

The Synergetic Transformation Path of Senior High and Higher Education Driven by Population Structure

Qinqin Li^{1*}

¹ College of Education, Guangxi Normal University, Guangxi, China

Email addresses

1022322758@qq.com (Qinqin Li)

*Correspondence: 1022322758@qq.com (Qinqin Li)

Received: 26 April 2025; Accepted: 14 May 2025; Published: 23 June 2025

Abstract:

This study is rooted in the current social development reality, comprehensively considering multiple factors such as the expansion of senior high schools, enrollment growth, the improvement of higher education participation rate, and the dynamic changes in higher education distribution. From a demographic perspective, it deeply analyzes the internal correlations and influence mechanisms among these factors. By exploring the trends of population change, this research interprets the effects of population dynamics on higher education distribution in terms of student sources, resource allocation, academic disciplines, and other dimensions. Furthermore, it proposes targeted optimization strategies to promote the synergistic development of the higher education system and population development. The study aims to provide theoretical support for educational policy-making and practice, while contributing to social talent cultivation and sustainable development.

Keywords:

Higher Education, Population Change, Educational Distribution, Structural Optimization

1. Introduction

The spatial-temporal evolution of higher education layout under demographic transitions has emerged as a critical issue for educational equity and regional development. China's rapid shifts in population structure—including aging, urbanization-induced migration, and inter-regional demographic imbalances—have created complex pressures on educational resource allocation. While eastern regions benefit from population agglomeration to foster vibrant higher education ecosystems, central-western and northeastern areas face declining enrollment, talent drain, and outdated disciplinary structures, exacerbating regional educational disparities. These challenges underscore the urgency of realigning higher education systems with demographic dynamics to ensure sustainable talent cultivation.

This study addresses this gap by analyzing the interactions between population change and higher education layout across three dimensions: policy coordination,

resource allocation, and disciplinary adaptation. Drawing on demographic data (e.g., the Seventh National Population Census) and regional case studies, it identifies structural bottlenecks in student source distribution, fiscal investment, and academic discipline alignment. By integrating theoretical frameworks from educational economics and population studies, the research proposes evidence-based strategies—such as dynamic planning mechanisms, targeted funding models, and interdisciplinary curriculum reforms—to optimize higher education layout for resilience and equity. The goal is to inform policy frameworks that reconcile demographic realities with educational development, thereby supporting national strategies for balanced socioeconomic progress.

2. The Trends and Projections of Population Change in China

2.1. Historical Review

For a long time after the founding of the People's Republic of China, the orientation of population policies and socioeconomic development jointly propelled a steady increase in population, providing a large reserve of potential students for subsequent educational development. Wolfgang Lutz once found through cross - national comparisons that for every 10% increase in the secondary education enrollment rate, the fertility rate drops by 0.5, and the accumulation of human capital has become the core driver of economic growth [1].

With the advancement of reform and opening - up, education gradually received more attention. The scale of senior high school education began to expand, becoming a crucial pre - requisite link for talent cultivation and delivery to higher education. Meanwhile, higher education started from an elitist model. Through reforms of the college entrance examination and expansions of university enrollments, the enrollment rate of higher education increased significantly, marking that China's higher education had entered the massification stage [2]. The dividend from early population growth laid a certain foundation for the expansion of the scale of higher education.

In the 21st century, with adjustments to fertility policies and changes in social concepts, the population growth rate has changed. Many families are willing to invest more educational resources and time in their children in the hope of enhancing their future development potential [3]. Senior high school education resources have been further expanded. Not only has the number of schools increased, but the quality of school - running has also gradually improved, continuously strengthening the ability to supply students to higher education. In the field of higher education, the implementation of university enrollment expansion policies has led to a rapid increase in the gross enrollment rate, initiating an accelerated phase of higher education popularization. The interaction between population and higher education has become increasingly close and complex.

2.2. Analysis of the Current Situation

2.2.1. Current Situation of Population Size

Data from Table 1, sourced from the Seventh National Population Census, accurately outlines the current population size in China. Although the total population remains high, the growth pace has significantly slowed, with the annual number of new births gradually decreasing. Regionally, developed eastern coastal areas and some central cities continue to attract large-scale population inflows due to their

superior economic environments and abundant employment opportunities, resulting in persistently high population densities [4]. In contrast, areas with difficult traditional industrial transformation in central and western China, as well as remote rural regions, exhibit prominent population outflow and relatively low population densities [5], making the imbalance in regional population distribution increasingly evident.

Table 1. National Population Census Data.

Census Year	1953	1964	1982	1990	2000	2010	2020
National Population (Unit: 10,000 Persons)	58260	69458	100818	113368	126583	133972	141178

At the senior high education level, localities have actively responded to the call for education popularization by increasing investment. As illustrated in Figure 1, the illiteracy rate has decreased, while the number of senior high schools has significantly grown and school scales have continuously expanded. In particular, in densely populated urban areas, large senior high campuses have emerged continuously, with enrollment numbers reaching record highs, providing a more robust student source base for higher education.

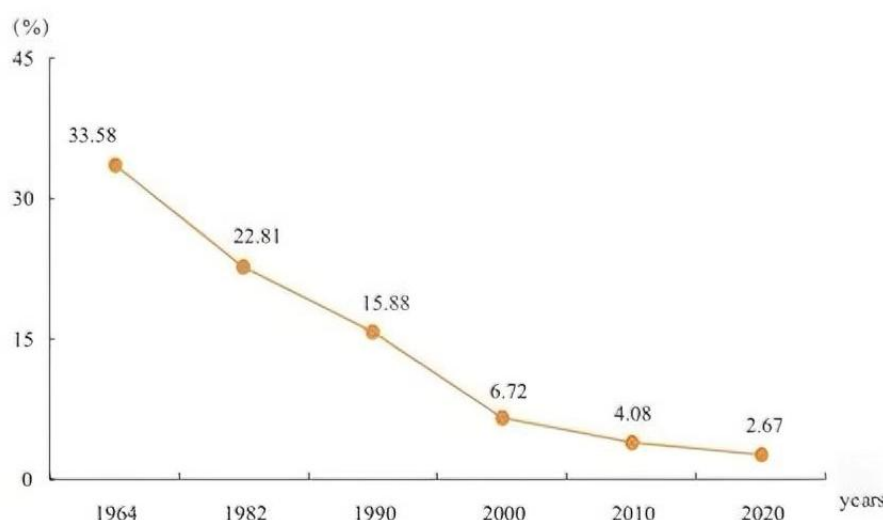


Figure 1. Illiteracy Rate.

Data source: Key Statistics from the Seventh National Population Census - National Bureau of Statistics of China

2.2.2. Analysis of Population Structure

(1) Age Structure

China's aging process has accelerated undeniably, with the proportion of the elderly population increasing annually. As shown in Figure 2, the child dependency ratio has experienced periodic changes, and the growth rate of the younger population has slowed down. This demographic transition in age structure has a two-way impact on senior high and higher education: On one hand, the demand for lifelong learning among the elderly has become increasingly vigorous. Some regions have explored extended forms of higher education such as senior universities and community colleges. For example, Changle County in Shandong Province has established senior universities relying on community resources, promoting the integration of senior education into community work systems to achieve a "two-way engagement" between

the elderly and the community [6]. This meets the elderly's pursuit of knowledge in culture, art, health, and other fields. On the other hand, the weak growth of younger student sources has created competitive pressures for senior high schools in enrollment. At the same time, it has prompted higher education institutions to preemptively strategize for student recruitment, paying more attention to improving student quality and shaping training characteristics.

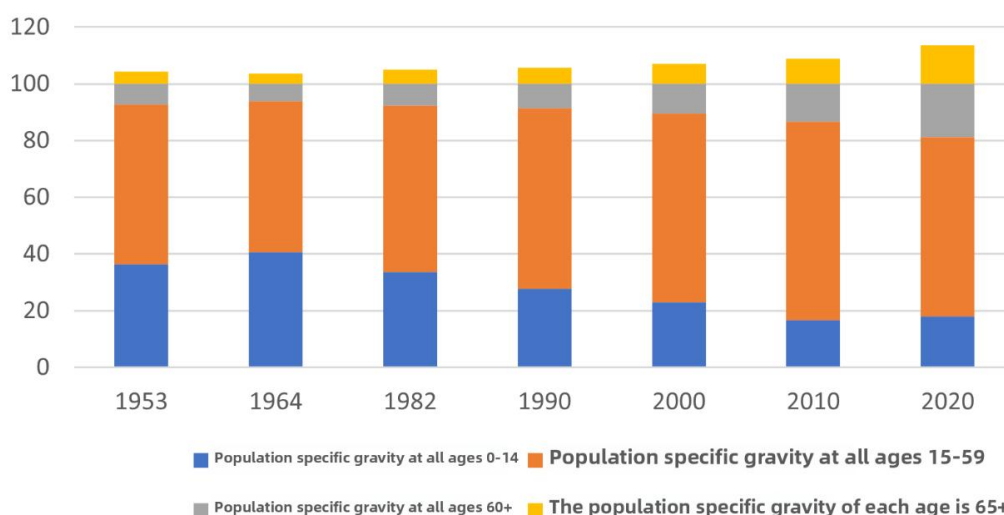


Figure 2. Proportion of Working-Age Population in 2020.

Data source: National Bureau of Statistics of China

(2) Urban-Rural Structure

The surging tide of urbanization has led to a massive aggregation of rural populations into cities, triggering a transformative change in the urban-rural population structure, as depicted in Figure 3. In the education sector, urban senior high schools far exceed their rural counterparts in terms of faculty allocation, teaching facilities, and curriculum resource development, attracting the vast majority of rural students to study in cities. This further exacerbates the imbalance of educational resources between urban and rural areas.

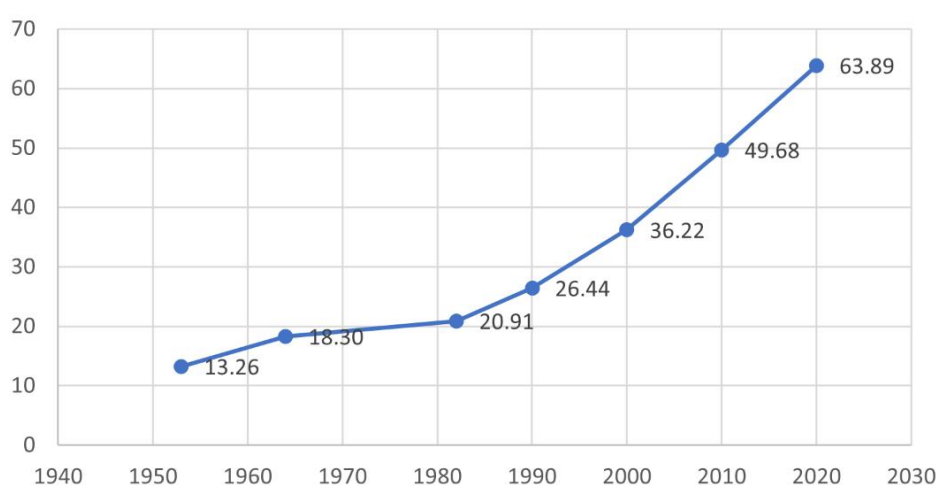


Figure 3. Urban Population Proportion in Previous Censuses.

Data source: National Bureau of Statistics of China

Higher education institutions are also predominantly concentrated in cities, with metropolises becoming hubs for higher education resources. Urban students hold a clear advantage in accessing higher education opportunities and enjoying high-quality educational services, while rural students face more obstacles, such as delayed information acquisition and weaker academic foundations. Rural students also remain at a disadvantage in the higher education enrollment system: current policies such as independent enrollment and recommended admission tend to favor urban students. Due to limitations in family background and educational resources, rural students often struggle to secure admissions to key universities through these channels [7], resulting in a persistent and significant gap in higher education access between urban and rural areas.

Regional Structure

From a macro-regional perspective, significant differences in population distribution exist among the eastern, central, western, and northeastern regions of China, with gaps in economic development levels directly reflected in the allocation of higher education resources [8]. Relying on a strong industrial foundation, advanced scientific research capabilities, and an open policy environment, the eastern region attracts a large influx of high-quality talent, boasting abundant higher education resources, a large number of universities, and diverse institutional levels. These institutions not only fully meet the needs of local students but also attract a significant number of students from other regions.

Despite the substantial development of higher education in central and western regions in recent years under national policy support, university growth remains constrained by factors such as economic strength and geographical location. Severe student outflow persists, and the distribution of higher education resources within these regions is uneven, with provincial capital cities dominating university development while surrounding areas lag relatively behind. In the northeastern region, delayed industrial restructuring and intensified population outflow have led to challenges such as funding shortages and faculty brain drain, resulting in overall insufficient vitality in higher education development.

2.3. Future Projections

This study leverages data from the advanced population forecasting software PADIS-INT to illustrate the national and regional population projection results released by the central authority, as shown in Figure 4, which depicts the projected total population size based on this forefront software. The total fertility rate (TFR) parameter adopted in the median-value scenario of the projection interval is the median of 100,000 future change trajectories obtained through probabilistic forecasting, serving as the recommended scenario. Additionally, by comprehensively considering key factors such as current fertility policy trends, socioeconomic development trajectories, and shifts in public education concepts, this study simulates and predicts China's population development trends over the next 25 years.

It is projected that the growth of the total population will continue to slow down, with aging deepening significantly. The scale of the elderly population will further expand, the proportion of the working-age population will show an irreversible downward trend, and the dependency ratio will continue to rise.

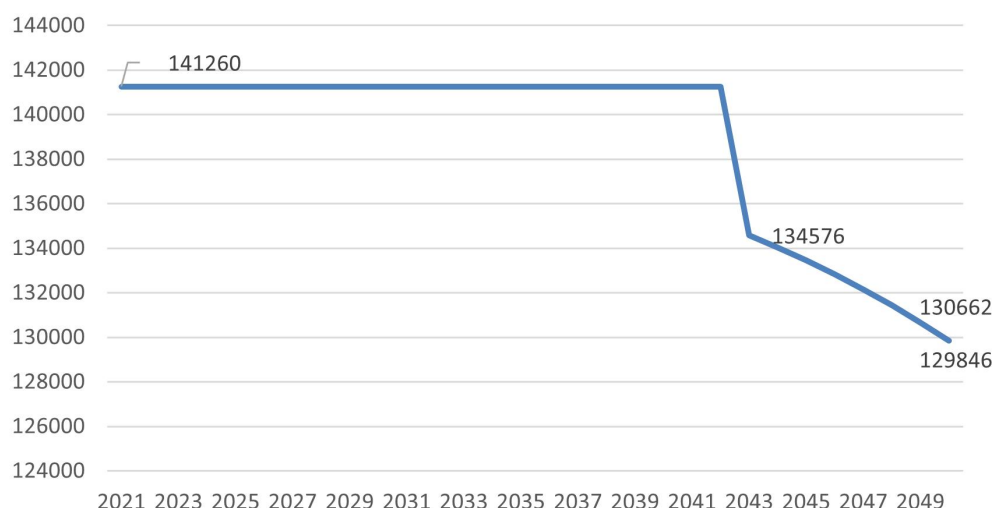


Figure 4. Projections of Total Population Size.

Data source: National Bureau of Statistics of China

In the Field of Senior High Education, with the deep implementation of policies to universalize senior high education, the distribution of senior high schools will become more balanced, and differences in school quality are expected to narrow. However, constrained by the total number of student sources, enrollment competition will intensify, making characteristic and diversified school-running the inevitable path for the survival and development of senior high schools. For Higher Education, the uneven geographical distribution of student sources will intensify, with fierce competition for students among eastern universities and a latent student crisis in central and western universities. The differentiation of college enrollment thresholds will become more evident. Meanwhile, as society's requirements for higher education quality increase and new demands arise from demographic changes, adjusting the layout of higher education has become urgent. Higher education quality needs to emphasize the integration of industry and academia [9], particularly accelerating optimized transformation in disciplines, professional settings, and resource allocation.

3. Analysis of the Impact of Population Change on the Layout of Higher Education

3.1. Changes in Population Size

3.1.1. The Chain Reaction Triggered by Short-Term Expansion of Senior High School Enrollments

In recent years, the expansion of senior high schools and increased admissions have, in the short term, significantly expanded the “reservoir” of student sources for higher education. Over the 40 years since the reform and opening-up, China's education sector has achieved remarkable development. In 1978, only 60.5% of primary school graduates advanced to junior high school, and the number of college students stood at 856,000. By 2017, there were 513,800 schools of all types and levels nationwide, with 270 million students in degree education and 16.2689 million full-time teachers [10]. This indicates that the number of schools in 2017 was nearly comparable to the number of students in 1978. At this astonishing growth rate, the number of schools to be built in the future could, if compared to 1978, nearly provide one school per student.

Not only has the number of schools increased, but their scales and enrollment numbers have also grown continuously. For example, senior high school enrollments have seen a substantial increase, evident from the nearly 1 million student growth in the past two years. Statistics show that in 2022, the gross enrollment rate in senior high school education reached 91.6%, an increase of 0.2 percentage points from 2021. There were 15,000 regular senior high schools nationwide, an increase of 441 schools; enrollment reached 27.139 million, an increase of 1.088 million students; and new admissions were 9.475 million, an increase of 426,000 students [11]. By 2023, China's senior high school gross enrollment rate reached 91.8%, an increase of 90.7 percentage points from 1949. Among them, the number of regular senior high school students increased from 210,000 in 1949 to 28.04 million in 2023, a 134-fold increase [12]. This suggests that college admissions now affect an increasingly large number of people, virtually concerning the hopes and futures of every Chinese family!

However, in the long term, the issue of uneven student quality has become prominent, placing greater screening pressures on colleges during admissions. How to accurately identify students with potential has become a challenge. Additionally, as the number of senior high school graduates increases annually—from 416 college-educated individuals per 100,000 people in 1964 to 15,467 in 2020—the rapid growth in educational attainment has intensified the pressure to popularize higher education and increased the load on college resources. Assuming all students pursue senior high education, the largest cohort of primary school students in 1990 would have graduated from senior high school 6–11 years later (i.e., between 1996 and 2001).

In reality, senior high school enrollments grew significantly between 2000 and 2010, stabilizing from 2010 to 2020, while primary school enrollments declined during the same period, as shown in Figure 5. This implies that primary school students from 2010 to 2020 will drive senior high school enrollments to peak in 2016 or even 2031. In the short term—over nearly a decade—teaching facilities and faculty staffing must rapidly keep pace, or there will be a risk of declining educational quality.

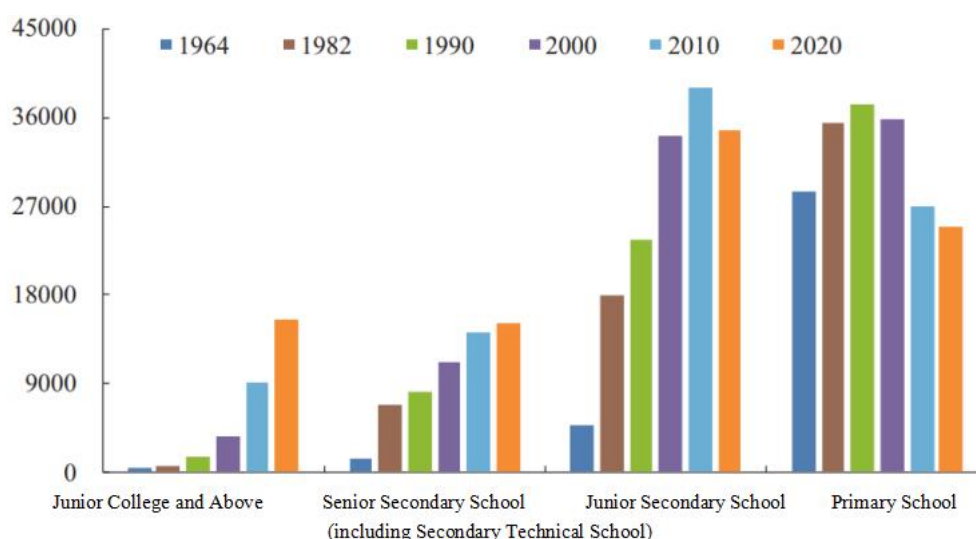


Figure 5. Number of People with Various Educational Attainments per 100,000 Population in Previous Censuses 0.

(person/100000 persons)

Data source: Key Statistics from the Seventh National Population Census - National Bureau of Statistics of China

3.1.2. The Student Source Dilemma under Long-Term Slowing Population Growth

Blake et al. confirmed through data visualization (Figure 5) that the global population growth rate declined from 2.2% in 1960 to 1.2% in 2020, and is projected to fall to 0.5% by 2050 [13]. The slowdown in population growth implies a shrinking base of college-age students, and the situation of "more monks than rice" in university enrollment will gradually emerge in the future.

China once relied on a large population for strength. In 1982, the one-child policy was fully implemented; in 2016, the two-child policy was introduced; and in 2021, the three-child policy was officially adopted. With the inflection point of the demographic dividend, the ratio of producers to consumers has peaked and begun to decline. When the proportion of the working-age population rises, the savings rate increases, which promotes the potential economic growth rate. The transformation of savings into investment not only stimulates current investment demand but also expands future capital stock and enhances economic supply capacity. Conversely, the slowdown or absolute decline in the growth of the working-age population tightens labor supply, increases the proportion of older workers in the total working-age population, and lowers overall labor productivity. Additionally, as the producer-to-consumer ratio decreases, savings rates and investment rates decline under constant other conditions, with capital stock growth slowing—collectively contributing to a decline in potential economic growth rates.

In the long term, nearly a decade from now, the number of senior high school students is expected to reach its peak. Due to the annual decrease in primary and junior high school students, the number of senior high school students will gradually decline (see Figure above). Some less competitive colleges and universities, especially local junior colleges and newly established undergraduate institutions, may face a crisis of insufficient student sources, difficulty in fulfilling enrollment plans, and even existential threats [14]. In contrast, high-quality universities will attract more students through brand advantages, disciplinary strength, and employment guarantees, further exacerbating the polarization in higher education.

3.2. Changes in Population Structure

3.2.1. Impact of Age Structure

(1) Expanding Demand for Elderly Education

In today's society, as it progresses toward deep aging, the spiritual and cultural demand structure of the elderly population has undergone profound transformations, with a notable increase in the desire for higher education-level learning. In their later years, they are no longer satisfied with basic material life security but harbor a strong wish to continue exploring the ocean of knowledge. They expect to enrich their knowledge reserves, deepen their understanding of the world through systematic learning, and thereby comprehensively improve the quality of their late-life. From the perspective of addressing population aging, the connotation of elderly-related talent education should be redefined. Through professional talent training in vocational education, higher education, family and intergenerational education, lifelong education, and diversified human resource development and training, the elderly-related talent education system can be reconstructed [15].

This new wave of social demands poses challenges to traditional higher education institutions, compelling them to break through inherent boundaries. Measures include

offering diversified courses covering classic studies in humanities and social sciences, art appreciation, health-preserving science popularization in natural sciences, and introductory courses in emerging technologies; organizing senior academic communities; and adjusting curriculum layouts to meet the learning needs of the elderly. However, the faculty allocation faces the dilemma of a shortage of teachers who both understand specialized disciplines and excel in elderly education. Curriculum design has not fully considered the characteristics of the elderly population, and the teaching management model lacks flexibility, exposing the shortcomings in the layout of higher education to adapt to diversified needs. Therefore, it is urgent to optimize and innovate in teacher training systems, curriculum development mechanisms, and teaching management models, promote the deep integration of elderly education and higher education, and improve the overall layout of higher education.

(2) Impact of Changes in the Structure of Young Student Sources

As the cornerstone and core force of higher education, every subtle change in the structure of young student sources is akin to a stone dropped into a lake, creating ripples and far-reaching impacts across the higher education landscape. On the one hand, with the steady development of the social economy and the significant improvement in people's living standards, the physical fitness and cognitive abilities of young students have greatly enhanced. They exhibit more active thinking and broader horizons, placing higher demands on the depth and breadth of teaching content in higher education, as well as the innovativeness and interactivity of teaching methods. The traditional one-way cram-style teaching model, which centers on teachers and requires students to passively receive knowledge, has become difficult to stimulate young students' learning potential and meet their growing learning needs, making innovation urgent.

On the other hand, in an era of information explosion and rapid industrial iteration, the career planning of young people has shown an unprecedented trend of diversification. They are no longer confined to traditional popular career paths but pay more attention to emerging industries and their broad employment prospects, such as cutting-edge technology fields like artificial intelligence, big data, and biomedicine, as well as majors related to new business formats such as cultural creativity, new energy, and e-commerce live streaming [16]. This shift in career preference is like a strong east wind, compelling higher education institutions to adopt forward-looking strategic vision and agile adaptability. Only by accelerating the adjustment and optimization of disciplines and majors, and accurately aligning with the changing needs of young student sources, can they gain a firm foothold in fierce educational competition and cultivate talents that meet the needs of contemporary development for society.

3.2.2. Impact of Urban-Rural

The drastic transformation of urban-rural population structure is akin to a powerful storm reshaping the geographical landscape of higher education, placing unprecedented adjustment pressures on its layout. Driven by urbanization, cities and towns have attracted continuous population agglomeration by virtue of abundant employment opportunities and high-quality public service resources. This trend has injected strong momentum into the development of urban senior high education, with an increase in the number of schools and improvement in school quality, thereby providing a large pool of student sources for higher education. However, urban higher

education resources are unable to bear the rapidly growing demand in the short term: campus spaces are cramped, and infrastructure such as teaching buildings, libraries, and laboratories are overburdened; the construction of teaching staff lags behind, with imbalanced student-to-faculty ratios, excessive teaching burdens on faculty, and risks of declining teaching quality.

In contrast, higher education development in rural areas has lagged relatively behind. Although the state has intensified support for rural education in recent years under the philosophy of educational equity, and the hardware facilities and faculty allocation in some rural senior high schools have improved, significant gaps still exist compared with the long-accumulated advantages of urban senior high schools. Due to lower educational starting points, rural student sources lag behind urban students in knowledge reserves, learning methods, and comprehensive quality development, and are at a disadvantage in college entrance competition, with a lower proportion of students admitted to high-quality universities [17]. The huge gap between urban and rural higher education not only affects the equity of individual development opportunities but also poses potential threats to balanced social development, urgently requiring systemic and in-depth reform measures to bridge.

3.2.3. Impact of Regional Structure

The imbalance in regional population distribution acts like an invisible yet powerful hand, directly manipulating the balance of higher education resource allocation and creating marked unevenness. Driven by the scale effect of dense populations and the strong financial resources from rapid economic growth, higher education in developed eastern regions has witnessed rapid development. With numerous universities clustered together and fierce competition among them, under the law of "natural selection, survival of the fittest," institutions have actively explored innovative school-running models, introduced international cutting-edge educational concepts and advanced teaching methods, optimized disciplinary and professional layouts, and focused on strategic emerging fields such as frontier technology, high-end manufacturing, and modern service industries. This has formed a virtuous cycle where educational development and economic growth mutually reinforce each other.

In contrast, central and western regions suffer profoundly from population loss. Large numbers of young and middle-aged labor forces flock to the eastern coast for development opportunities, leading to a dual decline in the quality and quantity of local college student sources and imposing multiple challenges on university development. Due to insufficient student bases, limited financial investment, and unstable faculty, universities in these regions struggle to cultivate high-quality talents that meet the needs of rapid regional economic and social development, failing to provide strong intellectual support for local growth and falling into a vicious cycle of development difficulties.

Colleges and universities in northeastern China also face severe challenges. Under the dual pressures of population outflow and economic downturn, they suffer from tight funding, slow infrastructure renewal, and outdated teaching and research equipment. Severe faculty brain drain—with backbone teachers and discipline leaders frequently seeking better opportunities elsewhere—has left disciplines without qualified successors. Traditional advantageous disciplines have failed to transform in a timely manner, while new disciplines have been weakly cultivated, making it difficult to meet market demands [18]. In this challenging situation, northeastern

universities urgently need to explore paths to break through the predicament and rejuvenate themselves through multi-dimensional measures such as deepening reforms, strengthening regional cooperation, and aligning with industrial needs.

The imbalance in regional population distribution has had a profound impact on the layout of higher education resources, with universities in different regions facing vastly different opportunities and challenges. Against this backdrop, regional universities must adopt targeted measures tailored to local conditions to achieve rational allocation and efficient utilization of educational resources and promote the sustainable development of education.

4. Optimization Strategies for Higher Education Layout under Population Structure Changes

4.1. At the Policy Guidance Level

4.1.1. Establishing a Coordinated and Collaborative Planning Mechanism

Against the backdrop of profound population structure changes, establishing a dynamic coordinated and collaborative planning mechanism based on population change data has become a key task for education authorities to coordinate the integrated development of senior high and higher education and achieve precise layout. Through technical means such as big data analysis, demographic modeling, and machine learning algorithms, this mechanism comprehensively analyzes multivariate data including birth rates, mortality rates, migration rates, and age structures, creating accurate portraits of regional population dynamics to provide a scientific basis for adjusting senior high school layouts.

In the short term, as senior high school enrollments are expected to peak in nearly a decade, new senior high school projects should be initiated in emerging urban areas, industrial parks, and regions with significant population return to optimize school spatial distribution. Meanwhile, given the rapid growth of senior high school students starting now, urgent resource integration is needed in areas with scarce student sources to prevent maximum impacts from resource idling and inefficient allocation. Enrollment scales should abandon one-size-fits-all standards; instead, customized enrollment plans should be developed based on student quality monitoring systems and regional education development disparities to ensure that students entering higher education not only meet quantitative university needs but also demonstrate balanced development in knowledge reserves, learning abilities, and comprehensive quality.

Higher education planning must be more closely linked to the development trends of senior high education. Using tools such as system dynamics models and grey prediction models [19], it should explore the potential connections between senior high education scale and higher education student sources, and combine population mobility trends to accurately predict future student numbers and formulate reasonable enrollment plans. In areas with abundant student sources, enrollment scales should be moderately expanded to meet societal demands for highly educated talent; in areas with tight student sources, professional structures should be optimized to focus on characteristic and advantageous disciplines, enhancing the alignment between talent cultivation and regional needs. Scholars have noted that the reform of new college entrance examination content emphasizes articulation issues and requires attention to comprehensive evaluation [20]. College entrance examination reform is a critical link

in the articulation between senior high and higher education. By reforming the college entrance examination and enrollment system and establishing a more scientific selection mechanism, effective articulation between senior high schools and universities can be better achieved. For example, expanding universities' independent enrollment rights and improving the comprehensive quality evaluation system can promote students' all-around development [21].

Additionally, university construction planning should have a long-term perspective, keeping pace with population distribution dynamics and senior high education development. New universities or branch campuses should be rationally planned in city clusters and metropolitan areas to create highlands of concentrated educational resources. In sparsely populated areas, emphasis should be placed on the intensive development of existing universities, optimizing disciplinary layouts, strengthening faculty teams, and updating teaching facilities. Exceptional educational quality should compensate for scale shortcomings to prevent excessive resource concentration or idle waste, achieving optimal allocation and efficient utilization. Through building a collaborative mechanism between senior high and higher education, educational layouts can be optimized in all dimensions, keeping pace with the trend of the times, cultivating high-quality talent for society, and promoting the vigorous development of education.

4.1.2. Strengthening Policies for Regional Balanced Development

In today's era, the imbalance in regional higher education development has become increasingly prominent, emerging as a key bottleneck restricting the comprehensive, coordinated, and sustainable development of education in China. This study reveals significant disparities between eastern and western regions in the allocation of higher education resources and their economic contributions through indicators such as undergraduate density and higher education's contribution to GDP, emphasizing that regional economic gaps are the core influencing factor [22]. Universities in developed eastern coastal areas differ from those in central-western and northeastern regions not only in hardware facilities but also in deeper dimensions such as faculty strength, scientific research transformation capabilities, and talent cultivation quality. Facing this severe situation, the government shoulders an irreplaceable responsibility and urgently needs to strengthen policy support comprehensively with a forward-looking vision and decisive courage.

First, increasing special fund investment is a critical measure to address regional higher education disparities. Further increasing investments in special funds, particularly preferential support for central-western and northeastern regions, is key to achieving balanced regional higher education development. This requires not only fiscal transfer payments from the central government but also increased educational funding from local governments based on actual conditions [23]. Due to geographical and economic development constraints, central-western and northeastern regions have long faced multiple challenges in higher education development. Many universities suffer from outdated teaching and research equipment, limited library resources, and lagging digital infrastructure, unable to meet the needs of frontier discipline teaching and innovative research. Therefore, the government should make resolute decisions to continuously increase financial support for higher education in these regions. Special funds should be precisely directed toward laboratory modernization upgrades, acquisition of advanced experimental instruments, scientific research project breakthroughs, enrichment of library physical books and electronic databases, and

optimization of campus network infrastructure, providing a solid foundation for academic exploration.

Second, implementing regional education collaboration policies is of far-reaching significance. Universities in eastern regions have accumulated rich experience in school-running concepts, faculty teams, and scientific research transformation by virtue of economic and policy advantages, leading the country in these aspects. In contrast, while central-western universities possess certain resources and development potential, their progress is slow due to multiple constraints. Therefore, the regional education collaboration policy of pairing eastern universities with central-western counterparts for support is particularly important. Through joint school-running models such as undergraduate dual-degree joint training programs and graduate joint training bases, central-western students can access the superior disciplinary curriculum systems of eastern universities, broaden their academic horizons, and enhance their comprehensive qualities. In terms of faculty exchange, key teachers from eastern universities should be regularly dispatched to teach and lecture in central-western regions, introducing advanced teaching methods and academic trends. Meanwhile, central-western teachers should be admitted to eastern universities for further study, participating in curriculum design and teaching practice seminars to comprehensively improve their teaching and research capabilities. The establishment of resource-sharing platforms—integrating online and offline approaches, opening up high-quality course and academic lecture video resources, and sharing laboratories and research equipment—breaks geographical barriers and maximizes the utilization efficiency of high-quality resources.

4.2. At the Resource Allocation Level

4.2.1. Optimizing the Spatial Layout of Universities

Against the backdrop of accelerating globalization and urbanization, the spatial layout of higher education institutions has become a critical strategic issue for national and regional development. Rational optimization of this layout requires comprehensive consideration of multi-dimensional factors such as population density, distribution of economic development hotspots, and future population mobility trends. Li Feng's empirical study confirms that higher education investment generates spatial spillover effects on regional economies through mechanisms such as human capital accumulation and industrial agglomeration [24]. Over the past decade, the number of senior high school students has approached peak levels, leading to explosive growth in higher education demand in some regions. Particularly in densely populated and industrially robust emerging areas—such as national-level new districts, which host a large number of high-tech industries and modern service enterprises and attract significant talent inflows—population density has risen sharply. New migrants hold high expectations for their children to receive quality higher education, while the vigorous development of regional industries urgently requires a large number of high-quality professionals, straining local educational resources. Core cities in urban agglomerations face similar challenges: as regional economic, cultural, and transportation hubs, they attract young labor forces and student populations from across the country, but the allocation of higher education resources has failed to keep pace with regional economic and innovative development needs. The layout of high-quality educational resources struggles to support the advantageous development of

urban agglomerations [25], further exacerbating the supply-demand contradiction in higher education resources.

To address this urgent situation, moderately increasing the number of senior high schools, universities, or branch campuses has become a top priority. New senior high schools should fully consider regional population distribution characteristics, with locations close to large residential areas to facilitate students (access to schools within their neighborhoods), supported by complete transportation and living facilities to ensure a safe and convenient campus environment. New universities or branch campuses must closely align with the needs of local leading industries, offering frontier disciplines and specialties such as artificial intelligence, biomedicine, and new energy materials to achieve precise integration of the education chain and industrial chain. The establishment of a high-level university branch campus can not only quickly enroll a large number of students in the short term to alleviate college entrance pressure but also leverage its research capabilities and talent aggregation effects to attract upstream and downstream related enterprises, foster a regional atmosphere of technological innovation, promote coordinated economic and social development, and form a virtuous cycle of mutual promotion between education and the economy.

Looking ahead to the next decade, as China's population structure transforms, the number of senior high school students will stabilize, and the quantity of senior high schools, universities, and branch campuses will enter a period of equilibrium. At that time, societal focus will shift to improving educational quality and optimizing resource allocation. In stark contrast, some regions—long constrained by industrial decline and geographical disadvantages—will experience severe and sustained population loss, leading to relative overcapacity of higher education resources allocated at conventional scales. Many universities suffer from prominent homogeneity issues, with professional settings lacking effective alignment with local characteristic industries, low school-running efficiency, and frequent waste of educational resources. Facing this dilemma, scientific integration and merger of some universities have become inevitable. The integration process should be based on in-depth research and meticulous evaluation: for universities with similar disciplines and severe duplicate construction, explore paths for merger and restructuring, break down administrative barriers, integrate faculty, laboratory equipment, and library resources, and redesign disciplinary layouts to create comprehensive universities with regional characteristics and core competitiveness. For universities with too small a scale, insufficient student sources, and limited development potential, decisive mergers or closures are necessary, with remaining educational resources appropriately allocated to other areas in urgent need to achieve “secondary distribution,” revitalize existing stock, and improve resource utilization efficiency. This ensures that limited educational resources are optimally allocated nationwide. Meanwhile, merger and closure decisions should take into account social impacts and legal norms, ensure proper handling of students' and faculty members' rights and interests, and consider universities' historical and cultural values [26] to promote the balanced and sustainable development of higher education in China.

4.2.2. Precise Investment in Educational Funds

Against the backdrop of rapid social changes and evolving educational landscapes, the precise allocation of educational funds has become a core driver for promoting high-quality and sustainable development in higher education. To this end,

establishing an educational funding model based on dynamic changes in population structure and educational needs is particularly necessary. First, in-depth analysis of the quantity and structural changes in senior high and higher education student sources across regions serves as the foundation for building this model. Influenced by China's population policy adjustments and regional economic development disparities, student sources in different regions exhibit significantly different dynamic characteristics. For example, in economically developed and highly attractive urban areas such as core cities in the Yangtze River Delta and Pearl River Delta, the influx of a large number of migrant populations has brought sustained growth in senior high school student sources, with an increasingly diversified student structure that includes both local registered students' traditional pursuit of high-quality higher education and the needs of children of migrants to integrate into the local education system. In contrast, due to lagging economic development and severe population outflow, some remote central-western regions have seen a gradual decline in student numbers, even facing enrollment difficulties at the higher education stage, with a relatively homogeneous student structure dominated by local left-behind students.

Scientific and dynamic allocation of fiscal appropriations can only be achieved based on detailed and dynamically updated student source data. In areas with rapidly growing student sources, such as emerging cities in a period of rapid development, newly built senior high schools and universities urgently require substantial funding for infrastructure, including modern teaching buildings, laboratories equipped with advanced experimental equipment, well-stocked libraries, and comfortable student dormitories. Meanwhile, expanding and training faculty is pressing, as attracting excellent teachers requires competitive compensation and development opportunities. In regions with weak educational resources, such as remote mountainous areas or poverty-stricken regions with old revolutionary bases, ethnic minorities, and border areas, there is not only a shortage of hardware facilities but also a severe lack of high-quality faculty and shared teaching resources. Fiscal appropriations should prioritize these regions to help them fill gaps and gradually narrow educational disparities with developed areas [27]. Additionally, expanding channels for raising educational funds and encouraging social capital to participate in higher education investment have become key strategies to break the deadlock. Guiding enterprises and social organizations to collaborate with universities in running schools can not only solve funding shortages but also introduce market operation experience and rich social resources, enhancing educational quality and efficiency.

Diversified educational funding is particularly important for the construction of emerging disciplines and senior education. Emerging disciplines such as artificial intelligence, quantum computing, and cutting-edge biotechnology are developing rapidly, requiring high-end and expensive research equipment, long R&D cycles, and high risks, which are difficult to meet solely through government financial support. Therefore, it is crucial to encourage powerful technology enterprises to cooperate deeply with universities. Enterprises not only invest capital but also bring industry practical experience into universities, while universities rely on their profound academic heritage and research talent reserves. The two sides complement each other's strengths to jointly overcome technical challenges and promote the vigorous development of emerging disciplines. In senior education, with the accelerated arrival of an aging society in China, the demand for knowledge updating and spiritual and cultural life among the elderly is increasing. However, current senior universities still face problems such as funding shortages, outdated facilities, and insufficient faculty

[28]. In this case, guiding enterprises and social organizations to cooperate with universities can not only inject funds and update teaching equipment but also develop courses tailored to the needs of the elderly, such as calligraphy, painting, and health preservation, and organize volunteer services to supplement faculty. Through these diversified cooperation models, a multi-source educational funding pattern can be gradually formed, comprehensively ensuring the sustained and healthy development of higher education, cultivating high-quality talents for the country, and contributing to the great rejuvenation of the Chinese nation.

4.3. At the Discipline and Specialty Adjustment Level

4.3.1. Optimizing Disciplinary Layout to Meet Demands

Higher education institutions should proactively optimize their disciplinary and specialty layouts in a forward-looking manner, closely aligned with the social demands arising from population structure changes. In their book *Labour Markets and Demographic Change* (2009), Michael Kuhn and Carsten Ochsén argue that low fertility rates have led to a decline in the proportion of young labor forces, while aging has intensified the rise in the elderly dependency ratio, directly impacting labor supply structures and productivity [29]. In response to the prominent trend of an aging society, universities should actively address the healthcare needs of the elderly population caused by physical function decline and frequent chronic diseases, vigorously developing disciplines and specialties such as geriatric medicine, rehabilitation therapy, and elderly care service management to cultivate professional senior care talents [30]. Specifically, in the field of geriatric medicine, universities need to carefully design foundational theoretical courses covering geriatric physiology, pathology, and pharmacology, while offering practical courses in clinical diagnosis and end-of-life care. Meanwhile, experts with both profound medical theoretical knowledge and rich clinical experience should be recruited to provide high-quality professional guidance to students. Additionally, by establishing close cooperative relationships with geriatric departments in major hospitals and rehabilitation centers, students can accumulate valuable practical experience in real medical environments.

The construction of rehabilitation therapy programs is equally critical. The elderly have urgent needs for disease rehabilitation and post-surgical functional recovery, requiring professional rehabilitation therapists to use physical therapy, occupational therapy, speech therapy, and other means to help them regain self-care abilities and improve their quality of life. Universities should increase investment in this field, equip advanced rehabilitation therapy equipment such as intelligent rehabilitation robots and high-precision motion assessment systems, and strengthen exchanges and cooperation with the international rehabilitation community to introduce cutting-edge concepts and technologies, cultivating professionals proficient in modern rehabilitation methods. The elderly care service management specialty is key to addressing the large-scale and professional development trends of the senior care industry. From the operational management of senior care institutions and optimization of service processes to the planning and construction of elderly communities and organization of cultural activities, elderly care service management professionals need interdisciplinary knowledge in management, sociology, and psychology. Universities should cultivate students' comprehensive literacy through relevant curriculum design, enabling them to solve various problems effectively in

frontline senior care services and promote the standardized development of the senior care industry.

At the same time, in response to the rapid rise of emerging industries such as artificial intelligence, big data, new energy, and biomedicine, higher education must focus on strengthening the construction of related disciplines and specialties, dynamically adjusting the proportion of science, engineering, agriculture, and medicine disciplines to better meet industrial development and social needs. These emerging industries are transforming the global economic landscape and reshaping lifestyles at an astonishing pace. Therefore, universities should not only offer core courses in artificial intelligence such as machine learning, deep learning, and computer vision but also focus on building practical platforms and establishing joint laboratories with technology enterprises to enable students to participate in real project research and development, cultivating their ability to solve complex problems. In the construction of big data majors, in addition to teaching data mining, data analysis, and data visualization, education in data security and privacy protection must be strengthened to ensure students can adapt to the complex challenges of the big data era. The new energy field requires the establishment of a complete disciplinary chain, from technology research and development in solar energy, wind energy, and biomass energy to application areas such as new energy vehicles and smart grids, cultivating compound talents proficient in both technology and application. Biomedical majors should keep pace with international frontiers, increasing research investment in hotspots such as gene editing, biopharmaceuticals, and precision medicine to cultivate innovative high-end talents.

Dynamically adjusting the proportion of science, engineering, agriculture, and medicine disciplines is also crucial. With the sharp increase in demand for science and engineering talents in emerging industries and the rising societal expectations for the quality of medical and health services, appropriately increasing the proportion of these disciplines can better meet industrial and social needs. However, this is not merely a matter of numerical adjustment but requires scientific and rational optimization based on factors such as regional industrial structure characteristics and population health demands. Furthermore, strengthening the interdisciplinary integration of basic and applied disciplines is essential. Basic disciplines such as mathematics, physics, chemistry, and biology provide a solid theoretical foundation for applied disciplines, which in turn translate basic theories into practical productivity. For example, mathematical models can optimize artificial intelligence algorithm performance, physical principles can be applied to new energy technology research and development, and chemical knowledge can support biomedical innovation. By creating disciplinary and specialty clusters that adapt to the industrial changes of the new era, universities can integrate resources, break down disciplinary barriers, and cultivate innovative talents with both theoretical depth and practical capabilities, injecting continuous momentum into social development and advancing steadily in the tide of the times.

4.3.2. Innovating Talent Cultivation Models

Universities should promote innovative reforms in talent cultivation models to meet the diversified and personalized learning needs of students against the backdrop of population changes. This reform aims to break down the barriers of traditional disciplines, implement interdisciplinary and modular curriculum systems, and allow students to independently select course modules according to their personal interests

and development goals, customizing personalized learning paths [31]. In this way, it not only satisfies the diverse learning needs of different students but also promotes interdisciplinary knowledge integration and the improvement of comprehensive application capabilities. Additionally, deepening industry-education integration and university-enterprise cooperation is a vital approach to achieving this goal. Universities should actively collaborate with leading industry enterprises to jointly build modern industrial colleges and internship training bases, introduce real corporate projects into classroom teaching, and implement an "order-based" talent cultivation model. This model not only enhances students' practical skills but also improves their employability, ensuring they possess professional skills adapted to market demands. Meanwhile, through close cooperation with enterprises, universities can promptly grasp industry development trends and technological frontiers, adjust teaching content and methods, and ensure a seamless connection between education and industrial needs. Ultimately, such innovative reforms will deliver more high-quality innovative talents to society and contribute to the high-quality development of the national economy and society. In specific implementation, universities also need to establish and improve evaluation mechanisms, continuously optimize curriculum settings and teaching models, and ensure the effectiveness and sustainability of reform measures to adapt to evolving social needs and educational environments.

In summary, facing the population change trends in real-world scenarios such as senior high school expansion, enrollment changes, and the improvement of higher education participation rates, optimizing the layout of higher education is extremely urgent. Only by pooling the efforts of the government, universities, and society, implementing precise policies, perceiving educational needs from a demographic perspective, and driving educational reforms with innovative thinking can higher education advance steadily amid the waves of dynamic population changes, lay a solid talent foundation for national prosperity, and write a new chapter in the development of higher education in the new era.

5. Conclusions

This study systematically analyzes the challenges and optimization paths for higher education layout under the background of population structure changes, and proposes three-dimensional strategies covering policy guidance, resource allocation, and disciplinary adjustment. Empirical evidence shows that dynamic planning mechanisms based on demographic data (e.g., PADIS-INT projections) can effectively address regional enrollment imbalances, while targeted fiscal investments and inter-regional educational collaborations help narrow resource gaps between developed and underdeveloped areas. The proposed disciplinary adaptation strategies, such as strengthening geriatric medicine and emerging technology disciplines, demonstrate potential to align higher education with aging society demands and industrial upgrading trends. Looking ahead, continuous monitoring of demographic dynamics, deepening industry-education integration, and improving the flexibility of educational resource allocation will be crucial for maintaining the adaptability and sustainability of China's higher education system. This research contributes to the theoretical understanding of population-education interactions and provides actionable insights for policymakers to foster a more equitable, efficient, and future-ready higher education ecosystem.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this article.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

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