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Beyond Population Size: Human Capital, Industrial Upgrading, and the Drivers of Shanghai's Economic Growth

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Abstract: This paper investigates Shanghai's economic growth trajectory from 2014 to 2023, highlighting the city's strategic shift from population-driven to talent-driven development. During this period, Shanghai's resident population remained largely stable at approximately 24 million, yet its GDP nearly doubled, reaching 4.72 trillion yuan in 2023. Using regression analysis, the study finds that higher education enrollment exhibits the strongest correlation with GDP growth ($r = 0.93$), exceeding the influence of both total population and migrant inflows. This underscores the emergence of a "talent dividend" where the quality of human capital increasingly drives economic expansion, effectively replacing the traditional "demographic dividend" associated with sheer population growth. Beyond human capital, complementary factors—including industrial upgrading, accelerated R&D investment, and targeted policy reforms—have reinforced this transition, facilitating structural transformation and innovation-led growth. The findings imply that megacities can sustain high-quality economic growth even under conditions of population stagnation, provided they strategically cultivate skilled talent and foster innovation ecosystems. Policy recommendations emphasize the importance of attracting and nurturing high-skilled workers, investing in advanced research and development, and improving urban livability to enhance long-term competitiveness and resilience in a rapidly evolving global economy.

Keywords: GDP growth; demographic dividend; talent quality; linear regression; industrial structure; Shanghai

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1. Introduction

Economic growth is widely recognized, both domestically and internationally, as a core indicator of a country's or region's comprehensive strength and development potential [1]. Among the various metrics used to measure economic performance, Gross Domestic Product (GDP) occupies a central position, reflecting the aggregate output, productivity, and overall vitality of an economy. Historically, population size and structure have been regarded as fundamental determinants of economic growth. The conventional perspective emphasizes that population expansion directly enlarges the labor supply and consumer base, thereby stimulating production, consumption, and overall economic activity. However, in the context of rapid urbanization, technological advancement, and industrial upgrading, the role of population "quality"—including educational attainment, professional skills, and innovative capacity—is becoming increasingly pivotal in shaping economic trajectories. In particular, studies suggest that organizational trust and effective capacity sharing can enhance workforce efficiency and collaborative innovation, indirectly supporting macroeconomic performance [2].

This paper seeks to systematically examine the relationship between economic growth and key demographic and non-demographic factors, integrating insights from existing literature with empirical observations of Shanghai's development practices to uncover the mechanisms driving high-quality urban growth and offer actionable guidance for future policy-making [3].

As China's hub for economic, financial, trade, and technological innovation, Shanghai has experienced remarkable GDP growth over the past two decades, accompanied by significant shifts in both population size and composition. Financial and institutional innovations, such as the institutionalization of private equity fund management, have also contributed to Shanghai's economic dynamism [4]. Similarly, technological advancements—including intelligent scheduling in supply chains and digital credit risk management practices—have improved industrial productivity and operational efficiency, further supporting high-quality urban growth [5,6].

Over the past decade, Shanghai's GDP nearly doubled, reaching 4.72 trillion yuan in 2023, cementing its status as China's leading economic metropolis [7]. In contrast, its resident population has remained relatively stable at around 24 million, with periods of negative growth between 2015 and 2019 and only modest recovery after 2022. This apparent decoupling of population growth from economic expansion poses a critical question: what underpins Shanghai's sustained economic momentum? Does it derive primarily from a “quantitative demographic dividend” i.e., the sheer size of the labor force, or from a “quality-driven talent dividend” rooted in a highly skilled and innovative population?

To address this question, the study draws on authoritative datasets from the Shanghai Statistical Yearbook and the Shanghai National Economic and Social Development Statistical Bulletin, employing rigorous quantitative analysis and regression modeling. The research examines the relationships between GDP and key demographic variables—including resident population, migrant inflows, and higher-education enrollment—while also evaluating the contributions of non-demographic factors such as industrial upgrading, technological innovation, and R&D investment. By elucidating the underlying logic of economic growth in a megacity context, this paper provides insights not only for Shanghai but also for other urban centers seeking to achieve sustained, high-quality economic development in an era of population stabilization and global competition.

2. The Relationship Between Population Size and Economic Growth

2.1. Classical Theory

In classical and neoclassical economic growth frameworks, such as the Solow model, population growth is a fundamental determinant of labor supply, which directly influences economic output. The concept of the “demographic dividend” widely discussed since the latter half of the 20th century, posits that an increasing proportion of working-age individuals can provide abundant labor, boost savings, and expand domestic demand, thereby fueling rapid economic growth. Historical evidence from the East Asian “economic miracles” supports this view: during periods of industrialization, countries like South Korea and Singapore experienced a virtuous cycle in which population expansion, labor mobilization, and capital accumulation reinforced each other, leading to accelerated GDP growth and structural economic transformation. The underlying assumption is that a growing population, if effectively employed and supported by social infrastructure, can serve as a key engine for economic development.

2.2. Empirical Research

Empirical studies generally support the positive correlation between population growth and economic performance, although the strength and nature of this effect are stage-specific. In early development phases, population expansion translates efficiently into labor supply and increased consumer demand, generating high marginal returns to growth. For example, developing countries in the mid-20th century often leveraged rapid

demographic growth to establish labor-intensive industries and expand domestic markets. However, as economies mature, the benefits of sheer population growth diminish. Excessive population expansion in advanced stages can generate structural pressures, such as rising unemployment, housing shortages, and overburdened public services, which may reduce overall economic efficiency and even hinder growth. This observation highlights a critical nuance: while population quantity provides a foundational base for economic development, its contribution is neither uniform nor unlimited.

2.3. Shanghai's Practice and Transformation

Shanghai provides a compelling case study illustrating this transition. Between 2000 and 2015, the city experienced rapid population growth: its resident population increased from 16.76 million to 24.20 million, while GDP surged from under 500 billion yuan to 2.6 trillion yuan. During this period, the expansion of labor supply and the accompanying consumer base aligned closely with economic growth, demonstrating the classical demographic dividend in action.

However, since 2017, Shanghai has adopted deliberate population regulation policies, including measures to manage household registration (*hukou*) inflows, optimize urban density, and improve public service allocation. Consequently, the resident population has stabilized, with slight negative growth observed between 2015 and 2019, yet GDP continued to grow at an average annual rate exceeding 6%. This decoupling of population size from economic expansion signals a structural shift: the marginal contribution of population quantity to GDP is declining, and the city can no longer rely solely on a "quantitative demographic dividend" to sustain growth.

The experience of Shanghai underscores a broader trend in advanced megacities: economic growth increasingly depends on the quality of human capital, innovation capacity, and structural transformation rather than the sheer number of inhabitants. Industrial upgrading, technological advancement, and talent accumulation are becoming the new drivers of urban economic vitality. This evolution also highlights important policy implications: cities aiming for sustainable, high-quality growth must complement population management with strategies to attract, retain, and cultivate highly skilled and innovative workers, thereby unlocking a "talent dividend" that can sustain growth in the absence of population expansion.

3. The Role of Demographic Structure and Talent Quality

3.1. Human Capital Theory

Human capital theory, as articulated by Schultz and Becker, emphasizes that investments in education, skills training, and knowledge acquisition significantly enhance labor productivity, which in turn drives sustained economic growth [8]. Unlike simple population size, the quality of the population-encompassing educational attainment, professional expertise, and innovative capability-plays a more decisive role in long-term economic development. Highly skilled talent not only increases individual productivity but also amplifies total factor productivity through technological innovation, knowledge spillovers, and improved management practices. In knowledge-intensive and technology-driven economies, the contribution of human capital often outweighs that of sheer labor quantity, highlighting a paradigm shift from demographic to talent-driven growth.

3.2. Domestic and International Case Studies

Empirical evidence from both developed countries and innovative urban regions underscores the growing importance of high-quality talent in sustaining economic growth [9]. For instance, Silicon Valley in the United States has maintained its long-term economic vitality by concentrating highly educated researchers, engineers, and entrepreneurial enterprises, generating continuous technological breakthroughs and commercial innovations. Similarly, Japan, despite facing an aging population and periods of zero population

growth, has preserved high productivity levels and global competitiveness through strategic investments in human capital, automation, and technological innovation. These cases illustrate that cities and nations can decouple economic growth from demographic expansion when talent quality, innovation ecosystems, and knowledge-intensive industries are prioritized [10].

3.3. Shanghai's Practice of "Talent Dividend"

Shanghai exemplifies the transition from a traditional demographic dividend to a talent-driven growth model. As China's premier talent hub, the city attracts substantial inflows of highly educated individuals, including master's and doctoral graduates, overseas returnees, and specialized professionals. According to official statistics, the proportion of Shanghai residents holding undergraduate degrees or higher has markedly increased over the past decade. Concurrently, the city's economic structure has shifted toward high-tech industries, financial services, and knowledge-intensive sectors, which now serve as the primary engines of GDP growth.

This evolution suggests that Shanghai's sustained economic expansion increasingly relies on a "talent dividend" rather than the historical "population dividend." To empirically quantify the impact of talent quality on economic performance, this study constructs a regression-based mathematical model, analyzing the relationships between GDP and variables such as higher-education enrollment, skilled labor proportion, and R&D intensity. All datasets are drawn from authoritative sources, including the Shanghai Municipal Statistics Bureau Annual Statistical Bulletins (see Table 1), ensuring robustness and reliability. The model demonstrates that indicators of human capital quality exhibit a stronger correlation with GDP growth than traditional demographic measures, confirming the strategic importance of talent accumulation in driving Shanghai's high-quality development.

Table 1. Variable Definitions and Data Sources.

Variable Type	Variable Symbol	Indicator Name	Unit	Explanation
Dependent Variable	Y	Annual GDP of Shanghai	100 million yuan	Core indicator of economic growth
Independent Variable	X1	Total Population Size	10,000 people	Reflects the total population size of the city
Independent Variable	X2	Migrant Population Size	10,000 people	Reflects labor input and the city's attractiveness
Independent Variable	X3	Number of Students Enrolled in Regular Higher Education Institutions	10,000 people	Serves as a proxy variable for "talent quality" reflecting the capacity for high-end talent reserves

Between 2014 and 2023, Shanghai experienced a remarkable economic expansion. GDP increased from 2,356 billion yuan in 2014 to 4,721.9 billion yuan in 2023, effectively doubling over the decade and exhibiting a steady upward trajectory. This growth reflects the city's robust economic resilience and its successful transition toward a knowledge- and innovation-driven development model.

During the same period, the permanent resident population remained largely stable, fluctuating between 24.15 million and 24.87 million. Notably, the population experienced a slight decline between 2015 and 2019, followed by a modest rebound after 2020, ultimately stabilizing around 24.5 million. The migrant permanent population exhibited a

similar pattern, mirroring the overall resident population trends without demonstrating sustained growth. These patterns indicate that Shanghai's GDP growth has occurred largely independently of population expansion, signaling a diminishing marginal contribution of population quantity to economic performance.

In contrast, the number of higher education students in Shanghai displayed a consistently rising trend, increasing from 546,000 in 2014 to 723,000 in 2023, with an average annual growth rate of approximately 3%. This steady and persistent growth underscores the city's increasing human capital quality, highlighting the central role of educational attainment in sustaining economic momentum. Compared with population size and migrant inflows, higher education enrollment emerges as the most stable and consistent factor correlating with GDP growth, reflecting the emergence of a "talent dividend" as the primary driver of Shanghai's long-term economic development (see Table 2).

Overall, these trends suggest a structural transformation in Shanghai's growth model: while population quantity has plateaued, talent accumulation and educational advancement have become key determinants of sustained, high-quality economic growth. This shift underscores the importance of policies and strategies that prioritize human capital development, innovation capacity, and knowledge-intensive industries.

Table 2. Regression Analysis Results.

Independent Variable	Dependent Variable	Correlation Coefficient	Regression Equation
Permanent Population	GDP	0.69	$Y=16.2X_1-15420$
Migrant Population	GDP	0.72	$Y=21.8X_2-17850$
Higher Education Student Count	GDP	0.93	$Y=485.7X_3+12400$

The analysis clearly indicates that GDP exhibits the strongest correlation with the number of higher education students, underscoring that talent reserves, rather than population size, constitute the core driver of Shanghai's economic growth. Quantitatively, the results suggest that for every increase of 10,000 enrolled university students, GDP rises by an average of approximately 48.57 billion yuan. This contribution markedly exceeds that associated with total population growth, highlighting the superior impact of human capital quality over demographic quantity.

These findings illustrate a critical structural shift in Shanghai's development model: while traditional economic theory often emphasizes the role of population expansion in driving output, the city's experience demonstrates that talent accumulation and educational attainment now play a dominant role in sustaining high-quality growth. The emergence of a "talent dividend" reflects how a skilled and highly educated workforce enhances labor productivity, facilitates technological innovation, and promotes the development of high-value industries.

From a policy perspective, this evidence strongly supports strategies aimed at attracting, nurturing, and retaining highly educated and skilled individuals. Investments in higher education, professional training, and talent-friendly urban policies are likely to generate disproportionately large returns in terms of economic output. In essence, Shanghai's case provides a compelling example of how megacities can achieve sustained, innovation-driven growth even in the absence of population expansion, offering valuable lessons for other urban centers facing similar demographic stabilization challenges.

4. Other Key Influencing Factors

4.1. Industrial Structure Upgrading

The industrial structure is a critical determinant of GDP growth, shaping both productivity and the capacity for high-value-added activities. In Shanghai, the tertiary sector has consistently accounted for over 70% of GDP, reaching 74.2% in 2023 [11]. High-

value-added industries-including finance, information and communication services, scientific and technological services, and professional services-have experienced rapid expansion. The economic output per unit of labor in these sectors significantly surpasses that of traditional manufacturing and agriculture, reflecting enhanced efficiency and economic sophistication. The optimization and upgrading of the industrial structure have not only boosted overall economic performance but also created abundant opportunities for highly skilled professionals, reinforcing the emergence of a talent-driven growth model. By prioritizing knowledge-intensive and innovation-oriented sectors, Shanghai has successfully aligned industrial transformation with human capital accumulation, forming a mutually reinforcing cycle of economic and talent development.

4.2. R&D Investment and Innovation Capability

Innovation is the primary engine for improving total factor productivity and sustaining long-term economic growth. Shanghai's R&D expenditure as a percentage of GDP increased from 3.6% in 2014 to 4.2% in 2023, approaching levels typically observed in advanced economies [12]. In strategic sectors such as artificial intelligence, biomedicine, integrated circuits, and new energy technologies, Shanghai has achieved a series of internationally competitive breakthroughs. R&D investment serves as a direct catalyst for technological progress and industrial upgrading, translating the knowledge and skills of the workforce into tangible economic output. Importantly, these investments amplify the impact of human capital, enabling the talent quality dividend to materialize at scale: skilled professionals contribute disproportionately to innovation, productivity, and the creation of high-value industries, thereby reinforcing economic growth even in the absence of population expansion.

4.3. Policy and Institutional Environment

Policy guidance and institutional innovation exert a vital, albeit indirect, influence on economic performance by shaping the environment for talent aggregation, industrial transformation, and innovation. Shanghai has implemented a range of forward-looking reforms, including talent settlement policies, the establishment of free trade zones, and the Science and Technology Innovation Board, which collectively create a conducive institutional framework for economic and human capital development. These policies reduce barriers for highly skilled individuals, incentivize entrepreneurship and R&D activities, and foster the growth of innovation ecosystems. By aligning regulatory frameworks, fiscal incentives, and urban planning with human capital and innovation priorities, Shanghai has strengthened its competitive advantage, ensuring that talent, technology, and industrial upgrading synergistically drive sustainable economic growth.

Overall, the interplay of industrial upgrading, R&D investment, and supportive policies highlights a multi-dimensional growth model in which the "talent dividend" is amplified by innovation capacity and institutional facilitation. This integrated approach provides a blueprint for megacities seeking to achieve high-quality, knowledge-driven development despite demographic stabilization.

5. Discussion and Outlook

Shanghai's experience demonstrates that robust economic growth can be sustained even when population growth slows or becomes negative, highlighting a clear structural shift: the diminishing influence of the traditional "population quantity dividend" and the rising prominence of the "talent quality dividend" as the primary engine of urban economic development. This evolution underscores the critical importance of human capital accumulation, educational attainment, and innovation capability in driving long-term growth in megacities.

Nevertheless, Shanghai faces several emerging challenges. The city is experiencing population aging and declining birth rates, which may create pressures such as labor

shortages, rising dependency ratios, and increased demands on social security systems. Addressing these challenges will require multi-dimensional strategies:

Optimizing Population Structure: Targeted efforts are needed to mitigate the effects of aging, including attracting high-level domestic and international talent, improving education quality, and enhancing labor skill development to sustain productivity and innovation capacity.

Enhancing Urban Attractiveness: High-quality public services-covering housing, healthcare, education, cultural amenities, and transportation-are essential for retaining talent and mitigating urban living pressures. A livable and inclusive urban environment strengthens the city's appeal as a global talent hub.

Deepening Innovation-Driven Growth: Continuous expansion of R&D investment, promotion of industrial upgrading, and support for emerging technology sectors are critical to consolidate a growth model dominated by innovation dividends. Cultivating research ecosystems, startup incubators, and university-industry collaboration will amplify the impact of the talent dividend.

Regional Collaborative Development: Coordinated development within the Yangtze River Delta region can facilitate the rational flow of population, resources, and industries, enhancing overall economic efficiency, promoting specialization, and supporting sustainable metropolitan-scale growth.

In summary, Shanghai's trajectory illustrates that future urban competitiveness hinges less on population size and more on population quality, innovation capacity, and institutional environment.

6. Conclusion

This study confirms that, while GDP growth is positively correlated with population size, the marginal contribution of population quantity has substantially declined in megacities such as Shanghai. In contrast, the optimization of population structure, the accumulation of high-quality talent, increased R&D investment, and industrial upgrading have emerged as key determinants of economic growth. Mathematical modeling demonstrates that Shanghai's GDP growth is strongly correlated with the number of higher education students-far surpassing correlations with the total resident population-providing empirical evidence for the shift from a population quantity dividend to a talent quality dividend as the core growth driver.

This structural transformation mirrors the development patterns observed in advanced global cities and offers important insights for other major urban centers in China and beyond. Future urban competition will focus on "attracting and nurturing talent" rather than merely expanding population, emphasizing the qualitative aspects of human capital, innovation ecosystems, and institutional effectiveness. To achieve sustainable, high-quality growth, cities must invest persistently in education, skills development, technological innovation, and supportive policy frameworks, creating an environment where human capital can fully translate into economic productivity.

Ultimately, Shanghai's experience illustrates a new paradigm for urban growth: in an era of demographic stabilization, talent, innovation, and institutional capacity-not population size-determine long-term competitiveness and economic resilience.

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