

5.3.1. Convergence Hypothesis and Condition

The club convergence approach is a more comprehensive way to demonstrate the human capital development trend. We involved the regression-based panel convergence test, and clustering algorithm originated from the work of Phillips and Sul (2007). it was also modified to discover the evolution and transitional dynamics of human capital across China's various provinces from 1985 to 2016 (Mendoza et al., 2022). This chapter is adjusted according to our human capital index to deliver better results.

This method sets the panel data X_{it} with a time-varying latent factor representation as to the following equation 5-1:

$$X_{it} = \delta_{it}\mu_{it} \tag{5-1}$$

Here we define X_{it} as the human capital index for province i in the year t. μ_{it} is a growth trend for the dynamic changes across each region while δ_{it} stand for time-varying factor loadings that are derived from the trend of μ_t for the transition pattern of each province. In the meantime, δ_{it} is also a coefficient that can contain all the atopic changes in the original panel data X_{it}. This equation 5-1 assumes that some particular factors can only achieve the dynamic balance of the human capital stock in each region. If δ_{it} converge to a simple constant when t is close to infinity. The target of examining the convergence of provinces over time can be reachable as its typical variance is dropped. The condition of the non-stationary transitional trend of δ_{it} need to be specified with the following equation (5-2) according to Phillips and Sul (2007):

$$\delta_{it} = \delta_i + \frac{\sigma_i}{\log(t)t^{\alpha}}\xi_{it} \tag{5-2}$$

ξ_{it} are independent and identically distributed between 0 and 1 for samples while not strongly dependent on t. σ_i denotes an idiosyncratic scale parameter, and α is the decay rate. It furtherly explains the particular form of the δ_{it} for its low speed of convergence to constant as t goes to infinity with α is not negative. The log(t) here for varying functions can generate a smooth change in the process.

Since the initial conditions have been set up, the null hypothesis of the convergence test should be:

$$H_0: \quad \delta_i = \delta \; for \; all \; i \; and \; \alpha \geq 0 \tag{5-3}$$

And the alternative for the test is:

$$H_1: \quad \{\delta_i = \delta \; for \; all \; i \; with \; \alpha \geq 0\} \; or \; \{\delta_i \neq \delta \; for \; some \; i \; with \; \alpha \geq 0, or \; \alpha < 0\} \tag{5-4}$$

The null hypothesis implies overall convergence for all provinces, assuming a more balanced and equally developed human capital with sustainability and inclusivity. Contrarily, the alternative hypothesis presents an opposite condition, which means no convergence or club convergence results can be achieved. It suggests that the different groups of the provinces share a similar dynamic convergence to equilibria, and at least one diverging region exists. This result may be more logically accepted for China's human capital development path.

5.3.2. The Log(t) test and Club Convergence Process

To estimate the factor loadings δ_{it}, the additional structure on δ_{it} and μ_{it} in equation 5-1 is required, according to Phillips and Sul (2007). A coefficient h_{it} is defined as deriving information from δ_{it}, which is designed to demonstrate the transitional trend of provinces to the overall panel average:

$$h_{it} = \frac{X_{it}}{N^{-1}\sum_{i=1}^{n} X_{it}} = \frac{\delta_{it}}{N^{-1}\sum_{i=1}^{n} \delta_{it}} \quad (5\text{-}5)$$

Equation 5-5 can estimate the relationship between panel mean and δ_{it} at time t, without the disruption of the growth factor μ_{it}. The following conditions 5-6 may be achieved if δ_{it} show its convergence to a constant within its limited ranges:

$$\lim_{t\to\infty} H_{it} = \frac{1}{N}\sum_{i=1}^{N}(h_{it} - 1) = 0 \quad (5\text{-}6)$$

This equation calculates the length between province performance to the general limit. For the condition of convergence status reached, H_{it} will converge to 0 when time is infinite. However, if there is no convergence could ever be achieved, which means H_{it} is always cheerful when time is up to infinity. The log(t) test will be involved to examine the null hypothesis of convergence status between all the provinces' human capital within the datasets. The regression will be deployed as follows:

$$log\left(\frac{H_i}{H_t}\right) - 2\,log(log(t)) = a + b\big(log(t)\big) + \ \mu_t \tag{5-7}$$

As t is under the pattern of t = [rT], [rT]+1…, T and r is the fraction parameter larger than zero. When T as the sample is no bigger than 50, r should be pinned to 0.3, according to Phillips and Sul (2007). As convergence generally implies a progressive process with a certain speed, the non-linear time-varying approach can demonstrate the dynamic changes for specific groups from their initial status to standard consistency. Typically, in provincial-level studies, some samples may not reflect a convergence propensity after several transitional heterogeneities or even divergent periods in the long-term development (Mendoza et al., 2021). We can also assume that, in China's case, an overall convergence on the provincial level is hard to achieve. The log(t) tests will be perfectly exploited for a club convergence result for 31 provinces in China.

Due to the premises of the club convergence, there should be several converging subgroups and a diverging group for the whole panel. To identify each of the clubs and groups, an ordering procedure should be given as follows (Phillips & Sul, 2007):

Step 1: Last Observation Ordering.

All the provinces need to be re-sorted in decreasing trend by their last observation X_{it}.

Step 2: Forming Core Group.

Several numbers (k) of top provinces are picked from the datasets to create overall categories of plausible subgroups, and k is between 2 to 31, then by conducting log(t) test and convergence test t-statistics for estimation of each subset. The size of k is derived from its maximum t-statistic result over k subject to its minimum t-statistic of k, which should be larger than -1.65 according to the null hypothesis' rejection rate at a 5% significance level. If k was found to be equal to 31, then the overall convergence can be stated across China. If k = 2 cannot be held for the first two provinces, then it should be abandoned, and the rest of the provinces will be re-selected for the same procedure again. This repeating process will only be stopped when a suitable group of provinces is observed for the core group. Otherwise, when all the null hypotheses are rejected for all the pairs, no convergence clubs can be made in the entire panel, which indicates the overall divergence result.

Step 3: Screening each province for club membership.

If the core group in step 2 can be created, then the rest of the provinces should be selected one by one to join the core club and see its log(t) test result. If the t-statistic surpasses a level of 0 here (For the total sample lower than 50, Phillips and Sul (2007) recommended), then the core club should absorb this new province as a new member. If the core club can absorb no additional provinces, then the core group constitutes a convergence club.

Step 4: Recursion and Exit Conditions

The following clubs should be established using the same rules through steps 1 to 3. If the rest of the provinces can be convergent as a whole, then the second convergence club will be created until no further convergence group can be summarized within the rest of the panel. The remaining provinces will be named as divergence groups.

Step 5: Club Merging

Because of the conservative clustering selection process, some of the provinces may have met the criteria of the upper group of the convergence. Phillips and Sul (2007) designed a series of log(t) tests again for the convergence between the neighbouring clubs. It can revise the t-statistic of each group, and any t-tests over -1.65 can be merged together as a bigger convergence club. The divergent group will also be examined to determine if they can have a chance to join this newly created larger group.

5.3.3. Kaya-Zenga Index

To understand the impact of different factors on human capital development over time and across different areas (clubs), we would apply the Kaya-Zenga index to test further the various factors' impact on this human capital development. As a decomposing method, it can measure different components' effects on human capital and reflect whether it can reduce or increase the unbalancing trend. This method was introduced to the carbon imbalance estimation in China by Wang et al. (2020) and further modified by Mendoza et al. (2022) for human capital imbalance research. We would like to furtherly expand it as an aggregated approach to improve our human capital inequality research.

Different from Mendoza et al. (2022), we break the human capital index into human capital schooling years (human capital return), years of schooling per life expectancy (education density), life expectancy per GDP per capita (life intensity), and GDP per capita. We offer the following equation 5-8:

$$HCI_i = \frac{HCI_i}{AYS_i} \times \frac{AYS_i}{LE_i} \times \frac{LE_i}{G_i} \times G_i = hce_i \times e_i \times l_i \times G_i \tag{5-8}$$

As we can observe from the equation, HCI_i denotes human capital index in province i, AYS_i represents average years of schooling in province i, LE_i means life expectancy in province i, and G_i is GDP per capita in province i. The first three extracted variables are named as hce_i, e_i, and l_i denotes human capital return, education density, and life expectancy intensity in province i, respectively. Furthermore, as the Kaya-Zenga index was designed to estimate the imbalance effect produced by different provinces, it can also derive the same decomposition approach to these selected factors, enabling us to investigate their contributions to the human capital unbalancing trend. Each part of the contribution index can be defined as:

$$I_i(HCI) = I_i^{hce}(HCI) + I_i^{e}(HCI) + I_i^{l}(HCI) + I_i^{G}(HCI) - I_i^{int}(HCI) \qquad (5\text{-}9)$$

Here you can see five decomposed index components in the right hand of equation 5-9. They represent the human capital return, education density, life expectancy intensity, GDP per capita, and interaction factors. But calculate these decomposed indices, we need to introduce the relative gap between the upper mean $M_i^{+}(HCI)$ and lower mean $M_i^{-}(HCI)$ of human capital with the following equation 5-10:

$$I_i(HCI) = \frac{M_i^{+}(HCI) - M_i^{-}(HCI)}{M_i^{+}(HCI)}$$

$$= \frac{M_i^{+}(hce)M_i^{+}(e)M_i^{+}(l)M_i^{+}(G) - M_i^{-}(hce)M_i^{-}(e)M_i^{-}(l)M_i^{-}(G)}{M_i^{+}(HCI)}$$

$$= \frac{M_i^+(hce) - M_i^-(hce)K_i(hce)}{M_i^+(HCI)} + \frac{M_i^+(e) - M_i^-(e)K_i(e)}{M_i^+(HCI)}$$

$$+ \frac{M_i^+(l) - M_i^-(l)K_i(l)}{M_i^+(HCI)} + \frac{M_i^+(G) - M_i^-(G)K_i(G)}{M_i^+(HCI)} - I_i^{int}(HCI)$$

$$= I_i^{hce}(HCI) + I_i^e(HCI) + I_i^l(HCI) + I_i^G(HCI) - I_i^{int}(HCI) \quad (5\text{-}10)$$

To calculate equation 5-10, we need to estimate these four extracted factors' upper and lower mean values. The calculation will be based on the ascending order (i = 1, 2, 3, … 31) of the human capital index for 31 provinces each year, while the province with the highest human capital index counts as number 31 (r=31). According to the definition of lower mean value, it will be calculated as the average value of all the provinces whose human capital index is lower or equal to province i using the equation 5-11 below:

$$M_i^-(HCI) = \frac{\sum_j^i HCI_j}{i} = \frac{\sum_j^i HCI_j}{\sum_j^i AYS_j} \times \frac{\sum_j^i AYS_j}{\sum_j^i LE_j} \times \frac{\sum_j^i LE_j}{\sum_j^i G_j} \times \frac{\sum_j^i G_j}{i}$$

$$= M_i^-(hce)M_i^-(e)M_i^-(l)M_i^-(G) \quad (5\text{-}11)$$

In contrast, $M_i^+(HCI)$, $M_i^+(hce)$, $M_i^+(e)$, $M_i^+(l)$, and $M_i^+(G)$ as the upper mean value will be calculated by the average across all the provinces whole human capital index is higher than provinces i. We also set the default for the highest human capital index provinces (r=31). The detailed calculation approach is right below (equation 5-12):

$$M_i^+(HCI) = \begin{cases} \frac{\sum_{j=i+1}^{r} HCI_j}{r-i} = \frac{\sum_{j=i+1}^{r} HCI_j}{\sum_{j=i+1}^{r} AYS_j} \times \frac{\sum_{j=i+1}^{r} AYS}{\sum_{j=i+1}^{r} LE_j} \times \frac{\sum_{j=i+1}^{r} LE_j}{\sum_{j=i+1}^{r} G_j} \times \frac{\sum_{j=i+1}^{r} G_j}{r-i} \\ = M_i^+(hce)M_i^+(e)M_i^+(l)M_i^+(G), i \le r-1 \\ HCI_r = \frac{HCI_r}{AYS_r} \times \frac{AYS_r}{LE_r} \times \frac{LE_r}{G_r} \times G_r = M_r^+(hce)M_r^+(e)M_r^+(l)M_r^+(G), i = r \end{cases} \quad (5\text{-}12)$$

Simultaneously, we also need to calculate the multipliers components: $K_i(hce)$, $K_i(e)$, $K_i(l)$, and $K_i(G)$ are estimated by polynomials of the upper and lower mean values. As for the calculation example, we will offer equation 5-13, and the other three can replicate the process by replacing the factors.

$$K_i(hce) = \left(\frac{M_i^+(e)M_i^+(l)M_i^+(G)}{2} + \frac{M_i^-(e)M_i^-(l)M_i^+(G)}{3} + \frac{M_i^-(e)M_i^+(l)M_i^-(G)}{3} + \frac{M_i^+(e)M_i^-(l)M_i^-(G)}{3} - \frac{M_i^-(e)M_i^+(l)M_i^+(G)}{6} - \frac{M_i^+(e)M_i^-(l)M_i^+(G)}{6} - \frac{M_i^+(e)M_i^+(l)M_i^-(G)}{6}\right) \quad (5\text{-}13)$$

Lastly, we still have to calculate the interaction term $I_i^{int}(HCI)$ which combines all the factors' upper and lower mean values. It can be interpreted as the following equation 5-14:

$$I_i^{int}(HCI) = \frac{[M_i^+(hce)-M_i^-(hce)][M_i^+(e)-M_i^-(e)][M_i^+(l)-M_i^-(l)][M_i^+(G)-M_i^-(G)]}{M_i^+(HCI)} \quad (5\text{-}14)$$

After all the calculation processes for estimating $I_i(HCI)$, we can see two derivative results. Firstly, we can have an overview demonstration of the imbalance of contributions in each year, followed by equation 5-15:

$$I(HCI) = \frac{\sum I_i(HCI)}{N} \quad (5\text{-}15)$$

To reveal more inequality issues and their potential policy suggestions, we can calculate the imbalance the clubs derived from convergence analysis contributed. Equation 5-16 shows the approach to achieve the target:

$$I_c(HCI) = \frac{\sum I_i^c\,(HCI)}{N^c} \tag{5-16}$$

Here we define I_i^c as the imbalance contribute by province i in club c while N^c represent the number of provinces in the club c.

5.4. Human Capital Convergence in China

The convergence of the human capital in China can demonstrate an unambiguous identification of the different developing patterns within the provinces. The main objective of this section is to show the convergence classification results of our newly created human capital index and compare them to the existing findings in the literature. This can lead us to an integrated understanding of how China's subnational level human capital has been developed in the long run.

Table 5-1 Convergence Club Identification of Human Capital Index

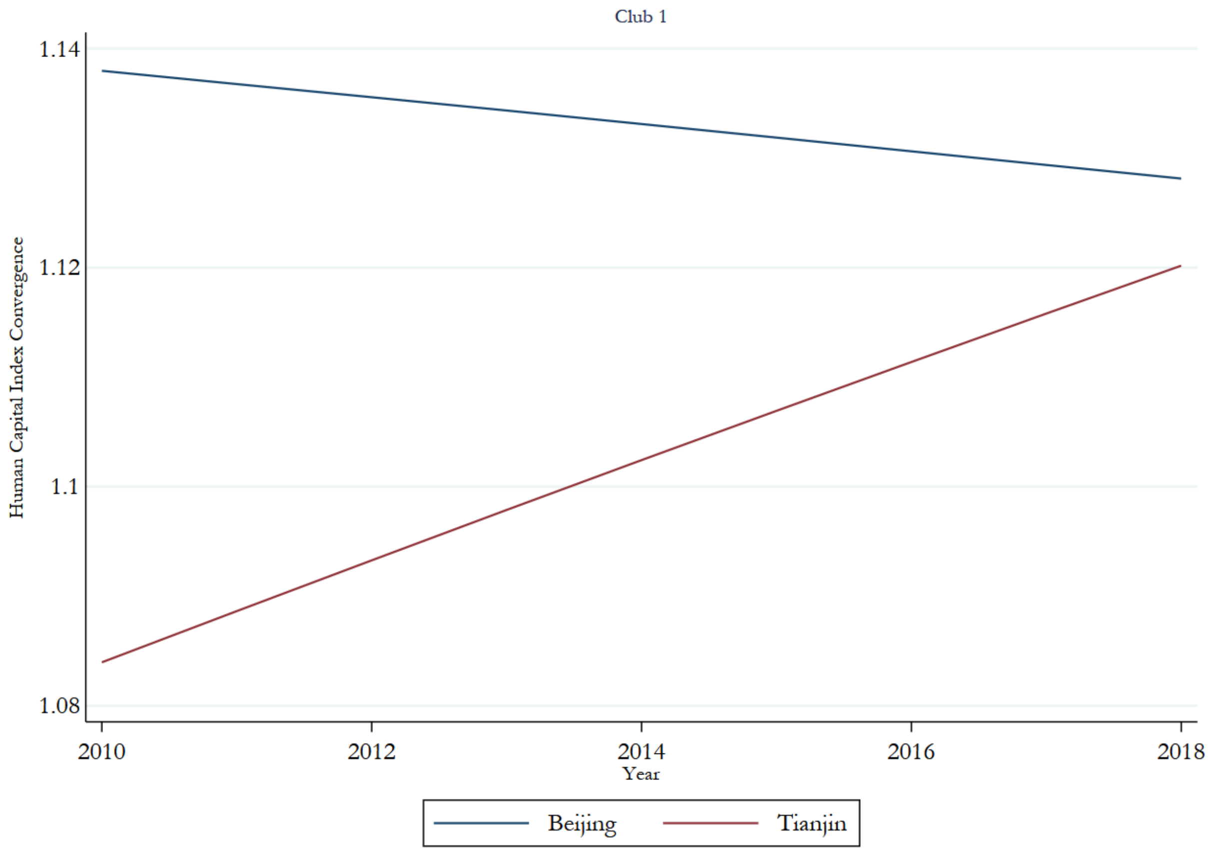
Clubs	Provinces	Coefficients	T-statistics
Full Sample	No overall convergence	-1.059	-37.232
Club 1	Beijing, Tianjin	2.425	3.767
Club 2	Anhui, Fujian, Guangdong, Hainan, Heilongjiang, Jilin, Shanghai, Shanxi, Zhejiang	-0.032	-0.338
Club 3	Gansu, Guangxi, Hebei, Henan, Hubei, Inner Mongolia, Jiangsu, Jiangxi, Ningxia, Qinghai, Shaanxi, Shandong, Sichuan, Tibet, Xinjiang	-0.029	-0.327
Club 4	Chongqing, Hunan	0.518	2.387
Diverging	Guizhou, Liaoning, Yunnan	-1.305	-46.838

Note: This Table presents results from the convergence analysis using Human Capital Index created in Chapter 4. The null hypothesis of convergence is rejected at the 5% level if the t-statistic < -1.65. Merging of the neighbouring clubs is rejected in both samples considered.

Source: Authors' calculation using the data from club convergence results.

The log(t) test first demonstrated no overall convergence across China from 2010 to 2018 on its provincial-level human capital development. Meanwhile, four convergence clubs and several diverging provinces are detected through the clustering process. All the clubs are presented according to the similarity of the human capital index accumulation trend related to club 1. The first club contains Beijing and Tianjin, two of the most advanced regions in China, and they also geographically neighbour each other. It shows a 2.425 coefficient of the log(t) test, indicating a high correlation between these two provinces. Figure 5-1 illustrates a clear human capital index convergence trend between Beijing and Tianjin, reaching the same level in 2018. More specifically, we can observe that as China's capital city, Beijing is still maintaining its highest performance regarding human capital accumulation in the whole country. However, the slightly descending trend implies some limitations have been reached. Beijing has been developed with abundant resources and human capital for several decades. With more people trying to achieve their dream lives here, the per capita resources are lower, and everyday life pressures are also at their peak. As a common issue in big cities, the Chinese government has been exploring the policy to release the population pressure on Beijing by establishing several sub-centers around and moving a bunch of “Non-capital core functions” to these newly founded regions since 2015. The core measure of this policy is to push Beijing-Tianjin-Hebei synergistic development. One of the reasons we can see the fast growth of Tianjin in the same period is from Figure 5-1. Moreover, Tianjin’s infrastructure and education resources have always been adequate, as it is one of the four municipalities in China. The geographic conditions also allow Tianjin to become the main channel of merchandise business in northern China since its double advantages are coastal and Capital-neighbouring.

Figure 5-1 Human Capital Convergence Trends between 2010 to 2018 of Club 1

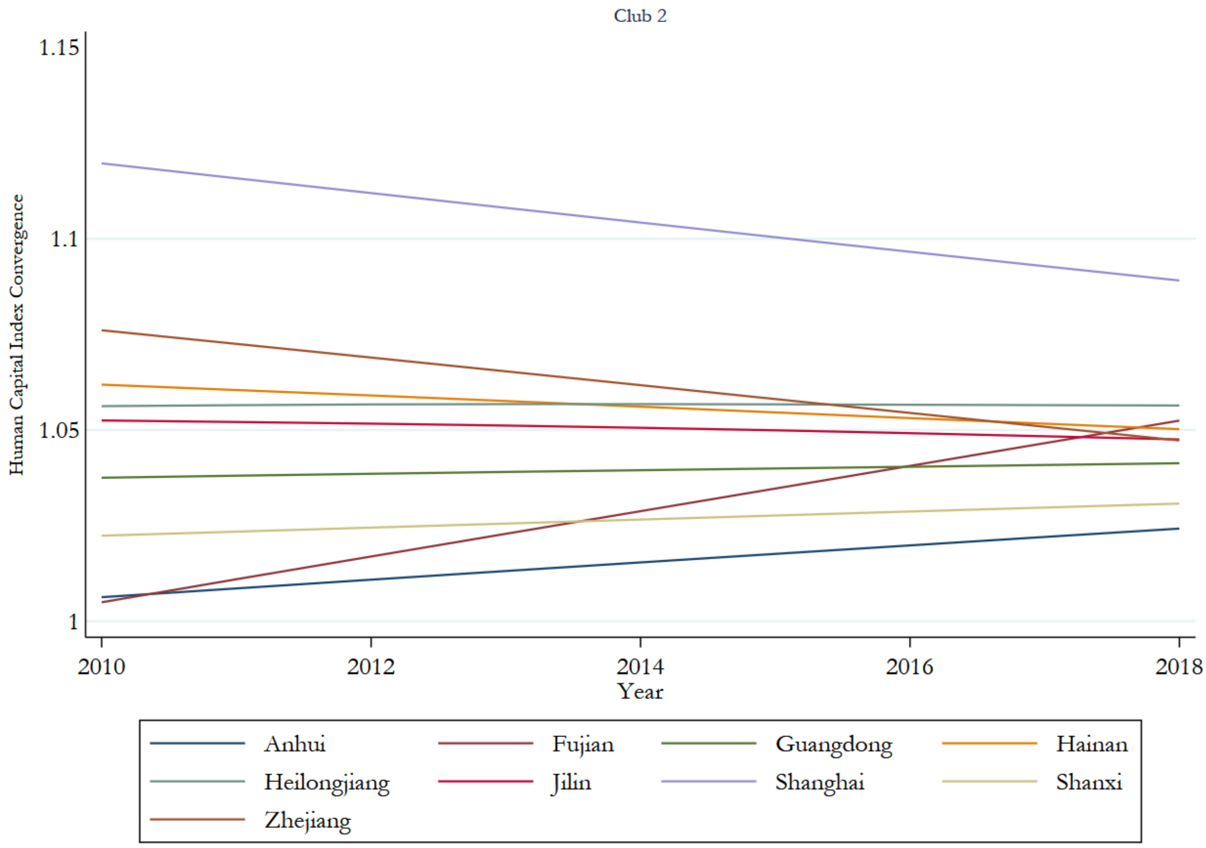


Source: Authors' construction using Human Capital Index, created in this dissertation.

The second club in Table 5-1 lists nine provinces but does not share a high-level correlation. Shanghai and Zhejiang, which should be recognized as another two economic engines in China, appear to be rejected by the first club. Figure 5-2 shows the trend of their human capital development. Shanghai started with a higher human capital index than Tianjin but could not maintain its level during this period. The same phenomenon of Beijing happened in Shanghai as it is also an overcrowded municipality on the east coast of China. However, Shanghai has more population than Beijing, while less than half of the space is occupied. It further created an enormous burden for Shanghai's limited resources, even with a mature market and business system. In the meantime, we can see great gaps between Shanghai and other provinces in the same club. Anhui and Zhejiang are also in this same club since these two are the “Yangtze River Triangle Economic Zone” members, for this area aims to absorb the related supply chain from Shanghai.

However, Zhejiang showed a similar trend to Shanghai, while Anhui rose in the same period. The main reason could be that the transitional economic structure revolution of the supply side was still in process. We can observe fast growth in Anhui, which indicates that more market demand has been raised. But unlike Zhejiang, Anhui is not a direct neighbour to Shanghai, which explains why Anhui starts at a low level of human capital. In contrast, Zhejiang is one of the neighbouring provinces of Shanghai. It also connects to Anhui, Jiangxi, and Fujian, which may further redistribute the human capital to all these regions, especially when these surrounding provinces offer better policies. Fujian is the best sample of this situation, demonstrating significant human capital growth because of its geographic and resource advantages.

Figure 5-2 Human Capital Convergence Trends between 2010 to 2018 of Club 2

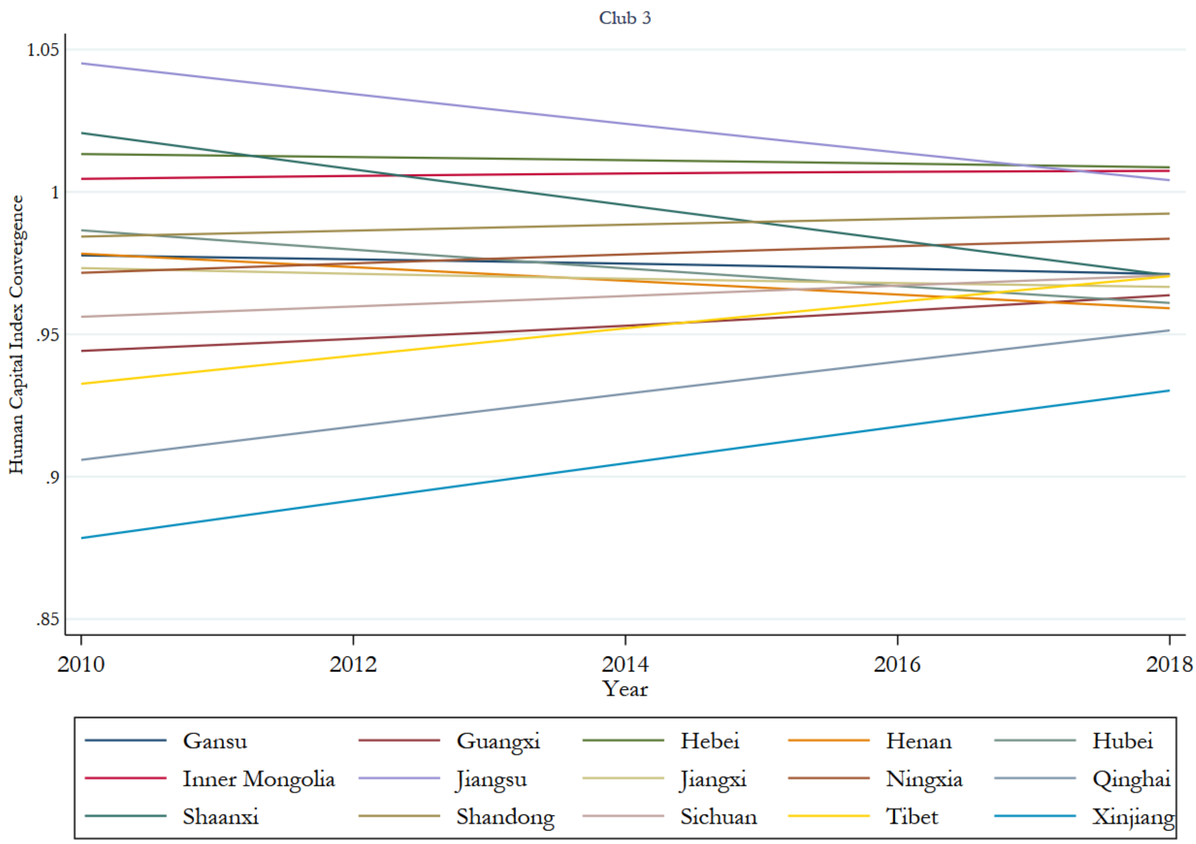


Source: Authors' construction using Human Capital Index, created in this dissertation.

Apart from the east coast area, the south coast provinces like Guangdong and Hainan also appear in the second Club. The slightly increasing trend of Guangdong does not suit the fame it has obtained since Shenzhen and Guangzhou as extensively developed cities around China. These two cities should have taken Guangdong province into a higher human capital accumulation. To explain this, we traced Figure 5-2 to see Guangdong's annual human capital index trend. It demonstrated a similar trend after 2010, from what we learned from the literature (Mendoza et al., 2022). We believe that Guangdong started with manufacturing industries which absorbed many labor-intensive jobs, while the local economic transition is harder to complete. Hainan, on the contrary, shows a negative coefficient while its original human capital index is flat and stable. As a southern island that relies on outstanding tourism, the Chinese government set up the "Hainan Duty-Free Pilot Program" in 2011 to make Hainan a better tourist service destination. We can see its great success in gathering human capital from all over the country. However, the negative coefficient may suggest the vulnerability of its local human capital system as its tourism cannot hold the opportunities sustainably.

Finally, two northeast provinces and a northwest province are listed in the first club. As Heilongjiang and Jilin are China's industry foundations with the most extended history, it is no surprise that they can still get this position. However, industry upgrade in China has been continuously knocking out backward production capacities. If appropriate policy incentives could be implemented, Heilongjiang and Jilin can hardly sustain accumulating human capital. For a similar reason, Shanxi's ore energy reserves greatly support local development. For environmental and sustainable development, emission issues caused by traditional coal energy have become a barrier in front of Shanxi's industry. But it can also potentially improve its human capital development by enhancing local energy research and coal mining technologies.

Figure 5-3　Human Capital Convergence Trends between 2010 to 2018 of Club 3



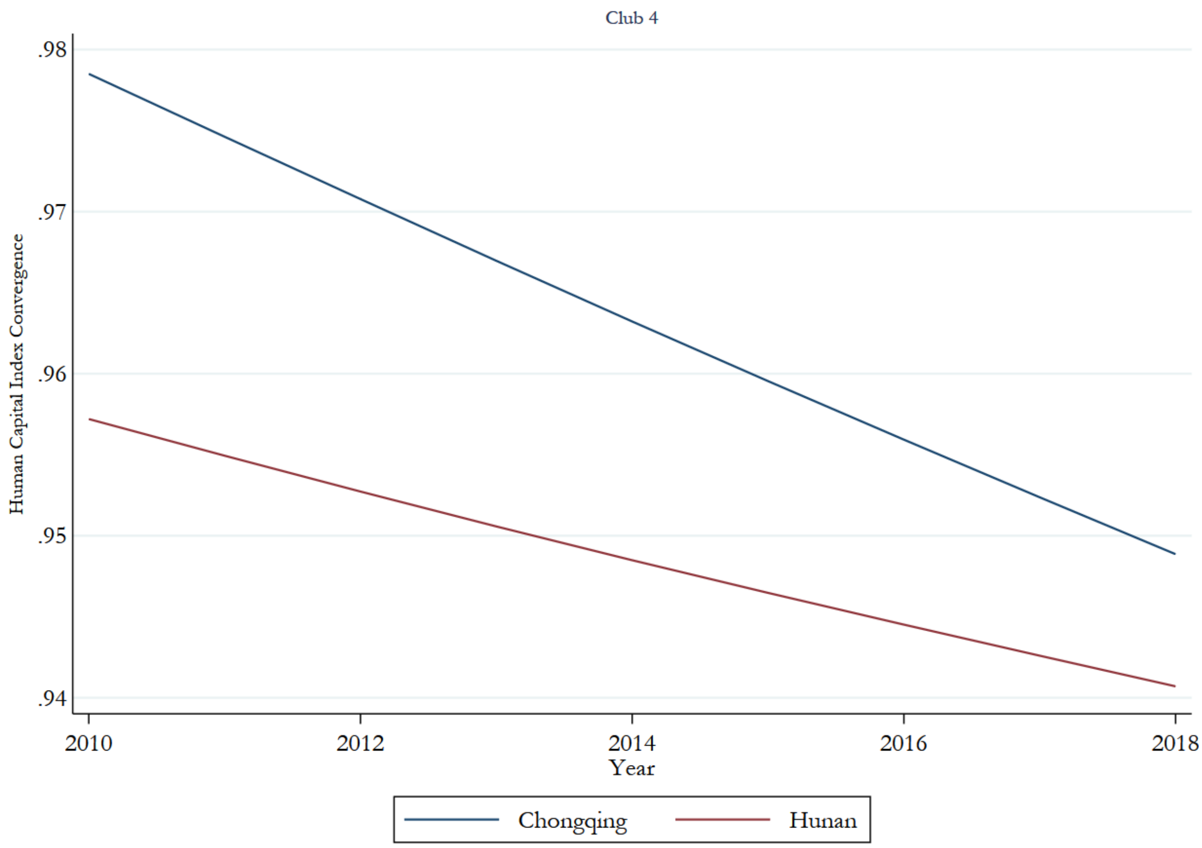
Source: Authors' construction using Human Capital Index, created in this dissertation.

The weakest correlation comes from Club 3 (Figure 5-3), containing 15 provinces. Uncommonly, Jiangsu appears in this club. The negative trend demonstrated that Jiangsu started at a high level of human capital stock. Still, internal and external issues had negatively affected the development of local human capital for these nine years. Although Jiangsu is recognized as a solid province, its north, east, west, and south area basically have their own self-directed policies. This decentralization of local administration separates the strength for synergetic development. Meanwhile, although the eastern region of Jiangsu is close to Shanghai, the capital city of Jiangsu, Nanjing, stands in the western area, which is much closer to Anhui. The overall human capital outflow might be faster than the human capital inflow and local generation.

Hebei, Henan, Hubei, Jiangxi, Inner Mongolia, and Shandong provinces are also inland areas with awkward geographic locations. Most of them are neighbouring to the provinces in Clubs 1 and 2, or Like Hubei is a central engine of China alongside the Yangtze River. These provinces are apparently less developed because of the lower attractions to the upper tiers of human capital. For the rest of most western regions in club 3, Sichuan and Shaanxi can still catch up with the majority of the areas. At the same time, Xinjiang and Qinghai performed lower with a positive coefficient. Guangxi is another kind of case since it has a coastal location and neighbouring Guangdong. However, these two great conditions didn’t help Guangxi generate impact and attract human capital. But still, its positive growth may slowly offer opportunities for future development. Among all the provinces in Club 3, we surprisingly observed a rapid increase in Tibet. The possible reason is that, as we included the health perspectives in human capital measurement, Tibet, a plateau area with less population than other provinces, may reflect a better health condition. Meanwhile, we also believe that as the direct traffic line has been developed to Tibet, more tourism and market choices have been introduced and led to this fast growth.

Figure 5-4 shows that the last convergence club has two decreasing provinces: Chongqing and Hunan. These two provinces should have better human capital development since their general conditions are better than most Western provinces. From the view of absolute numbers, they didn’t go backward too much compared to the provinces in Club 3. However, Chongqing, one of the municipalities and the only one in inland regions, should perform better.

Figure 5-4 Human Capital Convergence Trends between 2010 to 2018 of Club 4

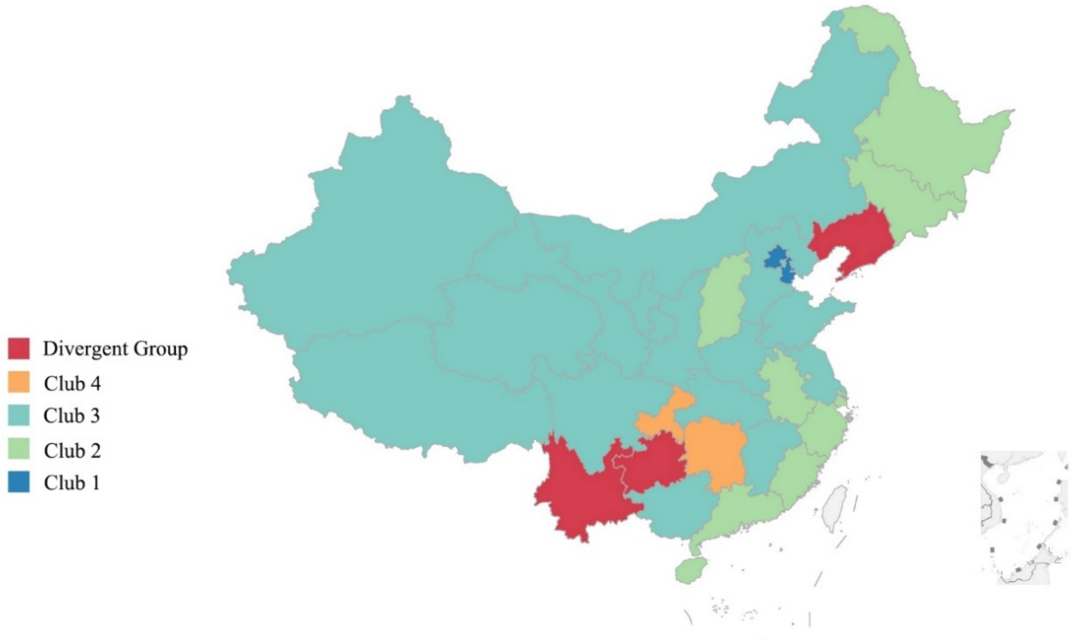


Source: Authors' construction using Human Capital Index, created in this dissertation.

Our findings suggest two diverging provinces from Table 5-1: Guizhou and Yunnan from the southwest region of China, as they have the lowest human capital index across the 31 provinces from 2010 to 2018, according to our calculation. Their ascending period between 2012 and 2016 evidently confirms that some incentives helped these two surrounding provinces in terms of human capital. We believe the long-term poverty-eliminating program has worked for local education and medical services. However, self-generatable productivity should be established for the local market to maintain long-term sustainable development.

To help understand the geographical interrelations of human capital inequalities across different clubs, the following Figure 5-5 is provided for further discussion. Blue represents the club with one member, red denotes diverging group 5, and other clubs are painted explicitly with colors. Our discussions in the previous club analysis explained that geographical locations potentially affect some of their neighbouring provinces. Unlike the long-term convergence result from Mendoza et al. (2022), our focus on the recent ten years indicated a more significant separation trend even though the original human capital index reflected the overall ascending trend.

Figure 5-5 Human Capital Index Club Convergence Map of China



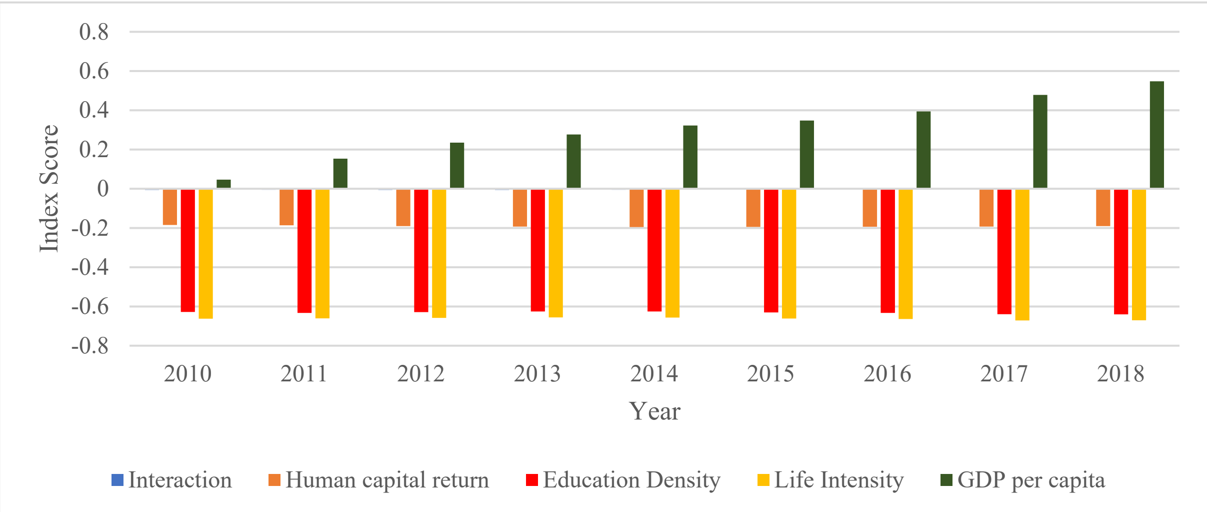
Source: Authors' construction using Human Capital Index, created in this dissertation.

This paper's overall convergence test result differs from other long-term human capital convergence research (Mendoza et al., 2022). Although nearly half of the provinces stayed the similar human capital development trend and convergence club positions compared to Mendoza's results, the other differences still attracted attention. The possible reason for these disparities is the duration of the research involved. Since we are more focused on human capital development in the last decades, while they traced all the way back to 1985, their longer targeted duration obtained the lowest beginning of each province right after China's Reform and Opening Policy. But for our research, the transitions between initial rough development and economic growth slowdown landing period are critical for China's future human capital sustainability. We hope our findings can offer new thoughts to the literature. We also want to reconceptualize the effectiveness of existing policies on human capital development at China's subnational level.

5.5. Kaya-Zenga Index Analysis

As discussed in the methodology, there are two approaches for presenting the Kaya-Zenga index analysis results. We want to illustrate the overall average estimate results for a general understanding of the imbalance issue of human capital development in China. Figure 5-6 shows the overall sample Kaya-Zenga Index results.

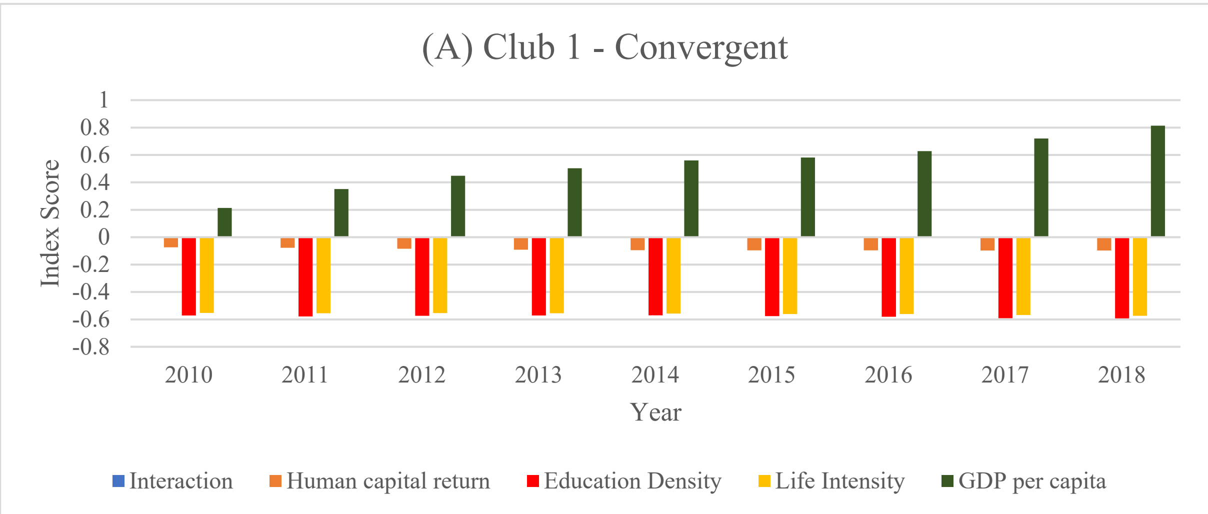
Figure 5-6 Kaya-Zenga Index Decomposed Results – Overall Average

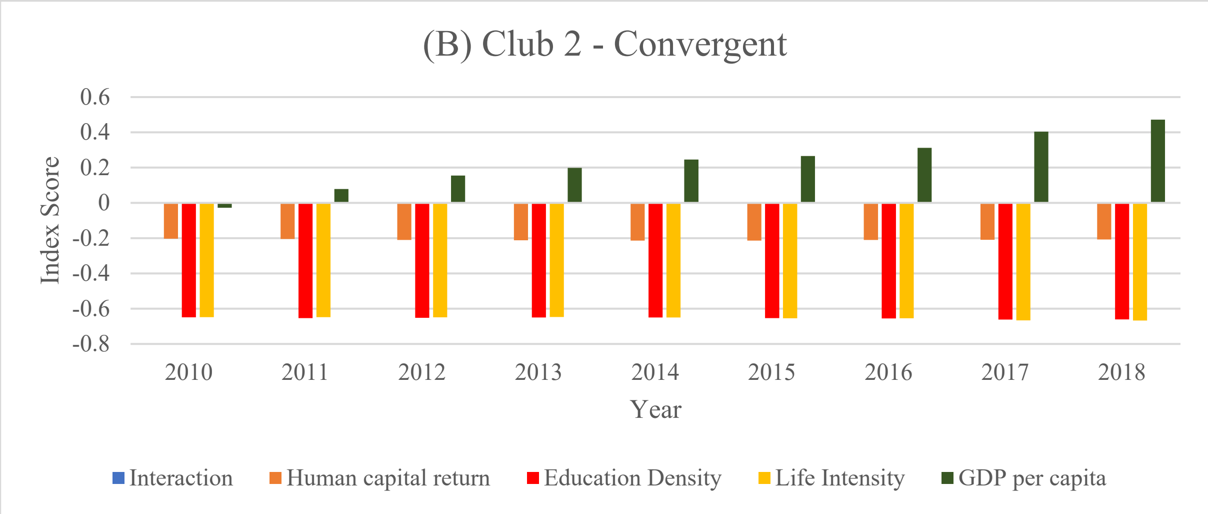


Source: Authors' construction using Human Capital Index, created in this dissertation.

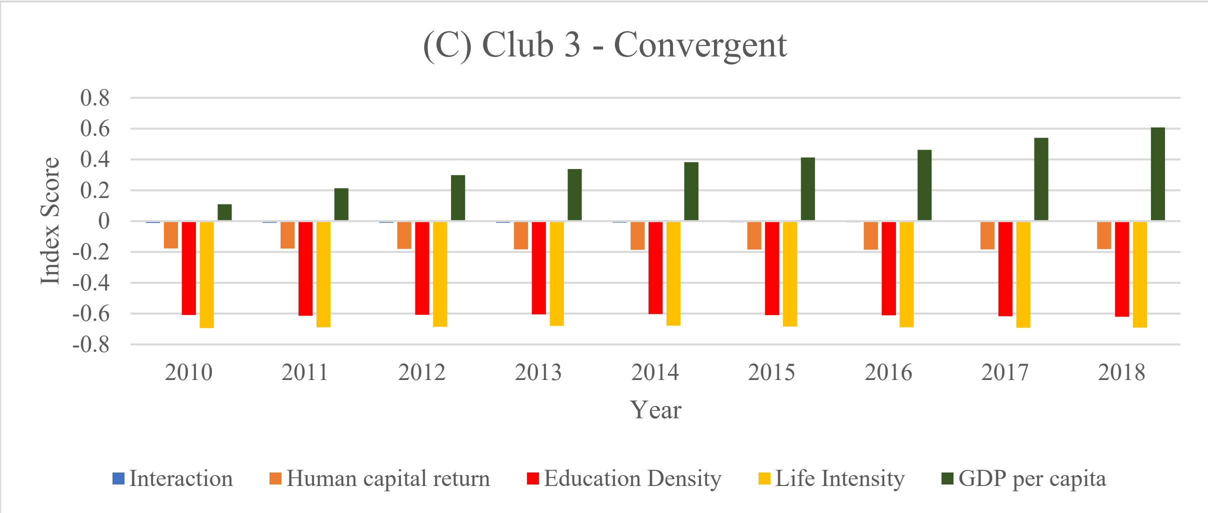
The overall samples' decomposed index for different factors shows that the imbalance of the human capital development across China is mainly because of the economic growth variation. In contrast, human capital return, education density, and life intensity reduce the effect of rebalancing human capital development. These overall results indicate that GDP per capita as an economic performance indicator may contribute more to the inequality of human capital between different provinces as the development speed gap formed by the rapid accumulation of wealth in this period become increasingly prominent. We can also observe a sharp increase in the contribution of GDP per capita to the overall human capital imbalance starting from 2010, implying that the unequal economic growth is continuously expanding the gap of regional disparities. Moreover, we also provide the Kaya-Zenga Index decomposition results within different clubs identified by previous club convergence analyses. Figure 5-7 can further demonstrate the five factors' effect on the imbalance of human capital for different clubs.

Figure 5-7 Kaya-Zenga Index Decomposed Results – By Clubs

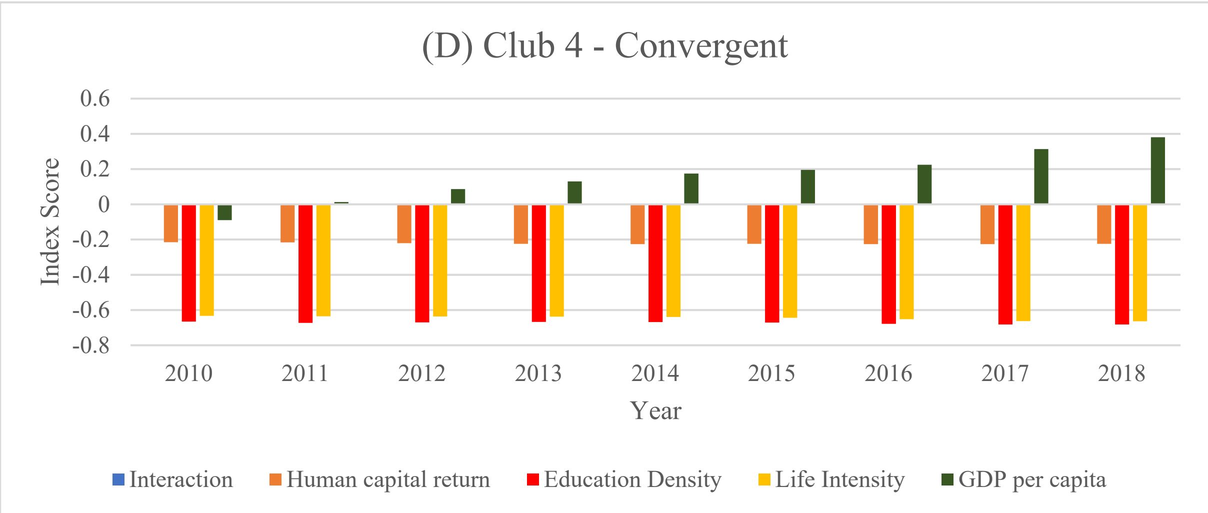




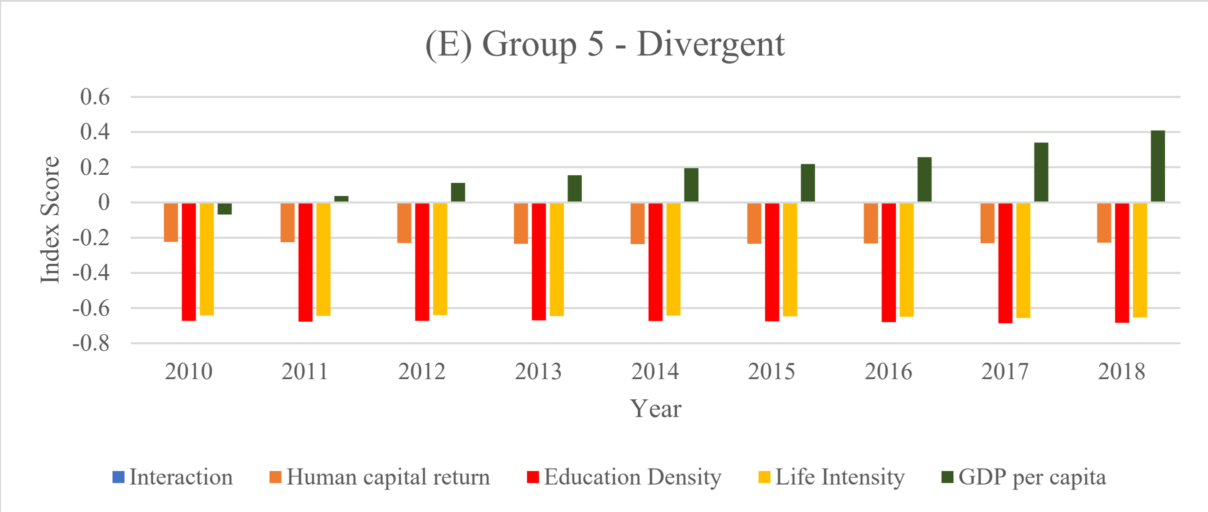
(B) Club 2 - Convergent
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
Index Score
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Interaction
Human capital return
Education Density
Life Intensity
GDP per capita



(C) Club 3 - Convergent
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
Index Score
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Interaction
Human capital return
Education Density
Life Intensity
GDP per capita



(D) Club 4 - Convergent
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
Index Score
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Interaction
Human capital return
Education Density
Life Intensity
GDP per capita



Source: Authors' construction using Human Capital Index, created in this dissertation.

With Beijing and Tianjin, we can observe that club 1 has higher GDP per capita than other clubs' economic performances. At the same time, we can see that club 2, 4, and diverging group 5 experienced early periods of imbalance reduction from GDP per capita. Human capital returns are more likely to help unbalanced provinces to reduce their overall human capital inequality issue, while it shows a lower value in club 1. The education density from Club 4 and group 5 shows a higher reduction effect to the imbalance issue than life intensity. This may indicate that higher educational incentives in these western provinces can help narrow down the human capital inequality gap compared to the previous clubs. On the contrary, Club 3 illustrates a higher contribution of life expectancy intensity, suggesting that better health standards are more critical for these provinces.

5.6. Conclusion

This chapter estimated the inequalities in human capital development across China from 2010 to 2018. Despite the fast-growing economy in this period, the original imbalance across the country can further generate the speed gap between them. As we can see from the convergence analysis, four clubs of convergences and a diverging group with three provinces demonstrated a severe imbalance in China's human capital development. Fortunately, China's policymakers are also dedicated to solving this long-term issue by implementing incentives and policy priorities for those lagging provinces. However, even though China has announced its achievements in completely eliminating absolute poverty in the whole country, there are still extreme issues right in front of the Chinese people.

And for potential policy directions of rebalancing human capital development across China, our attempts on the Kaya-Zenga index rewarded us with what we originally expected, as we may reduce the imbalance of human capital from three basic channels. First, we suggest that some redistribution method that transfers budgets to typically lagging provinces is important for the overall balance of economics. Moreover, as clubs show a better effect on education density by stimulating the local education system and strengthening education quality, more well-educated human capital can be fostered for their future development. Simultaneously, some other places' decomposed results reflect a higher reduction rate of imbalance of life expectancy intensity, which means there may be shortages in local health. We suggest these areas with a better funding strategy to establish a healthy nutrition plan for helping the local people. At the same time, the upgrades of local medical resources could become a solid backup to raise the fundamental quality of people's health.

Chapter 6 Assessing the Determinants of Human Capital Development in China: A Variance-based Decomposition Approach

6.1. Introduction

The question of how public spending on education and health affects human capital is long-standing among policymakers and scholars. For instance, a substantial body of empirical research concludes that a strong relationship exists between school spending and student outcomes in developed countries (Égert et al., 2020; Lorenzoni et al., 2018). Other studies point to spending inefficiencies in developing countries where an increase in spending does not correlate with improved student outcomes (Andrews et al., 2019). Recently, researchers have shown interest in the complementary or substitution between different types of expenditure as governments continue to face constraints to mobilize more revenue (Gaies, 2022). In China, for instance, government expenditure on education as a percentage of GDP has decreased since 2013, while health expenditure has been showing a strong positive trend (World Bank, 2020). This chapter contributes to this debate by bringing new evidence using sub-national data from China.

We aim here to further contribute to the field. As for human capital studies, we used an improved human capital index which can be challenging to implement in cross-country analysis. Meanwhile, some other cases discuss education and health policies separately (Égert et al., 2020; Lorenzoni et al., 2018). These constraints have prevented past research from offering practical policy suggestions. In other words, administrations can hardly coordinate education and health policies as public services and utilize limited spending more efficiently to make human capital development sustainable. This chapter attempts to give advice on coordinated education and health policies in China through the perspective of spending. The whole estimation framework will be modified based on the methods of Lorenzoni et al. (2018) and Égert et al. (2020). Moreover, we further implement a predictive importance analysis (Sterck, 2018, 2019a, 2019b) to measure the importance of each determinant of human capital development based on variance decomposition.

The rest of this chapter is divided into five sections. Section two will discuss the methodologies to explain how we will aggregately estimate determinants' effect on human capital from education and health perspectives. Section three will present the mainly selected determinants according to literature findings, and the corresponding data descriptions will also be stated. Section four will highlight spending interaction regression and predictive importance analysis regression. Some policy discussions will also be provided in this section. Final conclusion remarks will be given in section five.

6.2. Methodology

6.2.1. The Spending-Policy Interaction Model

Lorenzoni et al. (2018) and Égert et al. (2020) present an interactive framework for estimating the effect of the determinants through the concerning spending channels. As they were coincidently focusing on health and education policies, we can attempt to modify their approach for aggregately analyzing these two aspects. In their theory, the framework works perfectly on relative time-invariant variables, for it can be multiplied by the time-varying core independent variables such as spending. The health and education outcome effect can be amplified or attenuated by original policies and institutions.

Two equations should present the original idea of this interaction methodology: one is for estimating output such as life expectancy or human capital; the other is furtherly working on modeling the drivers of public spending. However, for this study, we are more concentrated on the effect of determinants' impact on human capital development across China's subnational level. It means that we will only involve the first equation of this methodology.

There are three parts of independent variables according to our adjusted approach. Spending on education and health will be defined as core drivers, and they both changes over time. Secondly, education policies include different levels of education that will be interacted with by education spending according to degrees. Lastly, health policies related to different health demands are the third part of the variables, for they will be multiplied by the health spending. The following equation (6-1) shows the complete structure of this approach.

$$HCI_{i,t} = \alpha_i GSE_{i,t} + \beta_i GSH_{i,t} + \gamma_i \sum_i EP_{i,t} \left[GSED_{i,t}\right] + \delta_i \sum_i HP_{i,t} \left[GSH_{i,t}\right] + \varepsilon_{i,t} \quad (6\text{-}1)$$

Here we define HCI_i represent the human capital index of province i in the year t. GSE and GSH denote the spendings on education and health from public and private sectors (government and society), and they are both the core drivers. The interaction terms GSE furtherly represent the education funding per student for each degree (primary school, secondary school, vocational secondary school, and university). At the same time, GSH is the overall spending per capita in certain provinces. EP and HP are two sets of education and health policies that can be translated into various indicators. $\varepsilon_{i,t}$ is the error term.

Table 6-1 Variable Descriptions

Variable Name	Variable Descriptions
$HCI_{i,t}$	Human capital index of province i in the year t
$GSE_{i,t}$	Public and private spendings on education of province i in the year t
$GSH_{i,t}$	Public and private spendings on health of province i in the year t
$GSED_{i,t}$	Education funding per student for each degree of province i in the year t
$EP_{i,t}$	The other determinant of education represents by indicators.
$HP_{i,t}$	The other determinant of health represents by indicators.

Source: Author's creation.

6.2.2. The Predictive Importance Model

To coordinate the result of spending interaction estimation, we also need to determine whether the determinant is worth promoting for human capital development. But the traditional general regression is not convincing enough to derive policy suggestions. Following Sterck (2018, 2019a, 2019b), we decided to involve the predictive importance of the explanatory variable model, which can also be recognized as an important analysis. The original idea of this approach is to estimate the contributions of each independent variable to the variance decomposed dependent variable with association with other variables.

$$y = \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \epsilon \tag{6-2}$$

$$Var(y) = \sum_{i=1}^{n} Var(\beta_i X_i) + 2\sum_{i=1}^{n-1}\sum_{j=i+1}^{n} Cov(\beta_i X_i, \beta_j X_j) + Var(\epsilon) \tag{6-3}$$

Equation 6-2 is the initial general regression model. We firstly denote y as the human capital index in this research while X_i is the set of all the determinants regressed in the spending interaction model. By decomposing the variance of y, the equation 6-3 is formulated.

We can see three parts on the right hand of the equation: the variance of each determinant itself, the covariance between determinants, and the variance of error term res. According to these definitions, there are two sources of the connection between X_i and y can be utilized. $Var(\beta_i X_i)$ measures the variation of X_i while $Cov(\beta_i X_i, \beta_j X_j)$ interlinked the covariance between one X_i And other regressors.

Sterck (2018, 2019a, 2019b) designed two approaches based on these two decomposed variance sources' effect over the original dependent variable $Var(y)$, and they are named "*ceteris paribus* approach" and "*non-ceteris paribus* approach". For the "*ceteris paribus* approach", it aims to generate the effect of each X_i independently while holding all the other variables unchanged. By doing so, the covariance terms are neglected, and we assume it as constant zero. The equation of this approach is given in the following equation 6-4:

$$b *_i^2 = {Var(\beta_i X_i)}\Big/{Var(y)} \tag{6-4}$$

Because we have ignored the impact of covariance terms, the independent effect from X_i itself directly equals $Var(\beta_i X_i)$. $b *_i^2$ as the squared standardized beta coefficient of X_i which is the most used indicator for interpreting the importance of explanatory factors. In theory, one standard deviation in X_i can be averagely associated with standard deviation rises of $b *_i$ from dependent variable y and ceteris paribus. In the meantime, $Var(y)$ can also reversely be decomposed by the standardized betas and offer similar consequences.

Moving forward to the "*non-ceteris paribus* approach", its name apparently reveals its concept that its calculation methodology will not fit *ceteris paribus.* It is because the covariance of different variables is included this time. Sterck (2018, 2019a, 2019b) explained that $\frac{Cov(\beta_i X_i, \beta_j X_j)}{Var(y)}$ can be considered as the elasticity of $Var(y)$ concerning $Var(\beta_i X_i)$. The "*non-*

ceteris paribus approach" can be stated as the following equation (6-5):

$$E_i = \frac{Var(\beta_i X_i) + \sum_{j \neq i} Cov(\beta_i X_i, \beta_j X_j)}{Var(y)} \tag{6-5}$$

The final estimated E_i can also be recognized as population R-squared as $Var(y)$ is fully decomposed by two sources, and the contributions now collaborate with explanatory variables and error terms. Furthermore, if all the coefficients are consistently evaluated, it will also make importance estimation consistent. With such a mechanism, when coefficients could be explained with causal effect, two decomposed results can also be interpreted as approaches to variables' importance causality. However, if this causal effect cannot be confirmed, $b*_i^2$ and E_i can still be seen as a predictive importance method. Since the determinants we concluded may not cover all the perspectives that reverse causality issues remain plausible, this paper's result will only be explained as predictive importance.

One last thing that needs to be clarified about this approach is that two indicators resulting from all the determinants must be analyzed coordinately. If E_i is larger than $b*_i^2$, it suggests that this factor gives the same effect as other essential variables. Oppositely, when E_i is smaller than $b*_i^2$, we would like to classify this determinant as having an aggressive effect on the other determinants.

6.3. Human Capital and Its Related Determinants

In economics, researchers describe the market as an "invisible hand" (Smith, 1776) since it can potentially reach a dynamically balanced equilibrium status through the competition from both supply and demand sides. However, the real world we live in is never gentle. The market is so profitable that some participants make irrational decisions. One of the government's duties is stability maintenance as a “visible hand” to prevent normal market functions from breaking into miserable situations from keeping healthy social competitiveness from breaking into miserable situations. Policy is one of the most important tools for this “visible hand”. Many studies have estimated different determinants of policies on effectiveness and outcomes all over the world.

However, with respect to human capital-related policies, much wider choices stand before the researcher. Due to human capital’s public attributes and deep linkages between social welfare and individual performance, we simultaneously investigated education and health determinants. Even so, the potential range of education and health determinants that could influence human capital is still extremely large. To build a clear path of selecting valuable determinants, we first learn from sample studies such as Lorenzoni et al. (2018) and Égert et al. (2020), as they focused on education and health determinants. They generally selected variables from different groups. Determinants concerning primary school, secondary and tertiary education are introduced separately. Similarly, health determinants include health financing, healthcare delivery, government support, and resource allocations. These groups can indicate issues of human capital determinants from an integrated framework.

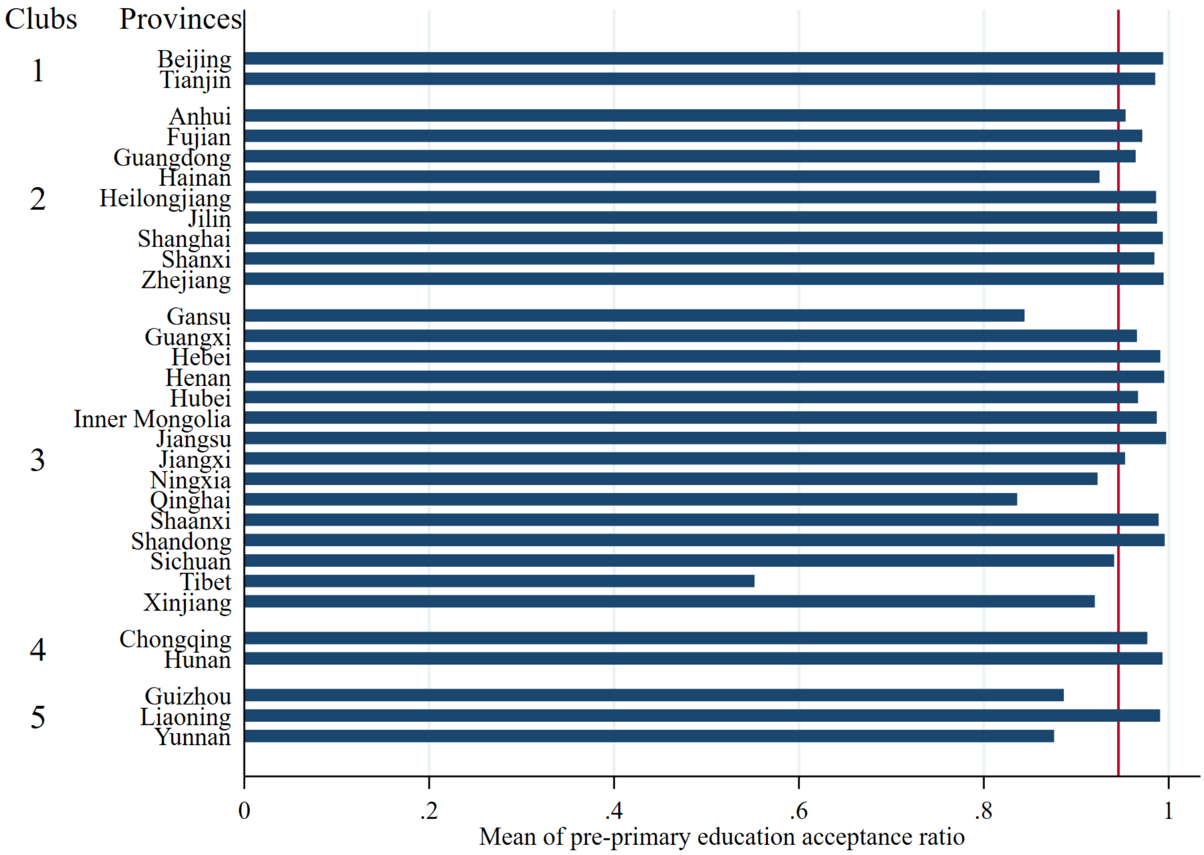
Regarding selecting these specific variables which act as determinants, the policy evolution from 2005 to 2018 from education and health perspectives are involved. As we have discussed in Chapter 2, China's focus on education policy gradually expanded from developing compulsory education to supporting more efforts to vocational and pre-primary education resources. As tuition fees in those periods of education were generally exempted, more Children were able to receive formal education for 9 to 12 years. The direct impact is the student-teacher ratio in different education degrees since the increment of the student may lower the education qualities if the number of teachers stays stable. Meanwhile, the allocation of education funding has been changing over time according to the transition of education policies we mentioned in Chapter 2. The different distributions of education funding could also reflect the policy effectiveness of human capital development. A similar discussion was also presented in medical and healthcare policy evolution from 2005 to 2018. As the three tiers of the medical system are gradually established, people are more likely to receive healthcare services that maintain the basic quality of human capital. Variables such as per capita hospitals, doctors, and beds are the health evaluation determinants of human capital development. Furthermore, reforming public medical insurance, public hospital administrative autonomy, and medical compensation strategy should also be determined as crucial variables of policy and expenditure changes in China's human capital development.

6.3.1. Pre-primary education experience

As far as we know, formal education can be very productive for human capital accumulation, and the most fundamental beginning of formal education in modern society is primary school. But there are also education periods early than primary school exists. An early education investment will be paid off if the full-period education stays in continuity (Heckman, 2008). For children with disadvantaged situations, early education support may offer great returns to raising cognitive abilities (Attanasio, 2015). Studies also confirmed that children with sustainable pre-school experiences generate higher school readiness scores than other students (Rao et al., 2019). These literatures show the possibility of pre-primary education strengthening the long-term quality and quantity of education performances.

According to various studies, several choices present the pre-primary education experiences as the variable. For this empirical research, we collected each province's pre-primary school-educated ratio of newly enrolled primary school students from 2010 to 2018. It can act as an intermediate determinant of education.

Figure 6-1 Pre-primary Education Acceptance Ratio, 2010-2018 Mean Value, percent



Source: Author's construction using the data from China Education Statistical Yearbook (Ministry of Education of People's Republic of China, 2010-2019).

Figure 6-1 above shows the fundamental mean value of each province in China. The red line represents the average ratio across the whole period and provinces, which is 94%. Apparently, when most of the provinces are above average levels or even close to 100%, five provinces are far from the line. Gansu, Guizhou, Qinghai, and Yunnan are between 80% and

90%, and Tibet only shows no more than 60% of the pre-primary education acceptance ratio in the area. The common characteristics of these provinces are their western location in China which fundamentally reflects the potential education shortages in these western provinces. The policy intention of China's central government was to improve the pre-primary education acceptance rate, according to Chapter 2. However, Figure 6-1 demonstrates that there is still a long way to go.

6.3.2. Education in Different Degrees

Teachers are at the frontline of education. A high-quality teacher can efficiently utilize the classes and clearly convey knowledge to students. As for the student, a teacher knowing how to teach can make the learning process a pleasant experience, highly boosting the children's educational performance. Furthermore, better teachers can attract pupils to the schools, positively correlated to the students' better knowledge learning by rising schools' attainment (Braga et al., 2013). Practically, increasing the quality of teachers requires good coordination of the teacher fostering system and schools' recruitment strategies. Better wages or welfare incentives can attract more competitiveness in the teachers' market. The concerning studies also come across China's case. As Park and Hannum (2001) discussed, the test score is likely to be differentiated by teacher quality, and long-term fixed teacher-student cohort interactions can further promote China's education qualities.

For the determinants' selection, there are multiple choices for measuring the quality of the teacher. But so far, the attempts to involve teachers' gender, age, diploma, and professional titles didn't reflect significant results for all the degrees. Under these circumstances, we learned the same techniques from Égert et al. (2020) and generally used the teacher-student ratio for teacher qualities proxies. We implemented teacher quality for four degrees: primary school, secondary school, vocational secondary school, and university.

The literature also discussed a lot about the effect of school autonomy. In theory, primary and secondary schools can make better decisions regarding hiring teachers, planning budgets, curriculum, and rising school education qualities for local requirements if their autonomy is assured (Égert et al., 2020). By comparing the school autonomy between China and America, Xia et al. (2017) found that schools in China present lower autonomy than US schools. The principal's decision accountabilities for teachers' decision participations and even curriculum/assessment decisions. But different from fundamental education, universities are more flexible and can manage their financial resources, staff, and even student selections for higher education performances (Oliveira et al., 2007).

The normal way of assessing a school's autonomy is using the PISA dataset. Unfortunately, there is no such thing at China's subnational level. By looking at the essential educational datasets, we have found that calculating the ratio between schools' individual spending (teachers' salaries and students' scholarships) and schools' overall spending (Public, individual, and infrastructure usage) can denote the propensity of schools' choices on benefiting staffs and students.

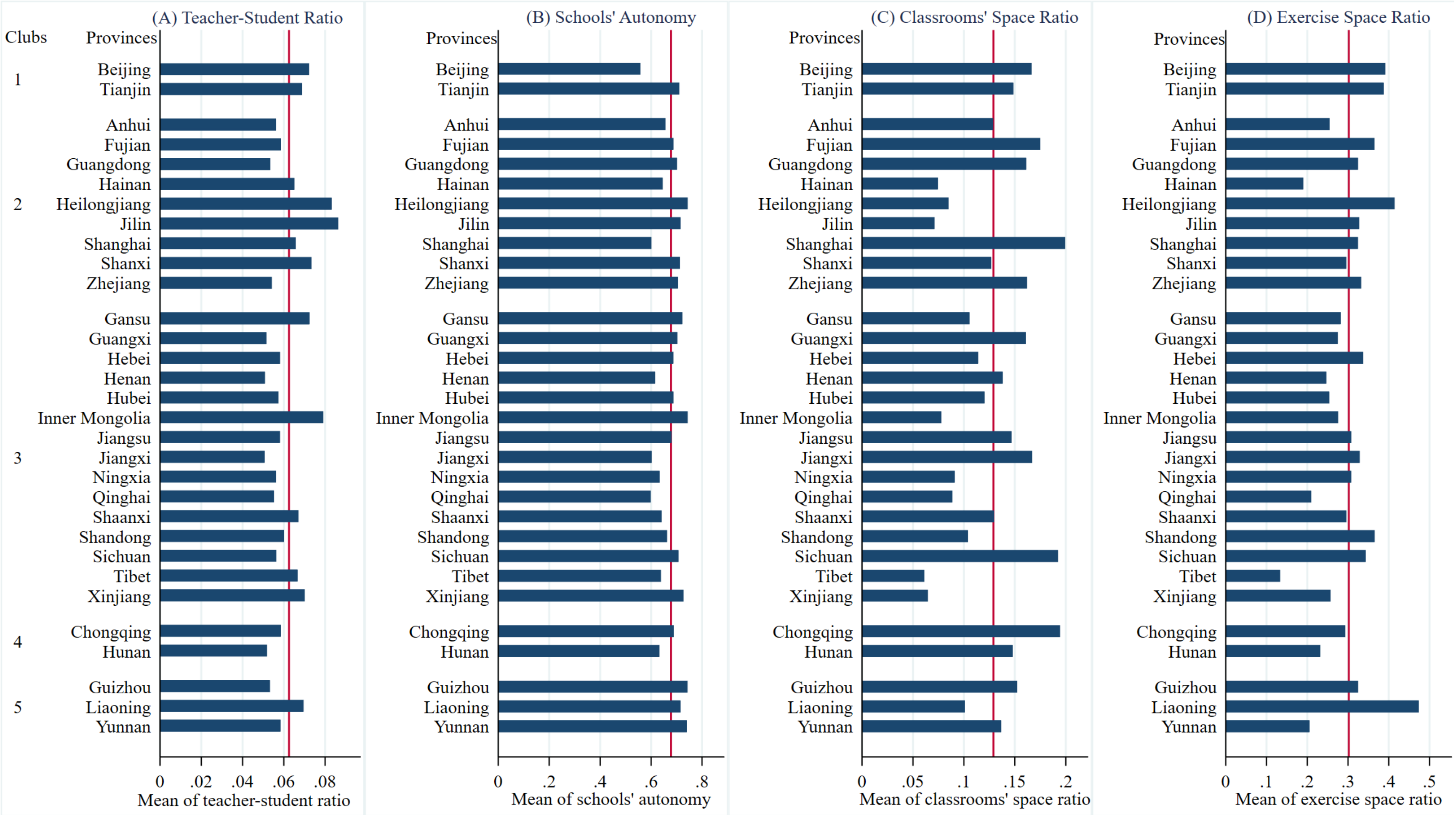
Besides the teachers' quality and schools' autonomy, we also involve schools' environment and education qualifications. For primary and secondary schools, we bring classroom space over the total school space ratio and sports-exercise space over the total school space ratio as schools' environmental factors. Similar environmental indicators have also been implemented in vocational secondary schools. Still, as a different type of education, we select sports-exercise space ratio and fixed assets value per student to demonstrate vocational secondary education's specific demand. Meanwhile, we also collect and calculate the ratio of teachers' diplomas higher than bachelor's degrees and professional titles higher than intermediate level among the vocational secondary schools' teachers as education qualifications determinants. Furthermore, we modified the indicators for universities as we utilize the universities' full-time faculty ratio among all the universities' employees, intermediate and higher professional title teachers' ratio of all the faculty members, and research employees' ratio to all the university staff. For the same reason, these determinants can demonstrate further information on universities' education policy status across China.

For a detailed description of all the factors we mentioned above, the following Figure 6-2 to Figure 6-5 illustrate the mean value of each determinant for all four degrees of education across provinces.

The primary education determinants in Figure 6-2, panel A reflect several patterns. Three of the four municipalities' cities, Beijing, Tianjin, and Shanghai, have higher than average level outcomes for the teacher-student ratio. In contrast, only Chongqing as a central-west municipality is performed on the contrary. However, the highest three primary school teacher-student ratios are in Jilin, Hebei, and Inner Mongolia, all located in the northern regions of China. We can also observe Shaanxi, Shanxi, and Xinjiang as northern provinces with a higher-than-average teacher-student ratio. Meanwhile, Hainan and Tibet are also trespassing on the average redline. The rest of the lower performed provinces are widely distributed across China.

The school's autonomy (Figure 6-2, panel B) shows a different situation in advanced areas like Beijing (lowest ratio) and Shanghai and undeveloped areas such as Tibet, Qinghai, Ningxia, etc., below the average redline. For provinces where primary schools' autonomy ratios are over the average line, it also included coastal and inner land regions. The only pattern we may conclude is that the geographical radiant effect on this ratio is reversed since developed provinces have lower individual spending ratios over total education spending. In comparison, their surrounding provinces may show greater ratios. Those most undeveloped areas also experience low school autonomy, perhaps for different reasons.

Figure 6-2 Primary School Education Determinants, 2010-2018 Mean Value

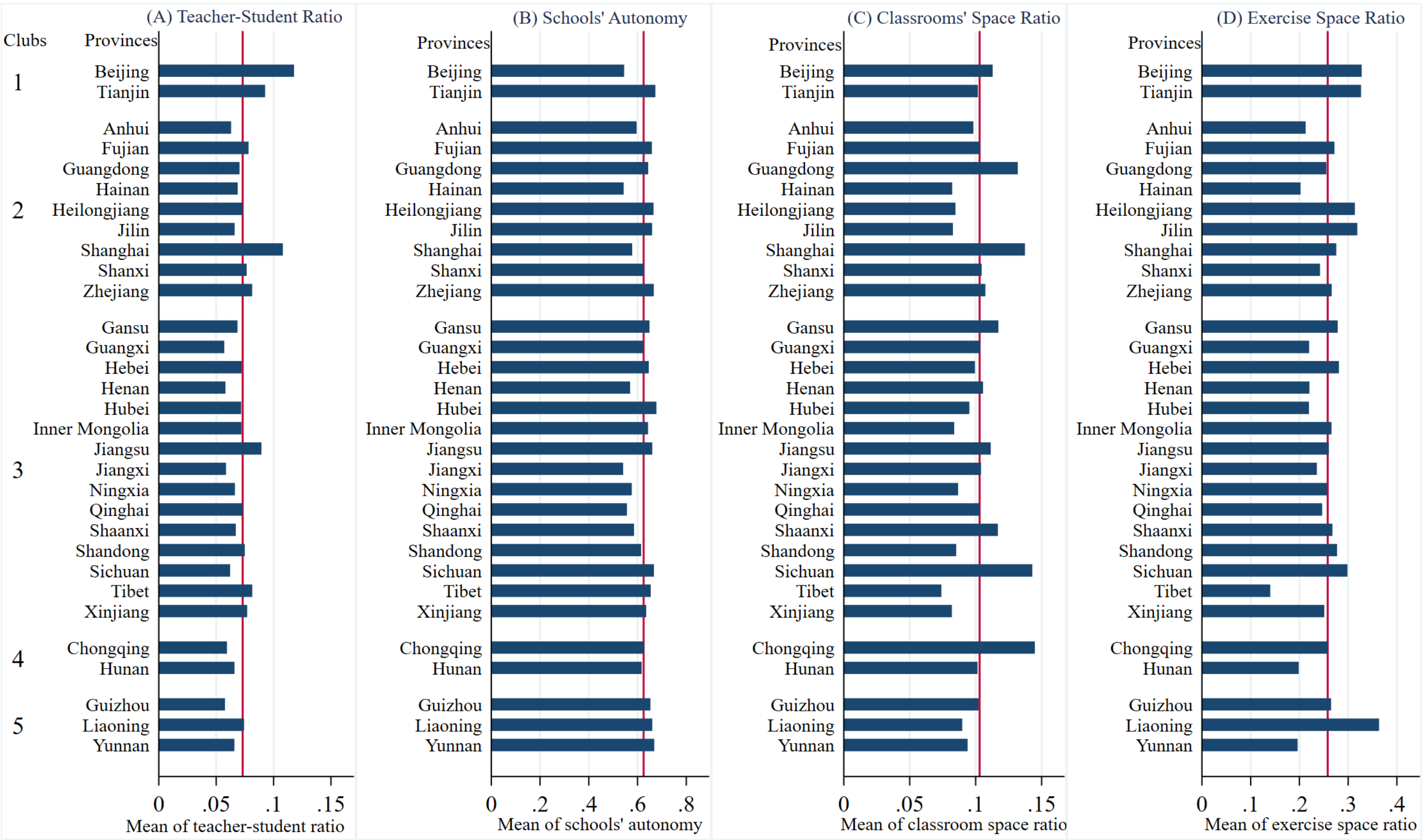


Source: Author's construction using the data from China Education Statistical Yearbook (Ministry of Education of People's Republic of China, 2010-2019).

The classroom space ratios demonstrate quite large deviations between different provinces. Shanghai demonstrated the highest mean ratio, with 20% of school spaces counted for classrooms, while Tibet and Xinjiang only utilized 5-6% of school spaces as classrooms. The specific pattern implies that higher population densities are generally related to a larger ratio of classroom spaces. On the other side, since China also implemented policies to reduce compulsory school students' educational burden and spare enough time for daily physical exercises, the exercise space of the primary school may also become a critical factor in human capital development. The graph in Figure 6-3 shows a similar trend to the classroom ratio. The lowest ratio of primary school physical exercise spaces is about 10% which is Tibet again, but the highest ratio is presented by Liaoning (Nearly 50%). Other highly developed regions such as Beijing and Shanghai also trespass the average performance among all the samples. It furtherly shows the imbalance of the primary education development integration for the western and rural provinces in China.

The following determinants for secondary school education are offered in Figure 6-3.

Figure 6-3 Secondary School Education Determinants, 2010-2018 Mean Value



Source: Author's construction using the data from China Education Statistical Yearbook (Ministry of Education of People's Republic of China, 2010-2019).

The teacher-student ratio illustrates a large deviation since Beijing and Shanghai reflect a ratio over 10%, while most provinces can only have 6 to 7 percent. However, an abnormal pattern happens in Tibet and Xinjiang, as they are the most western and undeveloped provinces in China but share a teacher-student ratio beyond the average redline. We consider the potential reason as the difference between student scales which implies that with a smaller number of students, rural areas may have more significant teacher resources and qualities but compared to municipalities such as Beijing, Tianjin, and Shanghai, or advanced provinces like Jiangsu and Zhejiang, the general teaching qualities and resources allocation were not on the same level.

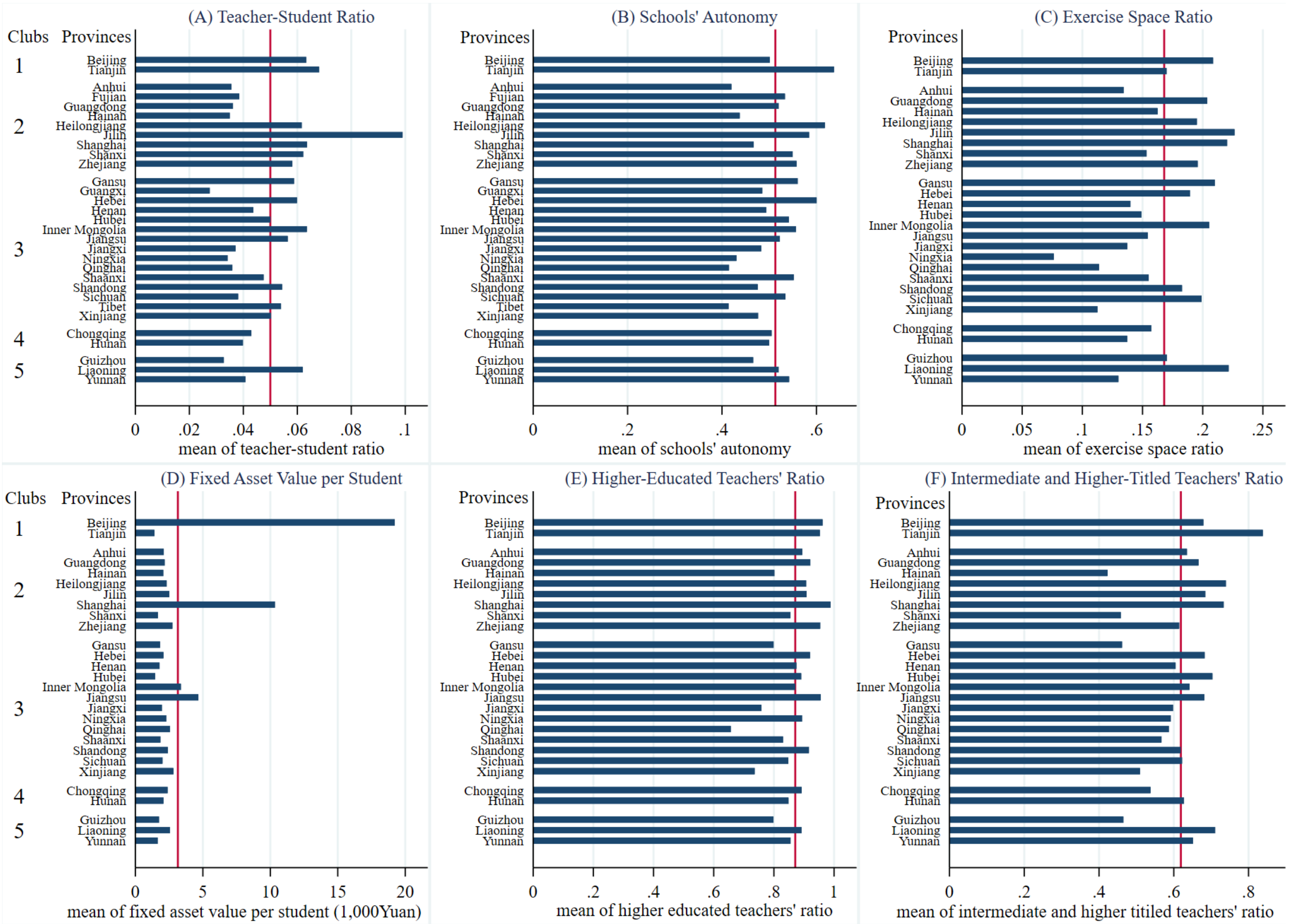
The individual spending usage ratio interprets secondary schools' autonomy across provinces to the aggregate school spending. The average red line demonstrates about 60% of secondary school spending is utilized on teachers' salaries and scholarship programs. We can observe a similar pattern to primary schools' autonomy: Beijing and some rural provinces reflect lower performances. But the general gap between high-performing and lower provinces wasn't so large. It may further suggest that secondary schools' autonomy across China is constrained by some potential mechanisms restricting the overall differences.

Classroom and exercise spaces in secondary schools are also part of the policy intentions of the central policy focuses. The mean value data description demonstrated in Figure 6-3 offers a similar shape to primary education across provinces where most of the highest rations are presented by those advanced regions. But in detail, the differences lie between primary and secondary education that: firstly, classroom space ratios in secondary schools are smaller than in primary education on average and not more newly developed regions show higher ratio; secondly, exercise space ratio also obtained a shrinking scale compared to a primary degree, but the overall pattern stayed as similar as primary schools. These phenomena indicate that the ultimate goals of primary and secondary education are different. With better teacher quality, secondary schools in China concentrate on generating students' academic outcomes rather than offering larger school spaces than primary education.

There is also part of the reason that may lead to the policy focusing on vocational secondary schools, which educated the students who didn't get enrolled in regular secondary schools. You may find more detailed information and data in the following Figure 6-4. More determinants are included in vocational secondary education since it has been concentrated from the top of the policy intentions for the past ten years.

The firstly two determinants remained the teacher-student ratio and schools' autonomy. We changed education resources determinants with a more detailed combination. The exercise space ratio represents the vocational secondary schools' space utilization. Meanwhile, the fixed-assets value per student can potentially denote the hardware resources and educational equipment, which is important in vocational schools' teaching quality. Teachers' resources were explicitly divided into two factors. One is the ratio of teachers who obtained a diploma higher than a secondary school degree. Another is the professional titles ratio of the teachers who are better than intermediate titles. These two variables can directly lead to the teachers' qualifications, experiences, and abilities.

Figure 6-4 Vocational Secondary School Education Determinants, 2010-2018 Mean Value



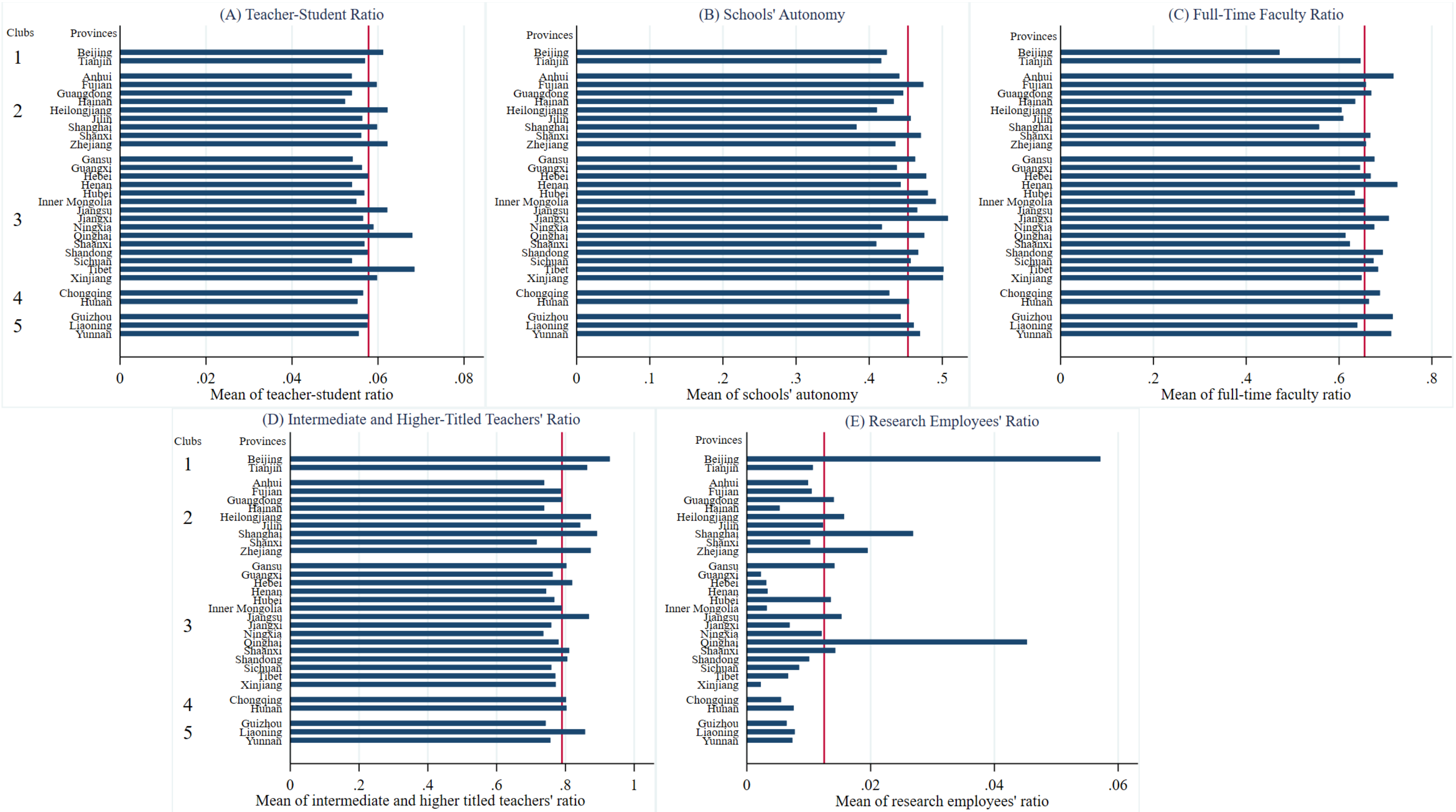
Source: Author's construction using the data from China Education Statistical Yearbook (Ministry of Education of People's Republic of China, 2010-2019).

We can observe that Jilin has a great advantage in the teacher-student ratio in vocational secondary education. Other regions that show beyond average mean value in teacher-student ratio do not show a specific pattern, meaning there are both eastern and western provinces reflecting vocational education importance. The provinces with low teacher-student ratios also contain different kinds of levels. You can observe provinces in central, southern, and western regions. Schools' autonomy also demonstrates another picture with a lower standard deviation across China. The general interpretation of the schools' autonomy shows a range of 40% to 60% of individual spending in vocational secondary education. Most provinces with the average level of school autonomy are those with a certain level of development. In contrast, those economically lower-performing provinces generally reflect a less-than-average ratio.

Vocational secondary schools' space and facilities factors in Figures 6-4 confirmed the fact that municipalities can have better campus structure and more fixed assets investment. But for some rural provinces, a large exercise space ratio on campus might be the most direct investment they can offer, and fixed assets related to schools' facilities and equipment are harder for undeveloped areas. Some provinces do not present actual data in these two variables, and we considered them as missing values in the final analysis.

Finally, teachers' qualifications and professional experiences in vocational secondary schools give us the impression that less developed provinces such as Gansu, Hainan, Jiangxi, Qinghai, and Xinjiang do not have enough high school and higher educated teachers compared to the overall average values which are about 90%. Similarly, these provinces' intermediate titled teachers' ratio demonstrates lagging results.

Figure 6-5 University Education Determinants, 2010-2018 Mean Value



Source: Author's construction using the data from China Education Statistical Yearbook (Ministry of Education of People's Republic of China, 2010-2019).

For universities and colleges (Figure 6-5), since China implemented a major policy focusing on college education quality and collaboration with industries and enterprises, apart from teacher-student ratio and schools' autonomy, full-time faculty ratio, intermediate and higher titled teacher ratio, and researcher ratios of the colleges are the inserted specific variables for investigating universities' education determinants.

The teacher-student ratio in most provinces is likely to maintain a value of about 0.06 per student. However, we can also see Qinghai and Tibet shows the slightly larger result, which may be explained by the lower scale of the college student in these two provinces. Schools' autonomy does not show clear patterns among all the provinces, but we can observe Shanghai and several lagging provinces are lower than the average value.

The university's full-time faculty member keeps the whole campus operating for daily routines. If more full-time faculty members can be counted among all the universities' staff, it may theoretically lead to redundant issues. But simultaneously, more experienced teachers among the full-time faculty members may increase the general education efficiency in universities. From the figure of these two factors, we observed a clear pattern: Beijing and Shanghai demonstrate low full-time faculty ratios. At the same time, they have a higher ratio of intermediate and above-titled teachers simultaneously. It implies that their colleges can have larger organizations and fewer faculty members for China's two most advanced areas. Still, talented and professional teachers stand a major role among the faculty members. In the same period, other provinces utilized a larger ratio of full-time faculty members and a normal proportion of professional teachers. Finally, since universities were encouraged to build close relationships with industries and enterprises for better education outcomes, the university's innovation ability and market sensibilities are required. We believe that the researcher ratio to the overall universities' staffs can denote the concerning factor. The last graph in Figure 6-5 illustrates a large gap in researcher proportions in Beijing, Shanghai, and Zhejiang to most other regions. However, we also find that Qinghai, a less-developed province in western areas of China, demonstrates the second high ratio of the researcher to overall staff in the colleges.

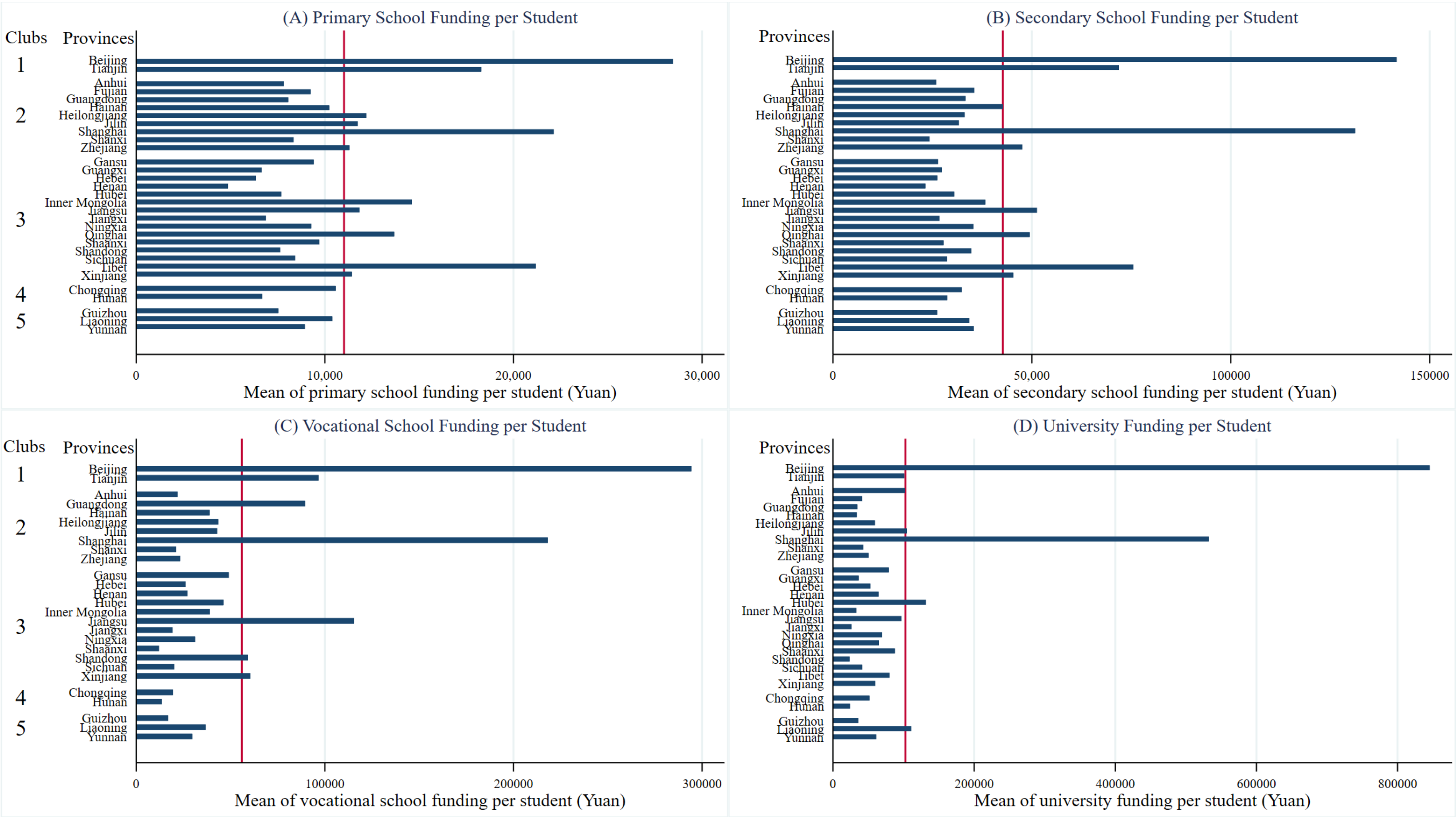
6.3.3. Education Funding from Public and Private Sources

Since we proposed introducing the funding effect into policy interactions modeling, public and private funding for different education degrees should not be avoided. The following Figure 6-6 presents the mean value of education funding from 2010 to 2018 for each province.

To eliminate the scale biases, we collect the education funding data per student level. The graph of four different degrees showed that Beijing and Shanghai have the highest education funding per student from public and private sources in all the degrees, and Beijing is always the highest one. From the integrated view, the overall funding scale increases from primary education to university, and the gap between the highest and lowest performance also expands over different degrees. In vocational and university degrees, education fundings face severer imbalance issues. However, we can also find support for central and western provinces in primary and secondary education as several lagging provinces received education funding with obvious policy tilt.

From the implemented policy we discussed in Chapter 2, such status quo in education funding across China can reflect the mitigation of funding gaps in compulsory education. However, vocational and university degrees' astonishing imbalance demands further policy movements.

Figure 6-6 Education Fundings per Student, 2010-2018 Mean Value



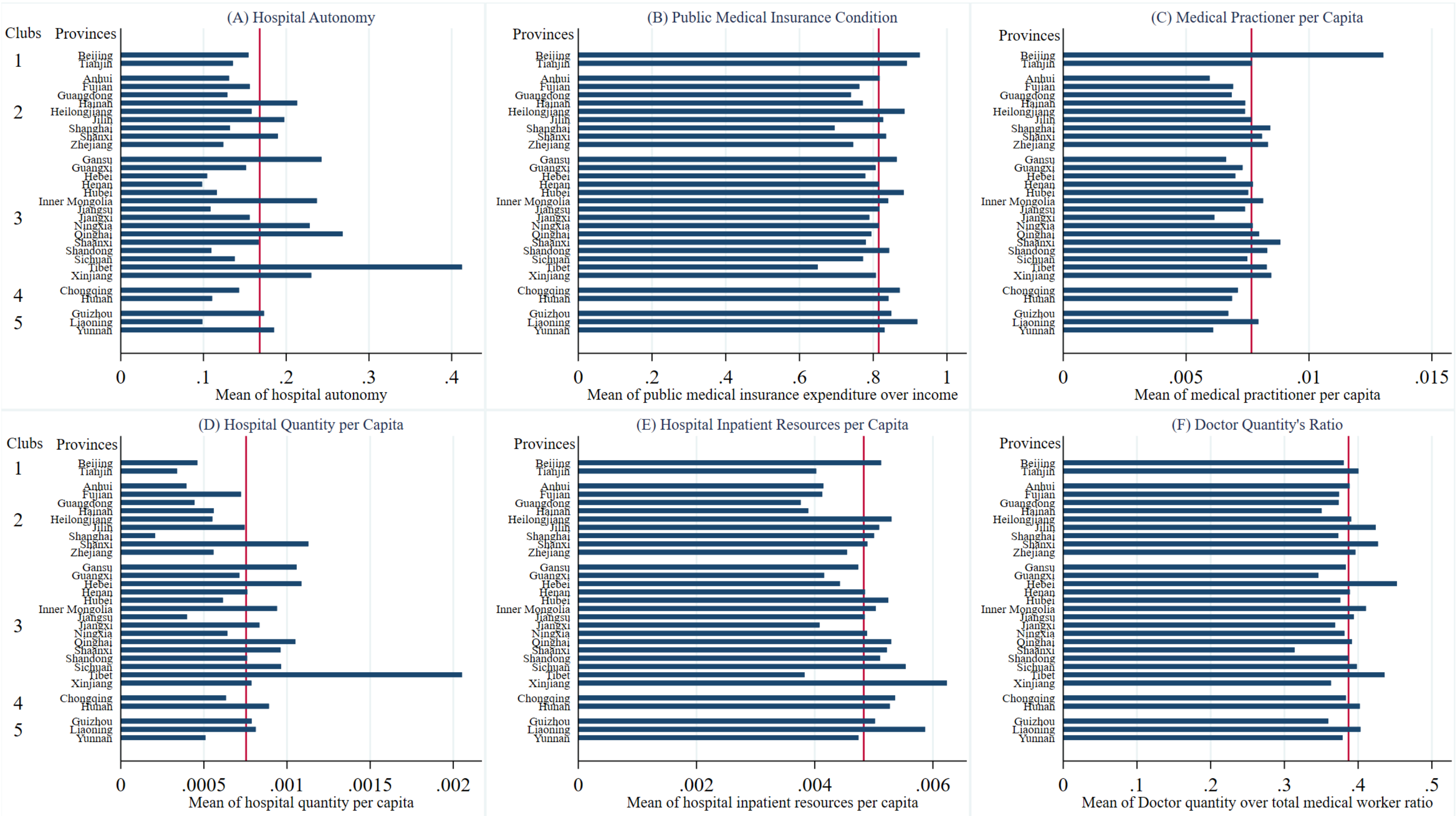
Source: Author's construction using the data from China Educational Finance Statistical Yearbook (Department of Finance et al., 2010-2019).

6.3.4. Medical and Health Determinants

In early studies, literature highlighted improving hospital autonomy to strengthen hospital efficiency while retaining its public attributes. Some governments started by varying the hospital autonomy degree to reduce government burdens and increase effectiveness (Chawla & Govindaraj, 1996). Later, a case study in Vietnam suggested that hospital autonomy may offer positive recognition of service, staff payments, and investments in municipal and provincial hospitals, which are relatively advanced. But for district hospitals or more fundamental clinics, the complex effect of hospital autonomy still requires further discussions (London, 2013). In China, Xu et al. (2019) suggested that a better financing strategy and value-based investment can support hospitals' management autonomy and improve hospital services.

As the literature agrees on the impact of government interventions and hospital autonomy, we select the ratio of institutional income to hospitals' total income across provinces. We assume that if more money comes from non-governmental sources, the hospital should have larger possibilities to gain its autonomy. Furthermore, as discussed in Chapter 2, the literature review chapter, China's central governmental medical and health determinants have been focusing on exploring the greater usage of urban and rural public medical insurance and strengthening the medical resources in many ways to ensure the medical quality of different tiers of the hospital. Under these circumstances, we collected six different medical and health-related determinants. The mean value of each province is demonstrated in the following Figure 6-7.

Figure 6-7 Medical and Health Determinants, 2010-2018 Mean Value



Source: Author's construction using the data from China Health Statistical Yearbook (Ministry of Health of the People's Republic of China, 2010-2019).

The hospitals’ autonomy figure, representing the government financial subsidies’ proportion of overall hospital funding, illustrates the high government interference in rural and undeveloped provinces. Gansu, Hainan, Inner Mongolia, Jilin, Ningxia, Qinghai, Tibet, Xinjiang, and Yunnan illustrate a relatively higher ratio of government subsidies than other provinces. These regions are located in the west, south, and north part of China, experiencing considerable medical resources and quality gaps with the rest of the Country. Surely, they would require extra support from the government to fulfill the local medical demands.

Populations in one place can all potentially become a patient in theory, and several medical services are highly concerned by patients. Firstly, medical insurance program is one of the most important tools for people to reduce their medical expenses when severe bodily injury or diseases happens. It can also be seen as encouraging people to seek treatment without having too much psychological burden if they feel uncomfortable. Some medical insurance programs will also encourage regular medical check-ups, which can help reduce unhealthy risks among the population. There are quite some different types of medical insurance around the world, Lorenzoni et al. (2018) have implemented private medical insurance variable from OECD countries, and they find that some supervision from the administrations for this market is needed because a completely business-designed medical insurance market may not be so positive for life expectancy development. Although there are also many different businesses in medical insurance in China, most citizens have already participated in the public medical insurance program that the government directs as public welfare. We have learned from the central government's annual work report that, with a proper developing path, urban residents’ medical care insurance and rural cooperative medical insurance were regulated separately. Still, both increased their financial support to the participants during the past 15 years. The integration process of urban and rural public medical insurance after 2016 kept motivating public medical insurance funding to universal usage, and participants could start to use their insurance without the restrictions of the registered areas. To show the effectiveness of the overall medical insurance payment, we selected the medical insurance expenditures ratio over total medical insurance incomes as the proximity of China’s public medical insurance indicator across provinces. The second figure in 6-7 suggests that most provinces can catch up with the mean spending ratio of about 80%.

In contrast, several provinces, such as Fujian, Guangdong, Shanghai, and Tibet, fall behind the red line. However, the reasons for these provinces’ variations may be different from each other, as Guangdong and Shanghai’s low medical insurance expenditure ratio may cause by the large population and medical insurance funding accordingly, while other undeveloped provinces’ low ratio resulted from the better natural environment and less local patients compared to those provinces which are in the middle of the industrial development upgrade process.

From the view of medical resources, firstly, the medical practitioner per capita uncovered a shocking fact that, in China's capital city, Beijing, even with its incredibly crowded population, its medical practitioners per capita can nearly double the result of the average most of the provinces. Meanwhile, Anhui, Jiangxi, and Yunnan lack medical practitioners in the horizontal comparison. This direct data interpretation easily reminds us of the medical resource’s imbalance from the first impression.

Looking into the medical resources issue from a larger scale, the hospital (Medical institutions including a hospital, professional medical institutions, community clinics, and so on) resources per capita reflect another scenario. Oppositely, urban provinces and municipalities show relatively lower hospital quantity per capita. In contrast, the most undeveloped provinces across China provide more hospital choices for the local people. The overall reason can be complicated, but we assume that population scale and professionality lead to this reality.

Each province's inpatient beds resource per capita does not show significant variance between them. We may find a central effect through its general pattern. The provinces with high bed resources per capital are distributed reasonably according to their geographical locations. As Beijing, Chongqing, Heilongjiang, and Xinjiang present better inpatient bed resources, their neighbouring provinces generally reflect a relatively low quantity. For the Yangtze River triangle region, Shanghai, Jiangsu, and Zhejiang maintain a similar level, while Anhui, Fujian, and Jiangxi, as the neighbouring provinces, also demonstrate lower numbers.

Lastly, as medical quality is also one of the central policy concerns, we collected the doctor ratio among all the medical practitioners (Including doctors, nurses, and other medical workforces) as the determinant. The last figure in Figure 6-7 shows a generally steady number across most provinces, and the average value is about 37%. In the meantime, we can also observe a relatively higher performer, Hebei, and its doctor proportion beyond the level of 40%. On the contrary, Shaanxi also has a relatively lower ratio, with only 30% of the medical workforce being doctors.

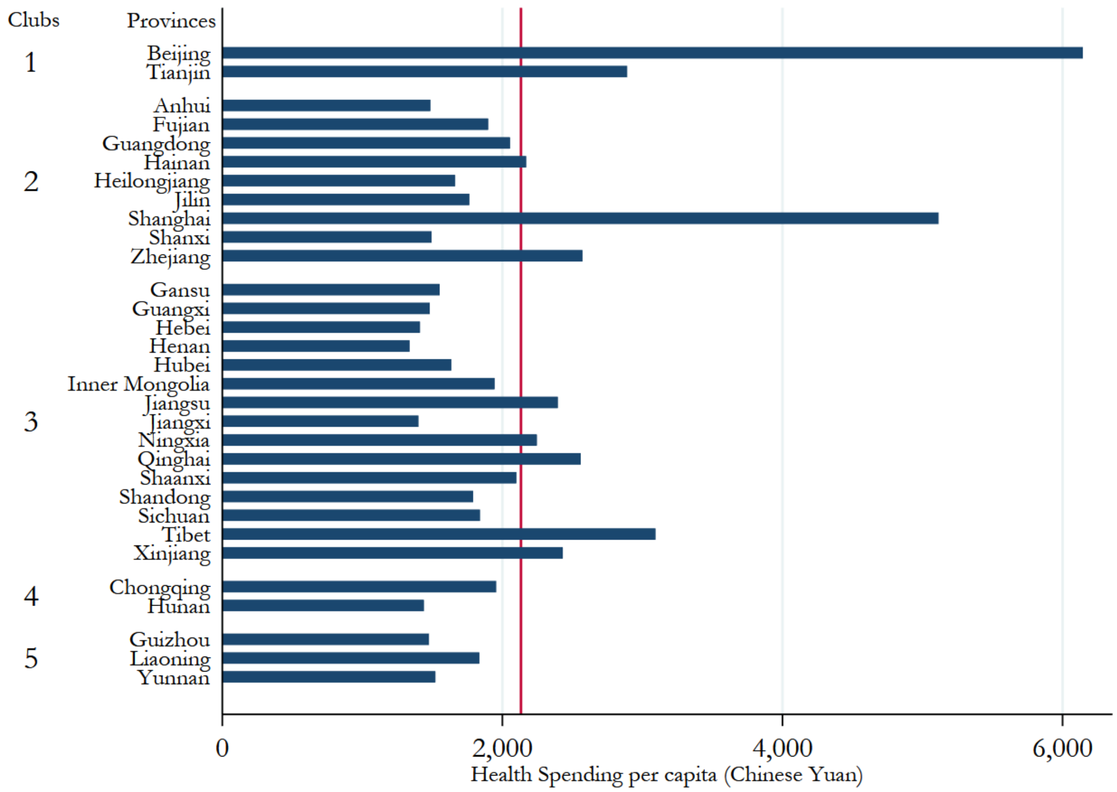
All the medical and health determinants chosen in this section can be considered relative proxies for this research. We admit that other data options can replace part of these variables. However, our research can generate reasonable and robust analysis results with these factors.

6.3.5. Health Spending from Government and Society

Similar to the educational funding described in the previous section, the health spending offered by the government and society is also required to accomplish our spending interaction model from the health perspective. Detailed information is provided in the following Figure 6-8. As you can observe from the figure, we controlled the variable to the per capita level with the basic Chinese Yuan (RMB) unit.

We detected a similar pattern to most other funding figures in China. Beijing and Shanghai occupied the top two health spending across China as Beijing spent more than 6000 yuan per capita and Shanghai spent about 5000 yuan per capita annually.

Figure 6-8 Government and Social Health Spending per capita, 2010-2018 Mean Value



Source: Author's construction using the data from China Health Statistical Yearbook (Ministry of Health of the People's Republic of China, 2010-2019).

Most provinces' health spending per capita is relatively low compared to the mean value.

However, we can still observe that Hainan, Ningxia, Qinghai, Shaanxi, Tibet, and Xinjiang outperformed other undeveloped provinces.

6.3.6. Overall Data Description

Table 6-2 below demonstrate all the data descriptions we have explained in the previous sections, and we have divided them into six categories for the sake of clarity.

Table 6-2 Overall Data Description

Category	Variable	Obs.	Mean	Std.	Min	Max
Spending	Log Primary School Funding per student (Government and Private)	279	9.183	0.495	7.772	10.480
	Log Secondary School Funding per student (Government and Private)	279	10.500	0.529	9.392	12.210
	Log Vocational Secondary School Funding per student (Government and Private)	253	10.620	1.253	8.326	20.860
	Log University Funding per student (Government and Private)	279	11.060	0.808	9.399	13.940
	Log Medical Spending per capita (Government and Society)	271	7.527	0.510	6.449	9.190
Primary School	Pre-primary education experience ratio	279	0.946	0.102	0.239	1.000
	Teacher Quality (Teacher Student ratio)	279	0.062	0.010	0.045	0.088
	School Autonomy (School Individual Spending ratio)	279	0.678	0.062	0.485	0.802
	Teaching conditions (Classroom space over total school space)	279	0.129	0.040	0.046	0.222
	Exercise conditions (Sports area space over total school space)	279	0.302	0.074	0.091	0.498
Secondary School	Teacher Quality (Teacher Student ratio)	279	0.073	0.015	0.051	0.134
	School Autonomy (School Individual Spending ratio)	279	0.625	0.068	0.398	0.774
	Teaching conditions (Classroom space over total school space)	279	0.103	0.019	0.061	0.153
	Exercise conditions (Sports area space over total school space)	279	0.258	0.048	0.106	0.370
Vocational Secondary School	Teacher Quality (Teacher Student ratio)	279	0.050	0.017	0.025	0.121
	School Autonomy (School Individual Spending ratio)	279	0.513	0.074	0.291	0.723
	Exercise conditions (Sports area space over total school space)	252	0.168	0.041	0.061	0.260
	Teaching conditions' quality (Fixed assets value per student)	252	3.147	5.168	0.523	58.420
	Teachers' ability (Higher educated-teacher ratio over all teachers)	252	0.871	0.088	0.400	0.996
	Teachers' experience (Intermediate and higher title ratio)	252	0.619	0.111	0.182	1.000
University	Teacher Quality (Teacher Student ratio)	279	0.057	0.004	0.049	0.075
	School Autonomy (School Individual Spending ratio)	279	0.453	0.068	0.246	0.600
	Faculty Scale (Full-time faculty ratio over all employees)	279	0.655	0.053	0.439	0.750
	Teachers' experience (Intermediate and higher title ratio)	279	0.799	0.062	0.429	0.945
	Research conditions (Research employees' ratio over all employees)	279	0.012	0.012	0.001	0.094
Medical And Health	Hospital Autonomy (Government funding ratio)	279	0.168	0.066	0.077	0.538
	Public Medical Insurance condition (Expenditure / Income)	279	0.815	0.080	0.495	1.006
	Medical Practitioner Resources (per capita)	279	0.007	0.002	0.004	0.0151
	Hospital Quantity (per capita)	279	0.0007	0.0003	0.0002	0.002
	Hospital Inpatient Resources (Beds per capita)	279	0.005	0.001	0.003	0.007
	Medical Worker Quality (Doctor quantity over total medical worker ratio)	279	0.387	0.0312	0.289	0.469

Source: Author's calculation using the data from China Health Statistical Yearbook (2010-2019), China Education Statistical Yearbook (2010-2019), and China Educational Finance Statistical Yearbook (2010-2019).

We also provide a specific explanation for each variable in the table to make the original definitions and attributes of these variables understandable. Most variables have 279 observations, and part of the vocational secondary school and medical and health spending variables have missing data. We have also offered a full correlation matrix with all the variables involved in Table A6-1 to A6-3 in the Appendix. It shows that most of the correlations between variables are significant. The correlation between different spending is the only part with a coefficient over 0.8 but will not be estimated together in the analysis. The correlations generally show convincing results for further analysis.

6.4. Results and Discussion

The two parts of the regression result will be explained separately first for their typical findings. But for final discussions, there will be an integrated framework to summarize all the findings for making the overall policy suggestions.

6.4.1. Result of Different Education Degrees

The spending interaction analysis used the panel fixed effect regressions, in which we fixed the effect on unit and time. Here the unit is not the provinces, but the clubs' identification derived from convergence analysis in Chapter 5, and the time-fixed effect is based on the year. Meanwhile, we can also analyze the determinants' predictive importance using the decomposition method. The original idea of this approach has been explained in the methodology section, for we can receive three different pieces of information from the results.

The coefficient shows the positivity or negativity of the factor to human capital while $b*_i^2$ (ceteris paribus) represent its independent importance among the whole model. E_i (non-ceteris paribus) tells us this variable's joint effects on others and how much it weighs in the R-squared.

This section will provide the regression result of two approaches with different education degrees and health perspectives. Table 6-3 shows the regression of primary education and health determinants.

Table 6-3 shows an aggregated impression of determinants from primary education and health perspectives. The spending interaction regression in the first column indicates the insignificant coefficient of primary education funding to the human capital index, while medical and health spendings generate positive correlations of 0.075. The interaction results start from primary education-related determinants. Pre-primary education, teachers' quality, and schools' exercise space ratio positively correlate to the human capital index through education funding. In the meantime, primary schools' autonomy and classroom space ratio may damage local human capital development through funding interaction. The medical and health determinants interacting with health spending present a negative coefficient of government financial subsidy ratio and inpatient medical bed resources within the same spending interaction system. One positive correlated determinant is the medical workforce's quality (Proportion of the doctors). Besides these three variables, other medical and health policies suggest insignificant results in this interaction model.

Table 6-3 Results of Primary Education and Health Determinants

	(1) Spending Interaction HCI	(2) β_i	(3) Predictive Importance $b*_i^2$	(4) E_i
Core Driver Spending		Core Driver Spending		
Log Primary School Funding per student	-0.008	-0.048***	6.199	-21.463
	(-0.67)	(-0.01)		
Log Medical Spending per capita	0.075***	0.142***	57.192	68.022
	(4.99)	(-0.01)		
Determinants*Core Driver		Only Determinants		
Pre-primary education experience ratio	0.009***	0.173***	2.058	10.766
	(2.97)	(-0.04)		
Teacher Quality (Teacher Student ratio)	0.164***	2.469***	6.698	16.383
	(6.41)	(-0.28)		
School Autonomy (School Individual Spending ratio)	-0.007**	0.059**	0.153	-0.173
	(-2.58)	(-0.02)		
Teaching conditions (Classroom space over total school space)	-0.011**	-0.062	0.068	-0.813
	(-2.24)	(-0.06)		
Exercise conditions (Sports area space over total school space)	0.013***	0.086***	0.429	5.11
	(5.27)	(-0.03)		
Hospital Autonomy (Government funding ratio)	-0.041***	-0.245***	2.527	5.654
	(-7.21)	(-0.06)		
Public Medical Insurance condition (Expenditure / Income)	0.004	0.003	0.001	-0.009
	(1.57)	(-0.02)		
Medical Practitioner Resources (per capita)	0.206	-0.804	0.017	-1.013
	(0.82)	(-2.08)		
Hospital Quantity (per capita)	1.279	6.984	0.054	-1.516
	(1.25)	(-8.52)		
Hospital Inpatient Resources (Beds per capita)	-4.337***	-40.531***	17.142	-0.653
	(-12.18)	(-2.78)		
Medical Worker Quality	0.017***	0.200***	0.418	0.768
	(2.70)	(-0.06)		
Constant	0.387***			
	(6.50)			
Observations	271	271		
R-squared	0.916	0.811		
Year Fixed Effect	Yes			
Convergence Club Fixed Effect	Yes			

Note: *** p<0.01, ** p<0.05, * p<0.1, Panel Fixed Effect Regression and Predictive Importance. The values in parentheses are confidence levels.

Source: Author's calculation using the results from Spending Interaction Analysis and Predictive Importance Analysis.

The three columns on the right are the independent predictive importance regression result of all the variables, which means determinants will not be multiplied by related spending and funding in the regression. The predictive importance result shows that in the combined system with primary education and health perspectives, primary school funding seemed to go against the provincial human capital development while medical and health aggregated spending continued to stimulate human capital growth. The ceteris paribus and non-ceteris paribus result further suggest that primary education funding would be against other variable functions in the system. At the same time, medical and health spendings highly support human capital development with 68% of contributions among all the factors.

Again, pre-primary education and primary schools' teacher quality positively affect human capital, with 10% and 16% of the same direction contributions in the whole model. Primary schools' autonomy generates positive returns on its own this time, but its systematic contribution still may interfere with other variables since it has a lower E_i. School conditions indicator only remain physical exercises space ratio maintain a significant result which is still a positive coefficient. The non-ceteris paribus result indicates 5% of exercise space ratio contributions.

Move to the health side, the hospital autonomy factors' negative coefficient and larger E_i suggests that fewer government financial subsidies to hospitals and offering more independent management choices may help stimulate human capital development. Straightly jumping to inpatient bed resources per capita keeps the negative result and an opposite direction's contribution to other factors. Lastly, the doctor ratio denoted medical workers' quality remained positive importance to human capital, but the overall contribution only reached 0.7 among the whole model.

Table 6-4 Results of Secondary Education and Health Determinants

	(1) Spending Interaction HCI	(2) β_i	(3) Predictive Importance $b*_i^2$	(4) E_i
Core Driver Spending		Core Driver Spending		
Log Secondary School Funding per student	-0.018	-0.099***	21.915	-47.098
	(-1.41)	(-0.01)		
Log Medical Spending per capita	0.048***	0.162***	54.233	77.297
	(2.66)	(-0.02)		
Determinants*Core Driver		Only Determinants		
Teacher Quality (Teacher Student ratio)	0.062***	1.155***	2.407	20.35
	(2.82)	(-0.28)		
School Autonomy (School Individual Spending ratio)	-0.002	0.026	0.026	0.532
	(-0.73)	(-0.04)		
Teaching conditions (Classroom space over total school space)	-0.028***	-0.416***	0.488	-2.107
	(-3.35)	(-0.11)		
Exercise conditions (Sports area space over total school space)	0.040***	0.326***	1.922	13.184
	(10.46)	(-0.04)		
Hospital Autonomy (Government funding ratio)	-0.024***	-0.154***	0.733	3.553
	(-4.99)	(-0.04)		
Public Medical Insurance condition (Expenditure / Income)	0.006**	-0.005	0.001	0.014
	(2.10)	(-0.02)		
Medical Practitioner Resources (per capita)	0.599**	3.312	0.206	4.176
	(2.15)	(-2.54)		
Hospital Quantity (per capita)	-0.003	-28.143***	0.645	6.108
	(-0.00)	(-8.68)		
Hospital Inpatient Resources (Beds per capita)	-4.011***	-36.486***	10.201	-0.588
	(-9.93)	(-3.39)		
Medical Worker Quality	0.021***	0.341***	0.891	1.309
	(2.78)	(-0.07)		
Constant	0.668***			
	(7.55)			
Observations	271	271		
R-squared	0.893	0.767		
Year Fixed Effect	Yes			
Convergence Club Fixed Effect	Yes			

Note: *** p<0.01, ** p<0.05, * p<0.1, Panel Fixed Effect Regression and Predictive Importance. The values in parentheses are confidence levels.

Source: Author's calculation using the results from Spending Interaction Analysis and Predictive Importance Analysis.

Moving to secondary education and health interaction regression, Table 6-4 reflects similar education funding and health spending results as secondary education funding is insignificantly correlated to human capital while health spending still offers a positive coefficient, which is 0.48 in the interaction panel regression. Teachers' quality and exercise space ratio show positive results among the secondary education determinants through the funding channel with 0.062 and 0.04, respectively. On the contrary, the classroom space ratio negatively affects human capital development through education funding, while secondary schools' autonomy does not illustrate significant results.

Health determinants now demonstrate a more significant result. Hospital autonomy's negative correlation suggests that more governmental hospital subsidies may not affect human capital development. The public medical insurance expenditure ratio gives a 0.006 coefficient in the model, which shows a good impact of more insurance spending through funding but not at a high level. Medical practitioner per capita reflects a 0.599 correlation combining health spending interaction. Hospital quantity does not show significant results in this model, but inpatient resources and medical worker quality generate positive and negative coefficients.

The predictive importance evaluation indicates the negative impact of secondary schools' funding and the positive influence of health spending on human capital in this system. Health spendings continue to show a large proportion of its contributions. From the condition of secondary school education determinants, teachers' quality, and exercises space ratio both maintained the positive coefficient and larger non-ceteris paribus results, implying the great importance of these two policies' intentions. Meanwhile, classrooms space proportion to total school spaces standstill on its negative result and lower E_i in the estimation which furtherly denies the contribution of classroom space requirements in secondary schools.

Hospital autonomy factors again support the idea of reducing the government's financial subsidies may universally increase human capital, and it has a larger E_i result, which indicates a 3.5% of contribution in comparison to other variables. Medical insurance expenditures ratio and practitioner per capita do not offer significant estimates of the importance regression on their own, potentially suggesting the effectiveness of health spending. Hospital quantity and hospitals' inpatient bed resources both reflect negative estimates, but the former gets a larger non-ceteris paribus result which means more medical institution resources in this system may not reduce the human capital only but also generate great importance by following the systematic direction while the inpatient bed resources even drop a lower E_i. The medical workforce's quality keeps its positive effect on human capital growth and obtains a 1.3% contribution as overall importance.

In terms of vocational secondary education, the combined regression with a health perspective is presented in Table 6-5. The result shows that per-student education funding in vocational degrees negatively affects human capital development. At the same time, medical spending from the government and society remains a good influence in the vocational secondary and health combined scenario. Nevertheless, teachers' quality of vocational secondary education can positively affect human capital accumulation through the education funding interaction. Meanwhile, vocational secondary schools' autonomy, teaching conditions, and teachers' ability (Diploma) reject any significant level when aggregated through education funding. Even though we can still observe positive reactions from the exercise space ratio and teachers' experiences, the functionality of education funding affects vocational secondary schools' physical exercise policy and experienced teachers' requirements, respectively.

Table 6-5 Results of Vocational Secondary Education and Health Determinants

	(1)	(2)	(3)	(4)
	Spending Interaction		Predictive Importance	
	HCI	β_i	$b*_i^2$	E_i
Core Driver Spending		Core Driver Spending		
Log Vocational Secondary School Funding per student	-0.018***	-0.007***	1.405	-4.355
	(-7.20)	(0.00)		
Log Medical Spending per capita	0.079***	0.076***	35.051	36.842
	(6.45)	(-0.01)		
Determinants*Core Driver		Only Determinants		
Teacher Quality (Teacher Student ratio)	0.021*	0.526***	1.81	7.765
	(1.79)	(-0.17)		
School Autonomy (School Individual Spending ratio)	0.002	0.094***	1.085	4.15
	(0.59)	(-0.03)		
Exercise conditions (Sports area space over total school space)	0.016***	0.229***	2.061	7.825
	(4.05)	(-0.04)		
Teaching conditions' quality (Fixed assets value per student)	-0.000	-0.002***	1.691	-5.934
	(-1.42)	(0.00)		
Teachers' ability (Higher educated-teacher ratio over all teachers)	0.002	0.044	0.352	4.049
	(1.04)	(-0.04)		
Teachers' experience (Intermediate and higher title ratio)	0.008***	0.044**	0.557	3.761
	(5.63)	(-0.02)		
Hospital Autonomy (Government funding ratio)	-0.022***	-0.058	0.192	0.959
	(-4.30)	(-0.05)		
Public Medical Insurance condition (Expenditure / Income)	0.014***	0.00	0.00	0.00
	(4.46)	(-0.03)		
Medical Practitioner Resources (per capita)	0.513	12.185***	8.408	16.071
	(1.58)	(-2.61)		
Hospital Quantity (per capita)	4.055**	-18.805	0.487	3.502
	(2.45)	(-13.13)		
Hospital Inpatient Resources (Beds per capita)	-3.537***	-35.543***	27.872	2.463
	(-8.13)	(-3.30)		
Medical Worker Quality	0.011	0.194**	0.778	0.894
	(1.27)	(-0.08)		
Constant	0.375***			
	(4.99)			
Observations	246	246		
R-squared	0.901	0.78		
Year Fixed Effect	Yes			
Convergence Club Fixed Effect	Yes			

Note: *** p<0.01, ** p<0.05, * p<0.1, Panel Fixed Effect Regression and Predictive Importance. The values in parentheses are confidence levels.

Source: Author's calculation using the results from Spending Interaction Analysis and Predictive Importance Analysis.

From the health perspective, hospital autonomy, public medical insurance, hospital quantity, and inpatient bed resources present significant results through the interaction model. With a negative hospital autonomy coefficient, the idea of promoting human capital development with government financial subsidies is still denied. Meanwhile, providing more support to public medical insurance expenditures on the individual level may become a better option. Unlike the previous two regressions, hospital quantity per capita in this combined estimation turns out to be positively correlated with human capital development. It may explain that the number of medical institutions in a specific scenario could be critical to the impact of general medical spending. Hospital inpatient bed resources remain a negative effect in the interaction estimation, reflecting a similar result to the previous two regressions.

The predictive importance regression on the right-hand side of Table 6-5 presents the negative effect of vocational secondary education funding and the positive effect of medical spending from the public and private sectors. Furthermore, medical spending obtains a larger non-ceteris paribus estimate (36.842), implying that medical spending could be crucial for human capital. The vocational secondary education determinants, teachers' quality, schools' autonomy, and exercise space conditions positively affect human capital accumulation. Their E_i estimates keep greater than $b*_i^2$, and occupied the proportion of contribution at 7.7%, 4.1%, and 7.8%, respectively. Fixed assets per student of vocational secondary education show a -0.002 coefficient in the predictive importance analysis. Even though its $b*_i^2$ shows 1.69 of the importance independently of the negative E_i reflect its bad cooperative contribution in this scenario. Teachers' diploma is not significant again, while the teachers' professional titled ratio generates a 0.044 correlated effect on the human capital index and a 3.76% contribution to the overall system.

Medical and health determinants showed a different significant level than spending interaction regression. The medical practitioner scale is hugely important for human capital as a policy focus, and it also presents a 16% contribution to the model as non-ceteris paribus suggested. Furthermore, medical workers' quality generates a positive importance estimate, but the contribution is not that attractive. Conversely, the hospital inpatient bed resource keeps its negative coefficient despite its importance. So far, we haven't seen specific benefits of increasing hospital inpatient beds.

Table 6-6 Results of University Education and Health Determinants

	(1) Spending Interaction HCI	(2) Predictive Importance β_i	(3) $b*_i^2$	(4) E_i
Core Driver Spending		Core Driver Spending		
Log University Funding per student	0.015***	-0.004	0.231	-2.69
	(3.06)	(0.00)		
Log Medical Spending per capita	0.045***	0.076***	35.232	36.184
	(4.17)	(-0.01)		
Determinants*Core Driver		Only Determinants		
Teacher Quality (Teacher Student ratio)	-0.177***	-2.062***	1.604	-1.209
	(-4.35)	(-0.72)		
School Autonomy (School Individual Spending ratio)	-0.008***	0.107***	1.223	0.309
	(-2.85)	(-0.04)		
Faculty Scale (Full-time faculty ratio over all employees)	-0.016***	-0.270***	4.836	11.941
	(-3.33)	(-0.07)		
Teachers' experience (Intermediate and higher title ratio)	0.014***	0.111**	1.101	6.894
	(4.49)	(-0.05)		
Research conditions (Research employees' ratio over all employees)	-0.045***	-0.641*	1.365	-4.98
	(-2.93)	(-0.34)		
Hospital Autonomy (Government funding ratio)	-0.030***	-0.176***	2.829	4.055
	(-6.60)	(-0.05)		
Public Medical Insurance condition (Expenditure / Income)	0.012***	0.023	0.081	-0.066
	(3.86)	(-0.03)		
Medical Practitioner Resources (per capita)	0.143	7.668**	3.282	9.67
	(0.52)	(-3.45)		
Hospital Quantity (per capita)	2.512**	-33.646***	2.732	7.303
	(2.31)	(-12.55)		
Hospital Inpatient Resources (Beds per capita)	-2.179***	-26.417***	15.853	-0.425
	(-5.87)	(-3.41)		
Medical Worker Quality	0.033***	0.431***	4.233	1.658
	(4.45)	(-0.08)		
Constant	0.485***			
	(6.50)			
Observations	271	271		
R-squared	0.886	0.686		
Year Fixed Effect	Yes			
Convergence Club Fixed Effect	Yes			

Note: *** p<0.01, ** p<0.05, * p<0.1, Panel Fixed Effect Regression and Predictive Importance. The values in parentheses are confidence levels.

Source: Author's calculation using the results from Spending Interaction Analysis and Predictive Importance Analysis.

Finally, it is time to synergize the university education and health perspective into one model. You may directly find details of the result in Table 6-6. We observe the synergetic positive estimates of education funding and medical spending in the spending interaction regression for the first time. Under the combined university education and health policy, the priority of financial support to universities is still high, while medical spending greatly influences human capital development.

Unlike compulsory or vocational education, universities' policy factors demonstrate the interaction effect differently. The teacher-student ratio, which we defined as teachers' general quality, failed to generate positive estimates, while universities' school autonomy also highlighted a negative effect through universities fundings. The faculty scale of the university may turn out to be over-recruited because of its -0.016 coefficient. The same issue happened to research involvement which shows larger researcher ratio would not necessarily give better returns to human capital accumulation through funding interaction. However, we still find a critical point that the experience of universities teacher can strengthen human capital development with the existing university funding strategy.

In the meantime, the medical and health perspective stayed similar to the previous regression. The hospital autonomy factor's negative correlation expresses the opposite effect of government financial subsidies on local human capital growth and denies the incentive interaction of medical spending. The expenditure's proportion of public medical insurance reflects valuable contributions to enhancing human capital with the support of public and private medical spending. Medical institution resources seem to be a great spending target since its interaction regression result is 2.512. On the contrary, hospitals' inpatient bed resource keeps their negative estimate like those in previous scenarios. Lastly, the quality of the medical workforce continued to be a useful medical spending policy for human capital development.

The second part of the regression, predictive importance estimation on university and health combined scenario, uncovered a further understanding of funding and policy effectiveness. For universities that received public and private funding, no significant estimates demonstrated that medical spending from the government and society keeps positive and high-contributively to human capital. On the policy intentions, Teachers' quality, faculty scale, and research conditions of the university education drop opposite effect, and only faculty scale furtherly shows higher importance and contributions. Universities' autonomy, as one of the main policies focuses, should be able to generate more advantages to promote human capital as it has a positive coefficient, but the non-ceteris paribus estimated E_i also suggest that the effect can be achieved with other contributive factors' sacrifice. Meanwhile, the professional titled teachers' ratio, which denotes teachers' experience, positively influences human capital and contributes relatively high to this model.

This combination of medical and health policies' predictive importance analysis continuously suggests that hospital autonomy is critical for human capital accumulation. The negative coefficient believes that government subsidies to hospital income may not be the best choice. A positive correlation between medical practitioners' per capita and medical workers' quality can be found. However, medical practitioners per capita get a larger E_i while the quality of medical workers requires other variables' effects reduction, hospital quantity for medical institutions choices and inpatient bed resources both generate negative estimates. More hospitals and clinics may even worsen the overall human capita performance in the long run.

6.4.2. Result of Full Model Regression

To reduce potential suspicion or missing effect, we would also like to provide Table 6-7 and 6-8 as follows. It contains all the variables we have used in the previous section to form an aggregated baseline estimation. Table 6-7 is the spending interaction analysis using panel fixed effect regression. Table 6-8 offers predictive importance analysis results.

Table 6-7 Panel Fixed Effect Regression Result – Full Model

	Spending Interaction HCI
Core Driver Spending	
Log Primary School Funding per student	0.039***
	(2.65)
Log Secondary School Funding per student	-0.029*
	(-1.95)
Log Vocational Secondary School Funding per student	-0.008**
	(-2.36)
Log University Funding per student	0.018***
	(3.54)
Log Medical Spending per capita	0.037**
	(2.06)
Determinants*Core Driver	
Pre-primary education experience ratio	0.007*
Primary School	(1.77)
Teacher Quality (Teacher Student ratio)	0.015
Primary School	(0.37)
School Autonomy (School Individual Spending ratio)	0.001
Primary School	(0.16)
Teaching conditions (Classroom space over total school space)	-0.021*
Primary School	(-1.66)
Exercise conditions (Sports area space over total school space)	0.002
Primary School	(0.33)
Teacher Quality (Teacher Student ratio)	0.062**
Secondary School	(2.42)
School Autonomy (School Individual Spending ratio)	-0.009
Secondary School	(-1.53)
Teaching conditions (Classroom space over total school space)	0.011
Secondary School	(0.53)
Exercise conditions (Sports area space over total school space)	0.021**
Secondary School	(2.08)
Teacher Quality (Teacher Student ratio)	-0.017
Vocational Secondary School	(-1.25)
School Autonomy (School Individual Spending ratio)	0.003
Vocational Secondary School	(1.17)
Exercise conditions (Sports area space over total school space)	0.000
Vocational Secondary School	(0.04)
Teaching conditions' quality (Fixed assets value per student)	-0.000*
Vocational Secondary School	(-1.83)

Teachers' ability (Higher educated-teacher ratio over all teachers)	-0.001
Vocational Secondary School	(-0.57)
Teachers' experience (Intermediate and higher title ratio)	0.004***
Vocational Secondary School	(3.20)
Teacher Quality (Teacher Student ratio)	-0.111**
University	(-2.56)
School Autonomy (School Individual Spending ratio)	-0.000
University	(-0.19)
Faculty Scale (Full-time faculty ratio over all employees)	-0.013***
University	(-2.65)
Teachers' experience (Intermediate and higher title ratio)	0.002
University	(0.87)
Research conditions (Research employees' ratio over all employees)	-0.014
University	(-0.80)
Hospital Autonomy (Government funding ratio)	-0.035***
Medical and Health	(-5.23)
Public Medical Insurance condition (Expenditure / Income)	0.004
Medical and Health	(1.50)
Medical Practitioner Resources (per capita)	0.632*
Medical and Health	(1.87)
Hospital Resources (per capita)	0.139
Medical and Health	(0.09)
Hospital Inpatient Resources (Beds per capita)	-4.580***
Medical and Health	(-9.94)
Medical Worker Quality (Doctor ratio over total medical worker)	0.025***
Medical and Health	(3.42)
Constant	0.554***
	(4.44)
Observations	246
R-squared	0.949
Year Fixed Effect	Yes
Convergence Club Fixed Effect	Yes

Note: *** p<0.01, ** p<0.05, * p<0.1, Panel Fixed Effect Regression. The values in parentheses are confidence levels.

Source: Source: Author's calculation using the results from Spending Interaction Analysis.

Starting with the funding and spending from public and private sources, the spending interaction model in Table 6-6 shows a positive coefficient on primary, university, and medical perspectives. At the same time, secondary-level education demonstrates negative reactions, no matter the normal or vocational category. More specifically, we can observe primary schools' funding reaches 0.039, which is even larger than medical spending's coefficient (0.037), and university funding is half of that.

Pre-primary education remained one of the significantly correlated determinants in the full model test. It continued to draw a good impact; 0.007 may not be recognized as a large estimate in the model. However, it still supports the intention of subsidizing the pre-school education policy in China. Contrarily, primary education classroom conditions still damage human capital with funding interactions, and we may consider this phenomenon a quality problem in primary schools. There are also two significant determinants in secondary schools. Teachers' quality and exercise space generate positive human capital returns through secondary school funding interaction. On the one hand, 0.062 of the teachers' quality correlation to human capital interprets that secondary school teachers may require better funding incentives to ensure human capital development. On the other hand, exercise space proportion in secondary schools with a coefficient of 0.021 confirmed the priority of central government policy narratives that motivate youth and teenage students to participate in daily physical exercises.

In the baseline regression, the vocational secondary schools' education does not show a high impact on human capital through its funding. The teaching environments and conditions represented by fixed assets per student drop a rather low effect though it seems to be a negative coefficient. Nevertheless, the professionality of vocational secondary schools' teacher is still important to promote human capital with properly targeted funding strategies, even though we admit that 0.004 as the estimate is not high among all the factors. At the higher education level, universities in China require deepened reform strategy to optimize the teacher group's structure since funding interacts with teachers' quality factors demonstrating a negative coefficient. Also, the faculty scale of universities requires further improvement to reduce potential redundancy issues. The -0.013 coefficient reminds us that universities should be treated more carefully in their funding strategy and interventions.

The baseline regression also keeps its continuity on the result of the health aspect. -0.035 of hospital autonomy's correlation to human capital index re-highlighted hospitals' governmental subsidies with medical spending may not be ideal for maintaining hospitals' public welfare attributes. Hospitals' inpatient beds resources must also be optimized with suitable medical spending measures. Its -4.580 coefficients recommend redistributing inpatient bed resources to those most needed regions. Meanwhile, with their quantity and quality, medical practitioners per capita ask for more targeted incentives to promote human capital development. Medical practitioners per capita illustrate a 0.632 return in the model with medical spending interaction, while medical workforces' quality presents its correlation with the number of 0.025.

To fully view these spending and determinants' effectiveness, the aggregated baseline test with predictive importance analysis is supplemented in the following Table 6-8. We can combine it with the spending interaction model and provide determinants' recommendations on whether funding or spending incentives can become a good choice for sustainable human capital growth. First of all, within the funding and spending, only medical spending per capita demonstrates a positive impact and large contribution to human capital development, while education fundings in four different degrees all reflect negative estimates, and half are insignificant. Combining the non-ceteris paribus result, we suggest that education funding for most levels in China should be reconsidered with a more accurate target. Meanwhile, medical spending may require higher priority from the fundamental budgets.

Table 6-8 Aggregated Predictive Importance Analysis Regression Full Model Result

Category	Variable	(1) β_i	(2) $b*_i^2$	(3) E_i
Spending	Log Primary School Funding per student (Government and Private)	-0.003	0.017	-1.347
	Log Secondary School Funding per student (Government and Private)	-0.076***	13.621	-37.875
	Log Vocational Secondary School Funding per student (Government and Private)	-0.009**	0.768	-5.288
	Log University Funding per student (Government and Private)	-0.002	0.015	-1.129
	Log Medical Spending per capita (Government and Society)	0.161***	58.948	78.457
Primary School	Pre-primary education experience ratio	0.116**	0.407	6.077
	Teacher Quality (Teacher Student ratio)	1.658***	2.476	11.343
	School Autonomy (School Individual Spending ratio)	-0.178**	1.139	0.739
	Teaching conditions (Classroom space over total school space)	-0.207	0.564	-2.318
	Exercise conditions (Sports area space over total school space)	0.049	0.096	2.575
Secondary School	Teacher Quality (Teacher Student ratio)	0.664	0.891	11.928
	School Autonomy (School Individual Spending ratio)	0.125	0.662	2.364
	Teaching conditions (Classroom space over total school space)	0.104	0.033	0.425
	Exercise conditions (Sports area space over total school space)	-0.035	0.021	-1.248
Vocational Secondary School	Teacher Quality (Teacher Student ratio)	-0.187	0.085	-2.758
	School Autonomy (School Individual Spending ratio)	0.065*	0.192	2.865
	Exercise conditions (Sports area space over total school space)	0.178***	0.462	6.085
	Teaching conditions' quality (Fixed assets value per student)	0	0.046	-1.601
	Teachers' ability (Higher educated-teacher ratio over all teachers)	-0.015	0.015	-1.388
	Teachers' experience (Intermediate and higher title ratio)	0.042*	0.185	3.562
University	Teacher Quality (Teacher Student ratio)	0.309	0.012	0.234
	School Autonomy (School Individual Spending ratio)	0.079**	0.25	0.107
	Faculty Scale (Full-time faculty ratio over all employees)	-0.117	0.359	5.465
	Teachers' experience (Intermediate and higher title ratio)	-0.036	0.044	-2.245
	Research conditions (Research employees' ratio over all employees)	0.11	0.016	0.847
Medical and Health	Hospital Autonomy (Government funding ratio)	-0.175**	0.655	2.909
	Public Medical Insurance condition (Expenditure / Income)	-0.007	0.002	0.04
	Medical Practitioner Resources (per capita)	-0.897	0.017	-1.183
	Hospital Resources (per capita)	-27.139*	0.376	5.054
	Hospital Inpatient Resources (Beds per capita)	-39.368***	12.681	2.728
	Medical Worker Quality (Doctor ratio over total medical worker)	0.256***	0.499	1.176
	Observations	246		
	R-squared	0.866		

Note: *** p<0.01, ** p<0.05, * p<0.1, Predictive Importance.

Source: Source: Author's calculation using the results from Predictive Importance Analysis.

There are three significant determinants in primary school education. We can find a great intention to promote pre-primary school education for its 0.116 coefficient and 6.077% of contributions in the model. Teachers' quality in primary school offers 1.658 to human capital growth, indicating a large effect. With 2.476 of independent importance and 11.343% of contributions, further policy incentives for enhancing primary school teachers' quality should be considered. However, primary schools' autonomy generates a negative effect at about -0.178, and it is a lower E_i Suggests that primary school might need some supervision. Secondary school education does not present any significant results, but the importance and contributions of teachers' quality and schools' autonomy should be critical for human capital development. Nevertheless, secondary education may no longer be as important as it is used to accumulate human capital within such a complicated system.

Since education policy intention from the central government gradually focuses on vocational education, vocational secondary education in our predictive importance regression reflects three positive factors. Secondary schools' autonomy seems to be useful for further human capital development. The vocational secondary school exercise condition gives a 0.178 coefficient, the largest impact on human capital. We can also observe 0.042 as the estimate of teachers' professional titles in vocational secondary schools. Larger non-ceteris paribus results are also easily detectable for these three positive effects as their contributions to the main model are 2.865%, 6.085%, and 3.562%, respectively.

The final section of the education degree is the university, and we can only find one significant result in its predictive importance analysis: the schools' autonomy. As we have learned, promoting higher educational institutions' autonomy has been one of the major concerns of the central government's policy intentions in the past 15 years. Its predictive importance of it also generates 0.079 as its coefficient. However, its $b*_i^2$ reaches 0.25, which is higher than its E_i (0.107), and we consider it relatively low importance on its own and a less contributive factor to the overall human capital development.

Last but not least, China's health and medical determinants demonstrate four significant results: hospital autonomy, hospital quantity, hospital inpatient bed resources, and medical workers' quality. Similar to the majority of the regression results in the previous section, the hospital autonomy presents a negative value of -0.175 and a larger non-ceteris paribus estimate of 2.909, and we interpret these related results as the recommendation that government should optimize their decisions on financial compensating the hospital and offer them more management space with independency. Furthermore, the policies on enlarging the scale of hospital quantities and hospital inpatient bed quantities remain negatively correlated to human capital, with -27.139 and -39.368 as their coefficients which can be recognized as severe influences. In the meantime, these two variables illustrate different directions in contributing to the whole system. While hospital quantity per capita keeps getting along with other variables, hospital inpatient bed resources contribute to the whole model by sacrificing other effects. Finally, the quality of medical workers maintains the positivity of the coefficient with 0.256 and combined with its 1.176% contribution to the model. We find it necessary to foster more doctors to mitigate the demand in the medical sector as a critical determinant in the full model predictive importance analysis.

6.4.3. Robustness Test

To ensure that the panel fixed effect results with our spending interaction regression are convincing and robust, we utilize the Hausman test with the same baseline variable set. The fundamental Hausman test result demonstrates a Chi-square with 702.53, and P-value equals

0.0000, supporting our modeling process's reasonability.

Furthermore, we also run a robust Hausman test to confirm the results with a stricter approach. We can see Chi-square in this robust Hausman test reflect 132.98, with its P-value remaining at 0.0000. We can put our faith in the regression result in this chapter.

6.4.4. Discussion

The modeling and regression results mainly concentrated on the impact of education and health-related funding, spending, and determinants on human capital development in China with the data from 2010 to 2018. We utilized the human capital index created in Chapter 4 and the club-convergence results from Chapter 5. The policy discussions can be established according to these regression results and the policy evolution discussions in Chapter 2 by implementing the spending interaction and predictive importance models.

First, we shall highlight the necessity of strengthening the medical and health expenditure per capita, especially for those lagging regions, since four separately estimated scenarios and the aggregated full model regression simultaneously demonstrate the positive effect and great contributions to human capital growth. Such regression results offer important credits to China's movement on healthcare investment and policy reforms. Meanwhile, the funding for education should be treated carefully from the central policy intentions, even though we know that education is one of the most important factors in accumulating human capital. Combining the discussion of China's education public expenditure strategy, the gradually expanded tuition fee exemption project is necessary. Also, it is important to support teachers financially to maintain their enthusiasm for making sustainable contributions. However, the large amount of investment in administrative purposes should be restricted as bloated structures will make the administrative capacity less efficient. Pre-primary education should be recognized as a necessary process for building children's learning habits and fundamental knowledge structure, especially for those lagging areas in China, since we can observe an obvious good effect in the primary and full model regression. Although the coefficient of pre-primary determinants in the spending interaction model is not high, the predictive importance estimated contribution still implies its necessity for rural regions. It could also be recognized as solid evidence for the long-term benefits of China's sustainable pre-primary education strengthening policy.

The regression results of four different education degrees with health perspectives suggest the importance of promoting teachers' quality in primary, secondary, and vocational education by enlarging the teacher-student ratio. The integrated analysis of spending interaction and predictive importance regression supported the idea of re-distributing more funding and giving policy priorities to foster teachers for these three degrees in the western and rural provinces that still lack such scales of educators in compulsory and vocational education. On the contrary, the teachers' quality in universities is already at its full capacity across China. The redundancy of teachers in higher education may indicate an unreasonable recruitment strategy across China's colleges. The low standard deviation of the universities' teacher-student ratio figure in Figure 6-5 also supported this idea as it differs from other education degrees. The gap among provinces is small. We suggest two measures to mitigate this issue and sustainably enhance human capital development. One is to redistribute some of the teachers' resources to lower levels of education gradually. Another is to enlarge the admission rate of the universities in rural and western provinces to narrow the teacher-student ratio accordingly. From China's education policy evolution discussed in Chapter 2, multiple policies were already aiming to expand the universities' admission rate and improve the enrolment scale to key universities in central and western provinces has been brought up since 2014.

Schools’ autonomy is another complicated aspect that may affect human capital accumulation from the education management policies perspective. Half of the degrees fail to generate significant results in the spending interaction model, and another half offer a negative impact. We confirmed that public and private sector funding could hardly motivate schools’ autonomy and return good effects to human capital. However, as one of the major concerns of schools’ management, the schools' autonomy, its usefulness in primary education, vocational secondary education, and the university is still imaginable because of the positive coefficient in their predictive importance analysis result. For primary and vocational secondary schools, better self-management can release the inner strength of the leadership and improve its education quality with synergetic movements to other policies.

Nevertheless, although universities’ autonomy can positively impact human capital, its backward effect on the aggregated system may sacrifice other determinants’ effectiveness. Such results indicate that the determinants of pushing school autonomy reforms are still important, especially for primary and college degrees. As the begin and final stages of the general education system, schools’ autonomy requires a reasonable reform strategy for long-term sustainability.

The rest of the education determinants concentrated on schools’ conditions and teachers’ professionality. The extension of the classrooms may no longer be a major quantity deficit issue in China. Still, it potentially requires better facilities and equipment support to highlight the importance of sustainable and substantial education quality improvements in hardware. Furthermore, the policy evolution is also intended to reduce students’ schoolwork burden and provide more space and opportunity for students to join physical exercises. The corresponding regression confirmed that it could reflect significant compulsory and vocational education results. It relates simultaneously to education effect and students’ health conditions in the long run, both of which can be crucial to human capital development. Therefore, the central government's policy of promoting one-hour daily physical exercise in compulsory education period is ideal for future implementation in all degrees.

Expectations on the effectiveness of raising teachers' professionality and experiences also seem to work out for human capital improvement. As teachers' experience in vocational and university presents positive effects not only through funding but also by its independent importance, the concentration of the education policy evolution on fostering teachers and overall education resources are proved to be crucial. The future target of this cultivation shall focus on the per-student level teacher quantity, and the sustainable increment of professional title certificated teachers' proportion among total educators. With properly targeted education funding and incentives, those teaching skills and knowledge professions can be transferred through educational activities. Such a policy can gradually form a sustainable cycle between teachers' training and students' cultivation.

Lastly, the medical and health policies should be designed to ensure basic medical resources that maintain people's health and quality of life. Regarding the policies we have discussed in Chapter two and the regression results in this chapter, hospital autonomy have constantly remained negatively correlated to human capital in the spending interaction or predictive importance model. By its definition, we assume that fewer government financial subsidies can return more autonomy to the hospital. Such impact reminds us of the central policy's intentions to reform public hospitals in China. It is dedicated to exploring a more effective and efficient cooperative relationship between public hospitals and the government.

We can also see the positive effect of public medical insurance expenditure proportion in the regressions. It partly supports the idea that public and private spending is useful. With a larger proportion of the expenditure, people can seek doctors and medical treatment with fewer economic concerns. However, since the full model regression does not completely agree with the further movement on public medical insurance, it may reasonably indicate that the existing policy strategy of medical insurance is acceptable but need further supervision in case of any sudden major outburst of a public health emergency.

It is also necessary to discuss the policy propensities on improving hospital quantity and cultivating medical practitioners. From the regression result, the hospital and inpatient bed resources may have a fragmentation issue. Since China has been pushing quite hard to establish different tiers of medical institutions to form an integrated hospital system according to the policy discussion in Chapter 2, it does not show effectiveness in promoting human capital development in our model. We believe that the initial idea of building such a comprehensive medical system and increasing the choices of medical institutions for society is trying to solve the inequality issues from the healthcare perspective. Still, with limited medical practitioners, doctors, and nurses, more hospitals may furtherly drive the imbalance of medical treatment across China. On the opposite side, we noticed the positive returns on medical practitioners per capita and doctors' ratio (medical workers' quality) in several regressions. They simultaneously generated synergetic contributions in the models accordingly. It proved that to truly reduce the inequality in medical and health perspectives, the quantity and quality of medical workforces are evenly important for realizing the policy purpose. Suppose China would like to maintain the existing medical system in both rural and urban areas, in which case, more balanced policies are required to cultivate medical practitioners. It is necessary to enlarge the group scale and quality of human medical resources by compensating doctors, physicians, and nurses with a suitable strategy to ensure their enthusiasm and establish a clear support system, including counterparts' cooperation for those who are working in the grassroots level in the most undeveloped areas.

6.5. Conclusion

The overall conclusion of this chapter can be summarized into three dimensions: the determinants' effectiveness on human capital development, the impacts brought by education and health policy evolution, and the necessity of improving balanced human capital with higher quality.

Undoubtedly, most of the education and health policies realized their original purposes in China, according to the findings in this chapter, as education shows a significant result from education quality and resource improvements. Health indicators also demonstrated great matters to human capital development, for the increase of public expenditures and medical resources continued to be efficient in human capital accumulation. However, the main findings also reflected that health benefited more from human capital development than education. Such a conclusion confirmed that over the past decade, health is gradually trespassing education with a larger proportion in human capital index components.

As China has been gradually extending the range of the education policy, it is easy to imagine that the marginal effect of education policy incentives will gradually get lower in general. From the view of maintaining human capital development, such changes in policy impacts are acceptable as it is still crucial for reducing the development gaps. In conclusion, China should maintain the education policy coverage but with more cautious in specific areas. In the meantime, drawing attention to medical and health policies is also critical. The most direct impact of health policy evolutions is that more people can afford hospital resources and maintain better health status in their daily lives. From the indirect way, the ongoing medical system reform is much more complicated. Although it works well in increasing the average health quality, excessive administrative interventions from the government made hospitals and medical institutions less autonomized with lower efficiency. Such findings conclude that China requires a more efficient medical and health strategy to reserve a healthier cycle between health input and outcomes.

Finally, the conclusion of improving sustainable human capital imbalance can be derived from the policy effectiveness and impacts. The descriptive statistics of the variables around all the provinces already demonstrated severe variations. We noticed that more existing policies were designed to support education quality increments in undeveloped provinces than health-related purposes. It can be recognized as one of the main reasons for human capital imbalance. Considering the development gap between provinces, health resources, and medical opportunities are much harder for equal and high-quality distribution compared to education perspectives. We will try to conduct several policy recommendations in the concluding chapter to rebalance the human capital disparities in China.

Chapter 7 Summary of Findings and Policy Recommendations

This final chapter serves as the overall conclusion of this dissertation. From all the analyses we have been through, the disparity in China's human capital development has been proved with various pieces of evidence. Education, health, human capital overall trend, and even policy designs have reflected significant inequality issues across China. The development gaps still lie between east and west, south and north, coast and inner lands, and urban and rural. These geographical or resource differences have driven more human capital imbalance in recent decades. We finalized this chapter into two parts. The first part will summarize all the findings of this dissertation, and furthermore, by analyzing these findings, offer new policy recommendations from the view of how to redistribute the resources of education and health perspectives for better coordinated human capital development in China with high quality.

7.1. Summary of Findings

This research started with the return to education analysis based on longitudinal data in China. By estimating the return to years of schooling and margins of return to educational attainment from the 1990s to 2010s, we observed the growth in China's education returns with significant results from the analysis of both survey datasets. It took China less than 20 years to achieve a 10% return to years of schooling from a very low level, which is higher than the world average in 2010. However, the turning point right after this fast growth warned us of the importance of making sustainable policy. We should foresee the potential issues hidden in the prosperity.

To overcome the singularity of the education variable proxies on human capital research, we developed our own methodology to form a human capital index with comprehensive components. The methodology's main contributions are scientifically calculating the different components and forming the human capital index. Although the original idea of our approach is inspired by World Bank’s Human Capital Project (World Bank, 2018, 2020), we have made multiple changes in the calculation process to fix the critical concerns of their original methodology and fit it into China’s reality. Specifically, we utilized the return to years of schooling for different provinces each year and adjusted the education years with suitable quality-based indicators according to the concept of LAYS (Filmer et al., 2020). Because the general quality adjustment indicator is unavailable in China, we utilized the relative college entrance exams score for the education quality adjustment. In the meantime, we have also changed the process to estimate health components and implemented another quality-based indicator to adjust it as well.

Together with the survival component, we aggregated our human capital index with a Principal Components Analysis to utilize their factor loadings in the final process, which is much more rational than directly multiplying these sub-indexes. By avoiding the shortages of the existing approaches in the literature, our method can furtherly offer us greater correlations to economic factors. Meanwhile, because of the PCA analysis, the factor loadings of the three components in different years can be recognized as their contributions to the overall human capital index. The trend of the contributions indicates a descending demand for education after 2015, while health and survival components have become more important in developing human capital in China. We can see the fast growth of demand for health services in all the provinces while education is less contributive to human capital than it used to be.

With this new human capital index, the imbalance issues across China can be examined, and rebalancing policy directions could also be raised. According to the club-convergence analysis in Chapter 5, human capital development in China from 2010 to 2018 failed to demonstrate an overall convergence result with all the provinces. However, four convergent clubs and one divergent group can be detected, highlighting China's human capital development imbalance over the past ten years. The capital-gathering effects, east and coastline advantages, and central to western provinces' inner land gaps contribute to imbalanced human capital development. By decomposing the human capital index into human capital returns, education density, health intensity, economic performances, and their interaction terms with the Kaya-Zenga Index approach, we realized the fact that China's human capital imbalance originated from the gap of economic development across different regions while education and health development are narrowing the inequality gap of human capital growth.

To further examine the potential drivers of the human capital disparities in China, we estimated the effect of education and health indicators on human capital in Chapter 6 by establishing a cross-verification using the spending interaction model and the predictive importance model. The findings demonstrated that health has gradually become a more critical factor in human capital development, while education policies require more targeted adjustment. It does not surprise us with the effectiveness of education and health policies in improving the overall human capital development in the past decade. However, such development cannot narrow the gap between top and bottom provinces regarding human capital performance. Such findings can be transformed into more precise policy recommendations for different scenarios for rebalancing the human capital development disparities between provinces for higher quality.

7.2. Policy Recommendations

We can see clear growth of the human capital index from the national level. However, the disparity issue between provinces cannot be denied. The imbalance of human capital development requires further coordination between education and health policies. At the same time, the strategy of public expenditure is also crucial for rebalancing the accumulation of human capital at China's subnational level. For those advanced provinces, we suggest that a redistribution of local educational resources to undeveloped areas is required to promote education quality. Meanwhile, medical and health issues should be emphasized in all areas since medical quantities and qualities still face shortage issues because of the population. Therefore, we would like to provide several macro-level policy recommendations to face the challenges in stimulating sustainable and balanced human capital development across China.

7.2.1. Redistributing Education Resources and Funding

The previous analysis of this research has shown that China's return to education has been decreasing since 2010 and has only bounced back on a small scale. Furthermore, the education sector's contribution to human capital development decreased after 2015. The education policies and funding effects on human capital have also proved that the imbalance across China didn't work so well in the status quo. We want to suggest a redistribution strategy for education resources and funding.

The main idea of this recommendation is to redistribute the redundant education resources and funding in advanced provinces to China's western and northern regions. The existing education policy mainly focuses on reducing the individual education cost for national compulsory education, rural vocational education, and rural high school education. Exempting the tuition and miscellaneous fee in these education degrees does help ensure that more children can access educational opportunities. However, it is not enough for lagging areas because of the provinces' lack of resources. These provinces, such as Ningxia, Qinghai, Yunnan, Shaanxi, Guizhou, Gansu, and Tibet, are hard to receive effective and evenly qualified education for students starting from their childhood.

Since the regression results confirmed that pre-primary education significantly strengthens human capital, we suggest that for provinces such as Gansu, Qinghai, Tibet, Guizhou, and Yunnan, the local government should involve more pre-primary education resources. One fastest policy idea is to establish counterpart connections to advanced provinces for sharing pre-primary education resources through the internet. Such strategies can redistribute important education resources to lagging areas while maintaining high quality in advanced regions. Similar suggestions can also be offered for the compulsory and vocational degrees because some other provinces, such as Anhui, Jiangxi, Guangxi, Henan, and others, also face a significant gap in well-developed provinces.

Furthermore, funding redistribution should be synchronized with the policy enhancement for lagging provinces. Beijing, Tianjin, and Shanghai are always engaging massive expenditures on students' level compared to other developing areas. We want to suggest another counterpart support scheme in which the provinces with greater education budgets can provide regular students and teacher exchange programs to those lagging provinces. Such a strategy will reduce educational disparities more appropriately.

We believe that more policy propensities to redistribute resources and funding to developing provinces should be the first step to forming sustainable human capital development across China as it can mitigate the regional gaps.

7.2.2. Strengthening the Quality of Education

Alongside the redistribution plan of policy incentives and education funding, the ultimate goal is to strengthen the education quality of lagging provinces. At the same time, the advanced areas can still maintain their present standard. The first and most direct major funding target should be teachers with the new education funding strategies. As we have discussed, with compensations to reduce students' economic burdens, the shortage of teachers will be the main barrier to human capital growth. Since the cultivation of new teachers is a long-term solution, China may still experience a shortage of overall teachers. We believe the current incentives to attract teachers to start their careers in lagging provinces are not satisfying. Theoretically, by offering better wages and bonuses for teachers in those developing provinces, the competition will be raised, and more high-quality teachers can be attracted to lagging provinces. More specifically, pre-primary, primary, and secondary education teachers should be further compensated for quantity and quality.

Regarding vocational education, the teachers' quality is much more important as China has been trying to promote a wider range of vocational education acceptancy between secondary and university degrees. From the view of China's modern vocational education after 2000, people are more likely to recognize vocational degrees as low-end in the job market, and society didn't offer vocational graduates adequate recognition. Such prejudice will further lower the quality of vocational education and even negatively impact China's massive labor market. To overcome such a barrier, we suggest a stronger vocational education stimulation. First, establish a more professionalized vocational education system, especially for those lagging areas. Secondly, improve the cultivation procedure of vocational teachers, and compensate certain certificated teachers with actual rewards. Lastly, extend the vocational education range to all techniques or skills-based subjects, and standardize vocational education to similar criteria to college education in China.

Conversely, universities in China are in a contrasting scenario under the same topic of enhancing education quality. Our research suggests that universities should further increase the student enrollment scale, especially in lagging areas, since the teacher resources seem redundant. At the same time, China has implemented a publicly funded teacher training strategy in universities to help more students in developing provinces and low-income families. By mitigating the teacher shortage in the degrees before undergraduate, similar strategies to other fields of majors in the universities may also be worth extensions. It can also be seen as the extended solution to raising vocational education quality in China. As we can see, there is a great gap between public expenditures per student to universities in Beijing and Shanghai. While other provinces may even lack resources for vocational education development, we believe certain policies that can reduce such inequality and transfer excessive education resources to lagging provinces should be offered soon.

Finally, improving reasonable curricula can also increase the quality of education. Although China has an effective examination system for primary to college education, the different exam questioning systems across provinces can damage education quality. Such an issue requires multiple solutions; one is trying to reform the curriculum for different provinces. A more flexible curriculum design strategy may rebalance China's human capital disparities. One of the curriculum design recommendations is strengthening students’ comprehensive competencies at the compulsory education level. By extending the range of education coverage, students can receive wider knowledge which can lead their interest to the study in the beginning—in the meantime, utilizing the internet education channels for sharing more standardized courses across China to reduce the inequality in education resources accessibilities. Standardized courses should contain all basic subjects and be considered the most important part of entrance examination guidance. Regular updates to the standardized course should also be mandatory. Besides the knowledge transfer through paper works, physical education should also be focused on during the compulsory education period. Furthermore, the student should also be able to choose some of their subjects as interests for the final examinations and be allowed to change them under certain circumstances. The chances of participating in the final examinations should also be gradually increased for offering student more opportunities while lowering average study costs.

7.2.3. Strengthening Medical Expenditure's Efficiency and Quality

Since we have observed the great gap in medical spending between developed and lagging provinces, the appropriate policy recommendation should encourage the government or social capital to offer more support to mitigate such imbalance. Those lagging provinces with large populations could have better medical resources and individual health qualities. However, it may be hard to realize such an idea. From the primary medical education that cultivates medical practitioners to hospital management and compensation, massive expenditure is demanded. When combined with the reality of public medical expenditures distribution across provinces, the disparity issue urges solutions to increase public expenditures for those lagging provinces. To overcome the shortages of local medical expenditures, we would like to recommend a more widely connected hospital-based counterpart medical diagnosis system between lagging and advanced provinces. The complexity of actual health issues and medical diagnosis requires both flexibility and professionality of the system. First, involve better point-to-point internet conditions for hospitals; next, organize regular communication mechanism between physicians; finally, properly distribute public expenditures to buy necessary equipment, compensate treatment costs, and support medical practitioners financially.

These research's findings offer the following recommendations in terms of how to increase the quality of public medical expenditures. On the one hand, by focusing on hospitals as organizations, their autonomy and self-management should be critical for medical quality. Our analysis suggests that China should gradually reduce government intervention in public hospitals' management through financial subsidies and furtherly promote the public hospitals' reformation plan to find a suitable balance between them. Meanwhile, China has been implementing its three tiers of medical institutions for rural areas, from counties to villages and community clinics in urban cities. Such a system has created many medical institutions that absorbed a large proportion of medical spending. Some fundamental medical institutions may not qualify to offer effective medical treatment. But such a system will become more efficient if physicians, doctors, and nurses are adequately fostered and equally distributed. Therefore, on the other hand, the central government policies in the health and medical sectors should be focusing on cultivating more medical practitioners. It is also necessary to improve their salaries, especially for promoting better incentives to encourage these physicians, doctors, and nurses to work in the community and village clinics. It could also be a good strategy to find a balanced point and reasonable regulations to encourage the involvement of private capital.

Last but also important, medical institutions should continue increasing medical diagnoses' accuracy. It is also a critical determinant for increase medical expenditure efficiency to a large extent. Such qualitative improvements will not be easily achieved in common sense. Still, by involving the new AI technology as diagnostic support in the future, the overall medical diagnosis efficiency shall get enhanced. We believe it will become a necessary supplementation to cultivate doctors and nurses for long-term sustainable human capital development.

7.2.4. Promoting Inclusive Economic Growth

Apart from the education and health policy suggestions given above, one more thing that may offer significant effect on human capital disparities across China is economic growth. Although economic growth is one of the most important development goals for both government and society, focusing on economic development as an exclusive goal will expand the disparity across provinces. A more inclusive strategy is needed to mitigate gaps between economically fast-growing and lagging areas. The traditional idea is to provide direct financial compensation to those economically left behind provinces. However, such a policy alone can hardly maintain a sustainable and healthy structure for long-term development.

According to the findings from this dissertation, the basis of inclusive economic growth should be able to feed back its education and health resources directly or help rise the efficiency of education and public health expenditures. By forming a virtuous circle between the input and outcome, the basic sustainability of the local economy can be established. However, there is always an external influence, such as the economic impact of neighbouring provinces. Therefore, by utilizing internet technology and modern logistics system, different economic functions that trigger the crowding effect in advanced areas can gradually be shifted to its surrounding area. By extensively strengthening infrastructure and transportation service capacity, economically developed regions can support lagging regions in a more targeted manner. Inclusive economic growth strategy between provinces can gradually allow lagging regions to establish a sustainable value chain connection to advanced provinces. These connections can further promote local education and health resources to improve its talent retention rate and achieve the effect of rebalancing human capital development across China.

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Appendix A

Table A2-1 2005 China's Education Policies Intentions

Quality	Quantity
Strengthen compulsory education in the rural area	Exempt compulsory education fees and miscellaneous fees in the rural area
Improve funding mechanism based on government input	Subsidize living expenses of the boarding students
Invest in improving the higher education quality	Develop various types of vocational education
Reform and innovate in teaching content and methods to reduce students' burden	Construct modern distance education projects
Promote the healthy development of private education	
Strictly regulate the enrolment and fee system of all types of schools	
Strengthen the financial management and supervision of schools	

Source: Authors' creation using the contents from the 2005 Report on the Work of the State Council Government (Wen, 2005-2013).

Table A2-2 2006 China's Education Policies Intentions

<table>
<tr><th>Quality</th><th>Quantity</th></tr>
<tr><td>Raise the level of public funding guarantee for primary and secondary schools in rural compulsory education</td><td>Total exemption of tuition and miscellaneous fees for students in rural compulsory education in the western region</td></tr>
<tr><td colspan="2">The total amount of new national financial resources for compulsory education will reach 218.2 billion yuan in the next five years.</td></tr>
<tr><td>Establish an investment mechanism for the repair and renovation of rural primary and secondary school buildings</td><td>Continue to provide free textbooks and subsidize boarding students' living expenses for students from low-income families</td></tr>
<tr><td>Improve the funding guarantee mechanism for teachers' salaries in rural primary and secondary schools</td><td>Bring compulsory education in rural areas fully into the scope of state financial protection</td></tr>
<tr><td colspan="2">The central government will invest 10 billion yuan in the next five years to support the development of vocational education.</td></tr>
<tr><td>Focus on improving the quality of higher education and promoting the construction of high-level universities and critical disciplines</td><td></td></tr>
</table>

Source: Authors' creation using the contents from the 2006 Report on the Work of the State Council Government (Wen, 2005-2013).

Table A2-3 2007 China's Education Policies Intentions

<table>
<tr><th>Quality</th><th>Quantity</th></tr>
<tr><td>Deepen the reform of the management system of vocational education</td><td>Exempt all compulsory education in rural areas across the country from school fees and miscellaneous fees</td></tr>
<tr><td>Establish the mechanism of joint participation of industries, enterprises, and schools</td><td>Continue to provide free textbooks and subsidize boarding and living expenses for students from poor rural families</td></tr>
<tr><td colspan="2">The central government will invest 10 billion yuan in implementing the rural junior high school renovation program</td></tr>
<tr><td>Support and regulate the development of private education</td><td>Improve the coverage of urban and rural vocational education and training network</td></tr>
<tr><td colspan="2">Establish a sound national scholarship system for vocational schools and universities. Central financial expenditure will increase from 1.8 billion yuan in the previous year to 9.5 billion yuan, and 20 billion yuan will be arranged next year</td></tr>
<tr><td colspan="2">Implement free education for teacher-training students at teacher-training universities.</td></tr>
</table>

Source: Authors' creation using the contents from the 2007 Report on the Work of the State Council Government (Wen, 2005-2013).

Table A2-4 2008 China's Education Policies Intentions

Quality	Quantity
Increase public funds for compulsory education in rural areas and raise the level of protection	Universal implementation of free compulsory education in urban and rural areas nationwide
Appropriately increase the standard of living expenses subsidy for boarding students from rural families with financial difficulties	From this fall to fully exempt urban compulsory education tuition and fees
Strengthen the construction of vocational education infrastructure capacity	Continue to tilt the increase of general college enrolment to the central and western regions
Deepen the reform of vocational education management, cultivate high-quality skilled personnel	
Optimize the structure of disciplines and specialties, and promote the construction of high-level universities and critical disciplines	
Strengthen the teaching force and improve and implement the teachers' salaries and allowances system.	
Encourage and regulate the development of private education.	

Source: Authors' creation using the contents from the 2008 Report on the Work of the State Council Government (Wen, 2005-2013).

Table A2-5 2009 China's Education Policies Intentions

<table>
<tr><th>Quality</th><th>Quantity</th></tr>
<tr><td>Raise the standard of public funds for compulsory education in rural areas</td><td>Implement the policy of free compulsory education in urban and rural areas</td></tr>
<tr><td colspan="2">Raise the public funds per student to 300 yuan and 500 yuan for primary and junior high schools, respectively</td></tr>
<tr><td>Promote the construction of high-level universities and critical disciplines</td><td>Increase financial support for students from low-income families in secondary vocational schools and higher education institutions</td></tr>
<tr><td>Guide higher education institutions to adjust their majors and curricula to meet the needs of the market and social development</td><td>Develop vocational education, with particular emphasis on supporting rural secondary vocational education</td></tr>
<tr><td>Implement a performance pay system for teachers in compulsory education</td><td>Implement free secondary vocational education. Start with students from poor rural families and agriculture-related majors</td></tr>
<tr><td>Improve the salary of 12 million primary and secondary school teachers;</td><td></td></tr>
<tr><td colspan="2">Strengthen the training of teachers, especially rural teachers, and encourage college students and teacher trainees to teach at the grassroots level and in rural areas</td></tr>
<tr><td colspan="2">Implementation of the national primary and secondary school building safety project promotes the standardization of rural primary and secondary schools</td></tr>
</table>

Source: Authors' creation using the contents from the 2009 Report on the Work of the State Council Government (Wen, 2005-2013).

Table A2-6　2010 China's Education Policies Intentions

<table>
<tr><th>Quality</th><th>Quantity</th></tr>
<tr><td>Exploring school management systems to adapt to different types of education and talent growth</td><td>Encourage social forces to set up education to meet the diversified educational needs</td></tr>
<tr><td>Accelerate the renovation of junior high school buildings in the central and western regions</td><td>Strengthen the construction of preschools and special education schools</td></tr>
<tr><td>National safety project for primary and secondary school buildings</td><td></td></tr>
<tr><td>Improve teaching methods, and focus on cultivating students' employability and entrepreneurship in vocational education</td><td></td></tr>
<tr><td>Implement the autonomy of higher education institutions to run management systems and enrolment systems furtherly</td><td></td></tr>
<tr><td>Motivate teachers to focus on education and strive to build distinctive and high-level universities</td><td></td></tr>
<tr><td colspan="2">Attract outstanding talents to join the education industry and encourage them to pursue a lifelong career in teaching</td></tr>
<tr><td colspan="2">Strengthen the training of teachers and principals in rural compulsory education schools, and encourage outstanding teachers to teach in poor rural areas</td></tr>
</table>

Source: Authors' creation using the contents from the 2010 Report on the Work of the State Council Government (Wen, 2005-2013).

Table A2-7 2011 China's Education Policies Intentions

Quality	Quantity
The public and private institutions should work together to increase preschool education resources and solve the problem of "difficult access to school."	
Strengthen the standardization of compulsory education schools and focus public resource allocation on rural and urban weak schools.	The vigorous development of vocational education
Effectively reduce the excessive burden of schoolwork on primary and secondary school students	
Focus on guiding and cultivating children's ability to think independently and practice innovation	
Ensure one hour of school physical activity per day for primary and secondary school students	
Guide high schools and higher education schools to run special features, improve the quality of education, and enhance students' employment and entrepreneurship	

Source: Authors' creation using the contents from the 2011 Report on the Work of the State Council Government (Wen, 2005-2013).

Table A2-8 2012 China's Education Policies Intentions

<table>
<tr><th>Quality</th><th>Quantity</th></tr>
<tr><td colspan="2">The budget is prepared according to the national financial expenditure on education, accounting for 4% of the GDP, and local finances should be arranged accordingly</td></tr>
<tr><td>Strengthen the construction of the teaching force, Implement quality education,</td><td>Strengthen pre-school education, continuing education, and special education, and build a modern vocational education system</td></tr>
<tr><td>Promote the democratic management of the school and gradually form a system</td><td>Gradually extend the tuition-free policy for secondary vocational education to all rural students</td></tr>
<tr><td>Implement a good nutrition improvement program for rural compulsory education students.</td><td>Expand the scope of financial assistance for students from low-income families in general high schools</td></tr>
<tr><td>Strengthen school bus and campus safety management to ensure children's safety</td><td>Develop private education, encourage and guide social capital to enter all levels and types of education</td></tr>
<tr><td colspan="2">Balance the development of compulsory education, resource allocation to the central and western, rural, remote, ethnic areas, and weak urban schools</td></tr>
</table>

Source: Authors' creation using the contents from the 2012 Report on the Work of the State Council Government (Wen, 2005-2013).

Table A2-9 2013 China's Education Policies Intentions

Quality	Quantity
Investing in the balanced development of compulsory education	
Improving the quality of education at all levels	Accelerate the development of modern vocational education
Further promoting educational equity	

Source: Authors' creation using the contents from the 2013 Report on the Work of the State Council Government (Wen, 2005-2013).

Table A2-10 2014 China's Education Policies Intentions

Quality	Quantity
Increase education resources in the central and western regions and rural areas, and promote the balanced development of compulsory education	
Comprehensively improve the conditions of compulsory education in weak schools in poor areas	
Strengthen the training of teachers in rural areas, especially in remote and poor areas	The number of rural students from poor areas attending key universities to increase by more than 10%
Improve efficiency in central financial investment use and strengthen supervision	Develop preschool education. Implement a special education upgrading plan
Expand the provincial government's power to coordinate education and the autonomy of universities to schools' management	Encourage the development of private schools
Accelerate the construction of a modern vocational education system oriented to employment	

Source: Authors' creation using the contents from the 2014 Report on the Work of the State Council Government (Li, 2014-2018).

Table A2-11 2015 China's Education Policies Intentions

Quality	Quantity
Comprehensively reform higher education institutions, examinations, and enrolment system	
Accelerate the standardization of compulsory education schools and improve weak and boarding schools' basic conditions.	Transform some local undergraduate universities into application-oriented schools
Support the development of higher education in central and western regions through counterpart support	Continue to improve the admission rate of college entrance exams in central and western regions and populous provinces
Strengthen special education, preschool education, continuing education, and various types of education in ethnic areas	
Comprehensively promote the construction of a modern vocational education system	

Source: Authors' creation using the contents from the 2015 Report on the Work of the State Council Government (Li, 2014-2018).

Table A2-12 2016 China's Education Policies Intentions

Quality	Quantity
Public education investment should be increased in the central and western and remote and poor areas	
Unify urban and rural compulsory education funding mechanisms	Students from low-income families are the first to be exempted from general high school tuition and fees
improve the weak schools and boarding schools' operating conditions	Promote the transformation of qualified ordinary undergraduate colleges and universities into application-oriented
Encourage the development of inclusive kindergartens	
Develop modern vocational education and promote the exemption of tuition and fees for secondary vocational education by category	
Implement policies to improve the salary of rural teachers.	Continue to expand the enrolment scale of key universities for rural areas in poor areas
Improve the teaching quality and innovation ability of colleges and universities	Support and regulate the development of private education

Source: Authors' creation using the contents from the 2016 Report on the Work of the State Council Government (Li, 2014-2018).

Table A2-13 2017 China's Education Policies Intentions

<table>
<tr><th>Quality</th><th>Quantity</th></tr>
<tr><td colspan="2">Unify the policy of "two exemptions and one subsidy" for compulsory education for students in urban and rural areas</td></tr>
<tr><td>Expand the coverage of high-quality educational resources and narrow the gap between urban and rural areas.</td><td>Continue to expand the enrolment scale of key universities for rural areas in poor areas</td></tr>
<tr><td>Develop and implement the China Education Modernization 2030</td><td>Increase the standard of national grant subsidy for doctoral students.</td></tr>
<tr><td></td><td>Continue to promote the transformation of some undergraduate universities to application-oriented</td></tr>
<tr><td></td><td>Accelerate the development of modern vocational education.</td></tr>
<tr><td colspan="2">Strengthen ethnic education, run special education, continuing education, preschool education, and elderly education.</td></tr>
<tr><td colspan="2">Support and regulate the development of private education.</td></tr>
</table>

Source: Authors' creation using the contents from the 2017 Report on the Work of the State Council Government (Li, 2014-2018).

Table A2-14 2018 China's Education Policies Intentions

Quality	Quantity
Promote the integrated development of compulsory education in urban and rural areas	
Eliminate "large class sizes" in cities and towns,	Continue to tilt investment in education to difficult areas and vulnerable regions.
Solve the problem of heavy extracurricular burdens on primary and secondary school students	Effectively reduce the dropout rate of rural students
Pay attention to the training of early childhood teachers	Continue to implement special admission programs for rural and poor areas.
Increase the supply of preschool education resources through multiple channels,	
Develop vocational education, support and regulate social forces to organize vocational education	
Optimize the structure of higher education, and support the construction of distinctive, high-level universities in central and western China.	

Source: Authors' creation using the contents from the 2018 Report on the Work of the State Council Government (Li, 2014-2018).

Table A6-15 Variable Explanation

Name	Explanation
PF	Log Primary School Funding per student (Government and Private)
SF	Log Secondary School Funding per student (Government and Private)
SVF	Log Vocational Secondary School Funding per student (Government and Private)
UF	Log University Funding per student (Government and Private)
MS	Log Medical Spending per capita (Government and Society)
p1	Pre-primary education experience ratio
pp2	Primary Education Teacher Quality (Teacher Student ratio)
pp3	Primary Education School Autonomy (School Individual Spending ratio)
pp4	Primary Education Teaching conditions (Classroom space over total school space)
pp5	Primary Education Exercise conditions (Sports area space over total school space)
sp1	Secondary Education Teacher Quality (Teacher Student ratio)
sp2	Secondary Education School Autonomy (School Individual Spending ratio)
sp3	Secondary Education Teaching conditions (Classroom space over total school space)
sp4	Secondary Education Exercise conditions (Sports area space over total school space)
vp1	Vocational Education Teacher Quality (Teacher Student ratio)
vp2	Vocational Education School Autonomy (School Individual Spending ratio)
vp3	Vocational Education Exercise conditions (Sports area space over total school space)
vp4	Vocational Education Teaching conditions' quality (Fixed assets value per student)
vp5	Vocational Education Teachers' ability (Higher educated teacher ratio over all teachers)
vp6	Vocational Education Teachers' experience (Intermediate and higher title ratio)
up1	University Education Teacher Quality (Teacher Student ratio)
up2	University Education School Autonomy (School Individual Spending ratio)
up3	University Education Faculty Scale (Full-time faculty ratio over all employees)
up4	University Education Teachers' experience (Intermediate and higher title ratio)
up5	University Education Research conditions (Research employees' ratio over all employees)
h1	Hospital Autonomy (Government funding ratio)
h2	Public Medical Insurance condition (Expenditure / Income)
h3	Medical Practitioner Resources (per capita)
h4	Hospital Quantity (per capita)
h5	Hospital Inpatient Resources (Beds per capita)
h6	Medical Worker Quality (Doctor quantity over total medical worker ratio)

Source: Author's creation.

Table A6-16 Correlation Matrix

	PF	SF	SVF	UF	MS	p1	pp2	pp3	pp4	pp5	sp1	sp2	sp3	sp4
PF	1													
SF	0.915***	1												
SVF	0.614***	0.668***	1											
UF	0.642***	0.686***	0.428***	1										
MS	0.904***	0.932***	0.631***	0.635***	1									
p1	0.0820	0.0630	0.0500	0.115*	0.221***	1								
pp2	0.487***	0.238***	0.114*	0.317***	0.226***	0.0710	1							
pp3	-0.0950	-0.251***	-0.165***	-0.296***	-0.124**	0.0800	0.250***	1						
pp4	0.0320	0.169***	0.0450	0.167***	0.211***	0.359***	-0.474***	-0.129**	1					
pp5	0.149**	0.099*	0.0580	0.197***	0.159***	0.538***	0.244***	0.134**	0.271***	1				
sp1	0.773***	0.871***	0.581***	0.715***	0.802***	0.155***	0.310***	-0.168***	0.186***	0.238***	1			
sp2	0.225***	0.114*	0.0780	-0.0200	0.274***	0.103*	0.155***	0.783***	0.0560	0.158***	0.173***	1		
sp3	0.123**	0.161***	0.123*	0.221***	0.270***	0.278***	-0.284***	-0.135**	0.820***	0.207***	0.147**	0.0320	1	
sp4	0.311***	0.205***	0.209***	0.318***	0.292***	0.506***	0.436***	0.177***	0.121**	0.896***	0.311***	0.201***	0.215***	1
vp1	0.520***	0.415***	0.251***	0.439***	0.412***	0.252***	0.680***	0.161***	-0.168***	0.272***	0.522***	0.306***	-0.0900	0.433***
vp2	0.102*	0.0110	-0.0510	0.0470	0.0980	0.339***	0.318***	0.554***	0.106*	0.383***	0.198***	0.602***	0.0940	0.443***
vp3	0.314***	0.231***	0.127**	0.242***	0.217***	0.295***	0.443***	0.180***	0.132**	0.536***	0.298***	0.223***	0.206***	0.599***
vp4	0.513***	0.601***	0.464***	0.565***	0.581***	0.185***	0.153**	-0.177***	0.271***	0.163***	0.651***	-0.00600	0.220***	0.204***
vp5	0.376***	0.407***	0.0970	0.415***	0.407***	0.562***	0.139**	0.0120	0.348***	0.410***	0.503***	0.294***	0.209***	0.328***
vp6	0.334***	0.365***	0.289***	0.383***	0.297***	0.397***	0.125**	0.0750	0.170***	0.392***	0.400***	0.318***	0.0200	0.352***
up1	0.381***	0.411***	0.451***	0.236***	0.355***	-0.398***	0.0480	-0.178***	-0.169***	-0.0780	0.377***	0.0320	-0.182***	-0.0500
up2	0.260***	0.215***	0.218***	-0.0970	0.360***	0.0390	0	0.272***	-0.0390	-0.0890	0.142**	0.500***	-0.0430	-0.0260
up3	-0.339***	-0.383***	-0.300***	-0.565***	-0.264***	-0.0520	-0.396***	0.306***	0.0320	-0.240***	-0.522***	0.303***	-0.0140	-0.347***
up4	0.554***	0.585***	0.373***	0.553***	0.527***	0.292***	0.298***	-0.0890	0.209***	0.430***	0.652***	0.141**	0.206***	0.485***
up5	0.426***	0.482***	0.494***	0.586***	0.434***	-0.00900	0.109*	-0.424***	0.128**	0.153**	0.546***	-0.260***	0.206***	0.265***
h1	0.338***	0.217***	0.241***	-0.0100	0.204***	-0.703***	0.293***	0	-0.528***	-0.511***	0.0260	0.0170	-0.334***	-0.351***
h2	-0.0390	-0.130**	-0.0440	0.0910	-0.155**	0.254***	0.229***	0.0610	-0.0600	0.279***	-0.0300	-0.00300	-0.0810	0.326***
h3	0.736***	0.741***	0.454***	0.590***	0.830***	0.270***	0.321***	-0.167***	0.0700	0.243***	0.712***	0.149**	0.118**	0.362***
h4	-0.0270	-0.146**	-0.206***	-0.274***	-0.136**	-0.568***	0.0910	-0.0110	-0.411***	-0.368***	-0.212***	0.0550	-0.261***	-0.321***
h5	0.473***	0.387***	0.283***	0.270***	0.578***	0.387***	0.226***	0.187***	0.0400	0.223***	0.270***	0.443***	0.163***	0.369***
h6	-0.132**	-0.142**	-0.119*	-0.0790	-0.266***	-0.221***	0.164***	0.0840	-0.249***	-0.0270	0.0140	0.0320	-0.255***	-0.0270

Table A6-17 Correlation Matrix Continued

	vp1	vp2	vp3	vp4	vp5	vp6	up1	up2	up3	up4	up5	h1	h2	h3	h4	h5	h6
vp1	1																
vp2	0.458***	1															
vp3	0.507***	0.346***	1														
vp4	0.366***	0.0320	0.242***	1													
vp5	0.452***	0.308***	0.400***	0.286***	1												
vp6	0.361***	0.400***	0.183***	0.172***	0.428***	1											
up1	0.130**	-0.143**	-0.0810	0.176***	-0.0100	0.142**	1										
up2	0.222***	0.208***	0.0220	0.116*	0.0400	0.0180	0.125**	1									
up3	-0.254**	-0.0320	-0.321**	-0.412**	-0.136**	-0.152**	-0.278**	0.344***	1								
up4	0.567***	0.320***	0.481***	0.407***	0.505***	0.461***	0.293***	0.0230	-0.510**	1							
up5	0.120**	-0.0950	0.133**	0.451***	0.0630	0.124**	0.437***	-0.137**	-0.702**	0.432***	1						
h1	0.0200	-0.242**	-0.226**	-0.0210	-0.495**	-0.336**	0.403***	0.176***	0.0270	-0.225**	0.0440	1					
h2	0.108*	0.137**	0.0390	-0.0670	0.0750	0.0560	-0.178**	-0.0790	-0.110*	0.121**	0.104*	-0.291**	1				
h3	0.444***	0.132**	0.247***	0.633***	0.330***	0.200***	0.263***	0.290***	-0.392**	0.467***	0.474***	0.107*	0.0350	1			
h4	0.0160	-0.134**	-0.0610	-0.248**	-0.491**	-0.401**	0.276***	0.248***	0.236***	-0.282**	-0.196**	0.642***	-0.231**	0.0140	1		
h5	0.347***	0.240***	0.0860	0.215***	0.132**	0.117*	0.0640	0.499***	0.105*	0.239***	0.0370	-0.0340	0.168***	0.600***	-0.00300	1	
h6	0.308***	0.105*	0.146**	-0.0870	0.0890	0.142**	0.183***	-0.0440	-0.0520	0.0580	-0.0260	0.0690	-0.0410	-0.214**	0.324***	-0.287**	1

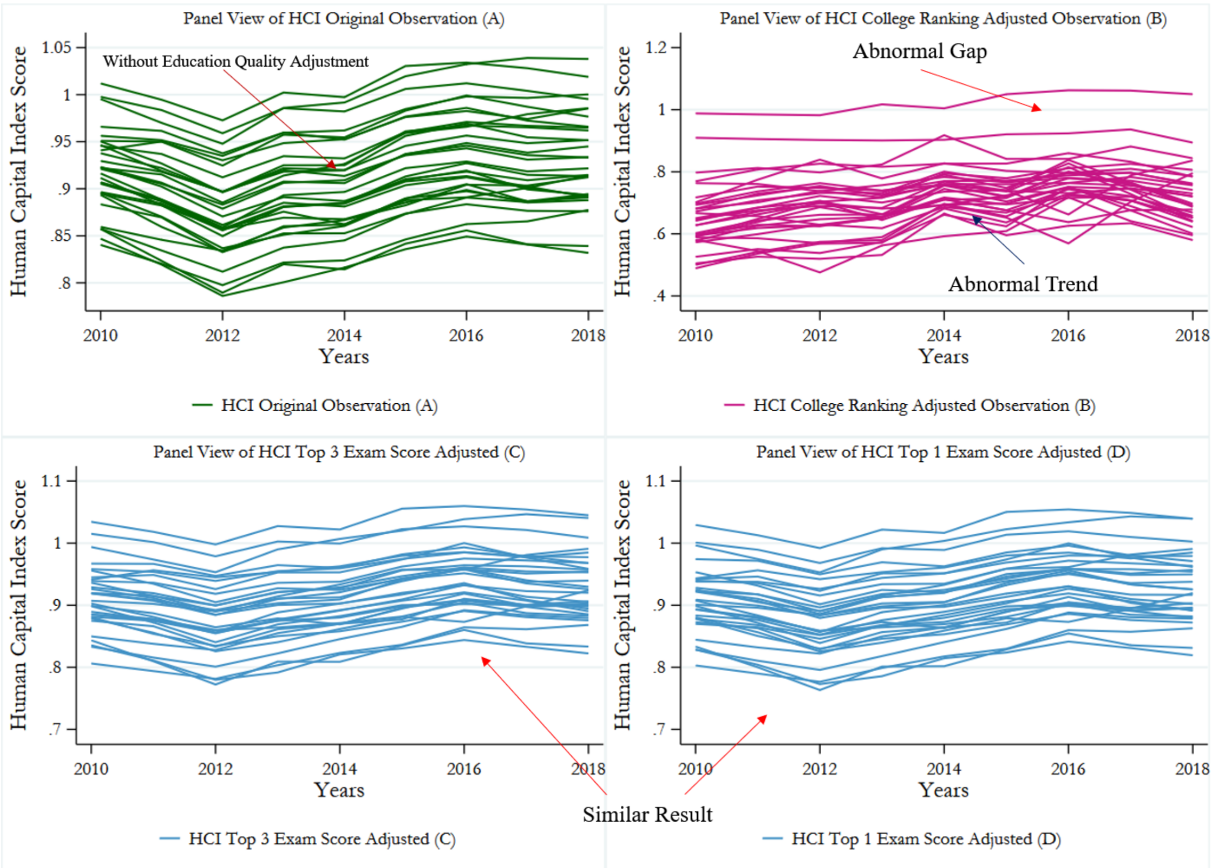
Source: Author's calculation using the data from China Health Statistical Yearbook, China Education Statistical Yearbook, and China Educational Finance Statistical Yearbook.

Appendix B

Discussion on the Selection of the Human Capital Index in Chapter 4

As you can see in the data description, we retained three different adjusted years of schooling variables and an original un-adjusted one to create the human capital index with our newly established approach. Figure B-1 shows the panel view of each human capital index's trend over time.

Figure B-1 Panel View of Four Different Human Capital Indexes for All Provinces

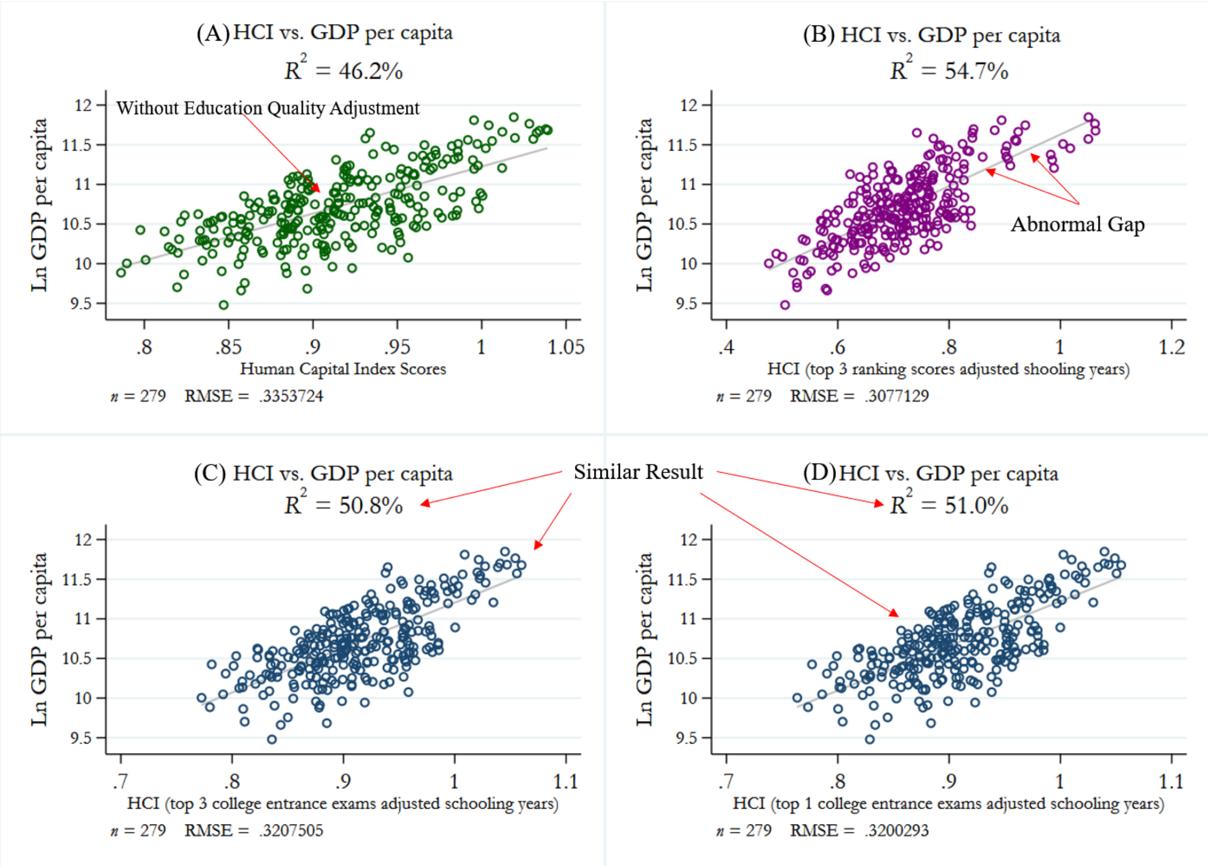


Source: Author's construction using the data from Human Capital Index, created in this dissertation.

As expected in the pre-processing data section, the human capital index adjusted by comprehensive college rankings shows a huge gap between the highest line and the rest of the provinces. It also contains the most unstable trend fluctuations compared to the other three indexes. Differ from the college ranking-adjusted human capital index. The other three human capital indexes are similar in the general panel curves. The layers are specific and transparent between the ranges with fewer sudden changes. The two indexes adjusted by college entrance exam relative scores are smoother than the original ones. Further, we provided correlation results between these four human capital indexes and natural logarithm processed provincial GDP per capita in Figure B-2.

We can see the lowest R-square between original education-based human capital and GDP per capita. The adjusted three human capital indexes are all observed to have R-square larger than 50%. Although the university ranking adjusted human capital index gives the highest R-square, the unreasonable panel view result prevents us from using it for the rest of the study. We can also observe several patterns from the scatter plots distributed in the graphs. The original years of schooling calculated human capital index widely dispersed the plots through the x-axis. In contrast, other adjusted human capital indexes share the same situation in that the cluster effect is more evident. However, the ranking score-adjusted human capital index shows a much lower level of the plots gathering, which is around 0.7, and exam scores adjusted human capital indexes reflect a higher status at approximately 0.9.

Figure B-2　Correlations between Four Human Capital Indexes and Log GDP per capita



Note: n means sample size. RMSE means Root Mean Square Error.

Source: Author's construction using the data from China Statistic Yearbook and Human Capital Index, created in this dissertation.

By showing these graphs and tables, we can finally decide which human capital index is suitable for further research. Since the LAYS are crucial for human capital and the unadjusted years of schooling formed an index to reflect a low correlation to GDP per capita, we first remove the choice of the original human capital. Furtherly, the adjusted human capital index college ranking scores do not demonstrate a reasonable trend within the duration. Even if it correlated well with GDP per capita, the bias of the index might lead to an insignificant conclusion. Meanwhile, two exam scores adjusted human capital indexes show a similar result from the tables and figures above. The top one university in each province cannot represent the true education quality. The rest of choice is the top three university students' entrance exam relative score-adjusted human capital index. The following research will be based on this index only.