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The Paradox of Education Spending and Economic Growth: Institutional Inputs and Urban Competitiveness

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Abstract

This study examines the paradoxical effects of institutional inputs and educational spending on urban competitiveness and economic growth within China, emphasizing the unforeseen negative impacts of such investments during periods of swift urban transformation. Employing a mixed-methods approach, including text frequency analysis and panel data regression performed using Stata 17.0, the research investigates the complex relationships among institutional inputs, education expenditure, technological adoption, and urban economic growth across Chinese provinces from 2011 to 2024. The findings reveal that, despite substantial increases in educational funding across various regions, productivity growth has lagged considerably. This paradox stems primarily from misalignment between market demands and the output of human capital, where extended schooling years have not translated into proportional economic gains. Regional analysis demonstrates significant variations in how education investments affect urban competitiveness, with eastern, central, and western regions exhibiting distinct patterns and challenges. This study underscores the necessity for context-sensitive policies that better align educational systems with regional labor market requirements while addressing the structural inefficiencies that currently limit the economic returns on educational investments.

Keywords: *Institutional Investment, Education Spending, Skill Mismatch, Productivity Growth, Urban Economy*

JEL Classification: H52, I25, J24

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1. INTRODUCTION

Urban economic growth in China is deeply influenced by institutional inputs, technological advancement, and policy interventions. In recent decades, the transition from an agrarian society to an industrialized urban economy has driven remarkable urban development in cities such as Beijing, Shanghai, Shenzhen, and Chengdu. This

transformation has been propelled by extensive government-led initiatives, including infrastructure investment, economic reforms, and support for industrial clusters. However, paradoxes have emerged, particularly in relation to skill mismatches due to increased educational spending, labor market inefficiencies, and unintended stagnation in productivity. These paradoxes challenge the conventional view that institutional investments and human capital development inevitably lead to economic growth. This study explores these contradictions, offering a nuanced perspective on urban development dynamics in emerging economies like China (Banerjee et al., 2024; Chen et al., 2024).

Wu et al. (2024) demonstrate that eco-industrial parks in China have significantly contributed to urban economic growth, resulting in a 7.61% increase in pilot cities by promoting sustainable industrial practices and mitigating the resource curse in certain regions. Man et al. (2023) examine how the global value chain enhances cross-border urban networks through R&D, production, and sales investments by manufacturing firms in Western China, highlighting the role of multi-centric urban networks in regional growth. Brill (2022) discusses the influence of urban governance structures on private sector risk management, emphasizing how investors and developers navigate urban projects based on regulatory conditions and risk distribution.

This study is driven by a growing recognition that traditional urban development models may not fully capture the complexities of emerging economies. China's rapid urban transformation provides fertile ground for examining how institutional and human capital investments interact in complex and often contradictory ways. The central paradox lies in the relationship between education spending and productivity. While increased investment in education is generally seen as a driver of economic growth, the resulting skill mismatch and overqualification in some regions have led to inefficiencies. These challenges are particularly evident in cities like Beijing and Chengdu, where a significant number of university graduates are underemployed, unable to secure positions that match their qualifications. By focusing on these unintended outcomes, this study provides insights into mitigating such paradoxes through context-sensitive policy interventions (Chikhi et al., 2024; Liu et al., 2024; Schmick, 2024; Zhu et al., 2024).

García et al. (2024) examine the European Union's Integrated Sustainable Urban Development Model, revealing that urban strategies supported by E.U. funds and decentralized tools are more integrated than those relying on a single fund or single-target strategies. Zhao et al. (2024a) show that urban-rural integration, alongside technological and transportation advancements, has significantly boosted regional economic growth across China, especially in areas with high ecological quality. Zhao et al. (2024b) present evidence that China's smart city initiatives significantly enhance global value chain upgrading, primarily through informatization, innovation, and industrial restructuring, with more pronounced effects in cities possessing robust human capital and fiscal resources.

The primary goal of this study is to analyze the unintended, paradoxical impacts of institutional inputs and human capital investments on urban competitiveness and economic growth. Specifically, it investigates why seemingly beneficial actions, such as increased education spending and institutional support, sometimes lead to unexpected negative outcomes. For example, data from Shanghai suggests that, despite significant educational investment, productivity growth has stagnated, implying a misalignment between educational outputs and market demands. This study seeks to uncover the underlying mechanisms contributing to these outcomes, thereby providing a more comprehensive evaluation of urban policy efficacy. Ultimately, the study supports adaptive policymaking that fosters sustainable economic growth while minimizing social inequalities and economic inefficiencies (Anthony, 2023; Keidar & Silver, 2023).

Chodkowska-Miszczuk and Lewandowska (2024) explore how Poland's largest cities align with the European Union's green deal and the smart city initiative, emphasizing socio-spatial disparities within urban policies, particularly in contrasting "smart hot spots" in city centers and "smart cold spots" in less developed areas. Hasegawa (2024) discusses how conflicting priorities and the lack of a cohesive national policy in Japan enabled ambitious projects like the trans-Tokyo Bay highway, reflecting ongoing urban development challenges. Xu and Wang (2023) examine the effects of innovative city policies in China, finding that such policies primarily promote technological entrepreneurship by expanding tech incubators and facilitating human capital mobility, with significant effects emerging after the third year of implementation.

This study adopts a mixed-methods approach to assess the complex impacts of institutional interventions and human capital investments. Term frequency analysis is employed to evaluate government documents, capturing the institutional narrative and economic sentiment, serving as an innovative proxy for understanding the qualitative emphasis of policies. Quantitative methods, including panel data regression, are used to examine the relationships among drivers of urban competitiveness, such as education, technological adoption, and institutional inputs (Prasuna et al., 2024; Royuela & Belloni, 2024). The differenced generalized method of moments (DIFF-GMM) technique addresses potential endogeneity issues, ensuring robust capture of dynamic relationships within panel data (Yang & Qi, 2024; Munzhelele & Obadire, 2023). Case studies of Beijing, Chengdu, and Guangzhou further illustrate regional disparities, highlighting the diverse impacts of similar policy measures across different socio-economic contexts. For example, Beijing's innovation-oriented growth diverges markedly from Guangzhou's manufacturing-led expansion, offering insights into how institutional frameworks and policies shape urban competitiveness and economic growth.

Paleologo et al. (2024) conducted term frequency analysis, correspondence analysis, and sentiment analysis on 19,906 Italian social media posts discussing "milk quality," revealing public perception gaps. Shao et al. (2024) applied sys-GMM and diff-GMM to analyze regional disparities in China's new quality productivity, finding

a positive effect of environmental regulations on industrial upgrading but a negative impact on structural rationalization. Zhang et al. (2024) used panel data regression to examine government support for rural development in Hubei.

The literature review positions this study within established theoretical paradigms, including endogenous growth theory, Schumpeterian innovation, and urban economic resilience frameworks (Li & Diao, 2024). Endogenous growth theory emphasizes the role of internal factors, such as human capital and innovation, in driving economic growth; however, this study reveals that these factors may yield contrasting outcomes across different contexts (Wu et al., 2008). Schumpeterian innovation, particularly its focus on creative destruction, informs the analysis, examining how technological advances simultaneously drive growth and disrupt urban labor markets. Comparative studies in other emerging economies demonstrate that similar policies can lead to varied outcomes depending on regional and socio-political influences, underscoring the importance of context. Ma et al. (2024) find that smart city development fosters economic growth in Chinese cities by promoting urban innovation and entrepreneurship, particularly in regions with higher marketization. Yu et al. (2024) highlight how new-type urbanization policies in China enhance urban economic resilience through innovation, economic agglomeration, new industries, and digital finance, with positive spillover effects within a 250 km radius of target cities.

Empirical analysis provides a granular examination of key variables, focusing on unexpected trends and regional disparities. Descriptive statistics reveal that increased education spending sometimes correlates inversely with productivity growth in certain regions, indicating significant skill mismatches (Greenspon & Raimi, 2024; Nunez & Prieto, 2024). For example, data from Chengdu shows that although tertiary education enrollment has surged, many graduates face underemployment due to a lack of roles commensurate with their skills, resulting in labor inefficiencies. Benchmark regression analyses juxtapose traditional growth metrics, such as GDP and employment rates, with unconventional proxies like term frequency-derived economic productivity indicators, unveiling counterintuitive trends. The findings emphasize that increased education funding without corresponding labor market alignment may lead to an oversupply of highly educated workers with skills misaligned with market demands (Anyigba et al., 2024; Tani, 2023). Boeren (2024) examines post-COVID E.U. recommendations on adult education, noting an evolving focus on digital and green skills, aligned with E.U. economic agendas and social goals of integrating vulnerable groups into the labor market. Peng and Xu (2024) analyze how universities stimulate urban innovation and economic growth, finding that high-quality institutions significantly enhance city-level entrepreneurship and economic vitality.

This study delves into the mechanisms underlying these paradoxes, particularly the moderating role of institutions on urban competitiveness. While institutions provide stability, they can also impose rigidities that inhibit innovation and entrepreneurial growth. The analysis uses interaction terms between innovation factors (e.g., technological adoption) and institutional variables (e.g., wage structures, sectoral

employment) to assess their impact on growth outcomes. Extending schooling years, rather than uniformly promoting productivity, may actually hinder economic efficiency in regions with prevalent overqualification or skill mismatches. This is particularly evident in Beijing, where high levels of educational attainment have not translated into productivity gains due to an oversupply of highly educated individuals in roles that do not fully utilize their skills (Bolang et al., 2024; Nurkaidah et al., 2024; Li et al., 2024).

Urban competitiveness represents a multidimensional, complex concept that extends far beyond traditional economic indicators. While economic performance (such as productivity and industrial upgrading) constitutes the core elements of competitiveness, modern urban competitiveness theory has evolved into a more comprehensive framework encompassing the interplay of social, cultural, environmental, and institutional dimensions. As emphasized by Audretsch and Belitski (2021), holistic urban competitiveness manifests not only in economic output and employment growth but also in social inclusivity, cultural vitality, environmental sustainability, and governance efficiency. Sánchez-Moral et al. (2018) further argue that these dimensions are interdependent, with cultural and social capital significantly impacting a city's innovative capacity and economic resilience, particularly in knowledge-intensive sectors. While this study acknowledges the multidimensionality of urban competitiveness, our analysis primarily focuses on economic and institutional dimensions due to data and methodological constraints. Nevertheless, we attempt to connect our findings to broader competitiveness concepts in our discussion, exploring potential pathways through which institutional inputs and educational spending influence various dimensions of urban competitiveness. This approach enables us to propose more comprehensive policy recommendations based on our empirical analysis, aimed at promoting balanced urban development across economic, social, cultural, and environmental dimensions, thereby enhancing overall competitiveness.

An innovative aspect of this study is its challenge to conventional views on the benefits of institutional and educational investments. By integrating qualitative and quantitative methods, especially the combination of term frequency analysis with panel data regression, the study links policy focuses with economic outcomes in a comprehensive manner. The concept of "urban economic resilience labs" is proposed as an adaptive mechanism for real-time policy adjustment, designed to continuously monitor intervention impacts and respond to shifting urban economic conditions. These labs could serve as dynamic entities, allowing policymakers to adapt strategies based on real-time data, thereby enhancing urban ecosystems' resilience and adaptability. The study also advocates for a shift towards vocational and market-aligned training programs that better align educational outputs with labor market demands, reducing inefficiencies associated with skill mismatches (Cheng et al., 2024; Yu et al., 2024; Mate et al., 2022).

Xia et al. (2025) reveal that economic restructuring improves land-use resilience in terms of carbon metabolism in Beijing, Shanghai, and Shenzhen, where each city requires tailored strategies to balance network efficiency and redundancy for

sustainable development. Li and Diao (2024) demonstrate that new urbanization policies significantly bolster economic resilience in China, especially in the eastern region, smaller cities, and areas with lower economic development, primarily through technological innovation and industrial restructuring. Wen et al. (2024) find that new infrastructure significantly enhances urban economic resilience in China, especially in central regions and larger cities, by fostering digital and green innovation, optimizing industrial structures, and promoting collaborative agglomeration.

This paper proceeds systematically, beginning with an introduction to theoretical frameworks, followed by empirical analysis and a discussion of mechanisms. It underscores the need for adaptive, context-specific policies capable of navigating the paradoxes inherent in urban development. The conclusion advocates for a multi-layered approach to policymaking that incorporates regional specificity, adaptive learning, and resilience-building. By challenging traditional economic assumptions and providing evidence of the unintended consequences of well-intentioned policies, this study contributes to a deeper understanding of urban development dynamics and underscores the need for agile, responsive governance structures.

2. LITERATURE REVIEW

2.1 Evolution of Urban Competitiveness Theories

The exploration of paradoxes within education spending and institutional inputs has become crucial due to the increasing complexity of urban competitiveness and economic growth, especially in emerging economies like China (see Table 1). As urban areas grow and economies develop, institutional frameworks, technological progress, and policy interventions are often identified as key drivers of success. However, persistent paradoxes—such as misalignments between educational investment and labor market needs, inefficiencies in institutional inputs, and unanticipated economic stagnation—challenge the assumption that these interventions invariably lead to positive outcomes. These contradictions emphasize the need to reassess urban policy frameworks to prevent socio-economic disruptions and foster sustainable urban economic growth (Huang et al., 2024; Yu et al., 2024; Yushanjiang et al., 2024).

Table 1. Overview of Key Themes in Urban development and Institutional Investments

Section	Key Concepts	Summary
Evolution of Growth Theories	Endogenous Growth Theory Schumpeterian Innovation Urban Economic Resilience Framework	Focuses on how internal factors, such as human capital and technology, drive economic growth. Discusses creative destruction's role in growth and displacement, and urban resilience's role.

Institutional and Human Capital Dynamics	Special Economic Zones (SEZs) Human Capital Investments Comparative Analysis Across Emerging Economies	Evaluates how government policies like SEZs lead to diverse outcomes—success in China, contrasted with challenges in India. Emphasizes skill mismatches from education investment.
Highlighting Gaps and the Call for Analysis	Unintended Consequences Rigid Institutional Structures Gaps in Traditional Growth Models	Identifies gaps in addressing negative externalities from economic interventions, such as education misalignment leading to stagnation. Calls for nuanced urban policies to handle growth.

Banerjee et al. (2024) found that foreign institutional investor (FII) holdings exhibit an inverse relationship with corporate risk-taking behavior, suggesting that higher FII presence reduces firm risk-taking by enhancing risk-return profiles. Dhingra and Yadav (2024) conducted a bibliometric analysis tracing the evolution of research on institutional investor behavior, identifying critical themes and future research directions related to corporate behavior, trading patterns, and governance impacts. Liu et al. (2024) examined how ecosystem service multifunctionality impacts human well-being, finding that peri-urban areas offer a balanced array of benefits compared to purely agricultural or forest landscapes, thus advocating for land-sharing models in urban development. Tang et al. (2024) demonstrated that innovation capabilities in Chinese urban agglomerations significantly enhance green development through talent agglomeration and industrial upgrading, with varied outcomes based on regional and policy differences. Zeng et al. (2024) proposed an urban growth model using cellular automata to simulate growth scenarios influenced by land-use policies and economic zones, offering predictions for urban patterns and aiding sustainable urban planning.

Analyzing these paradoxes serves several critical functions. First, it exposes the limitations of traditional urban development theories, such as endogenous growth theory and Schumpeterian innovation, which argue that investments in human capital and technological progress necessarily lead to economic growth. Emerging paradoxes suggest that context-specific factors play a key role in determining the effectiveness of such investments, indicating that a one-size-fits-all approach to urban policy is inadequate. Second, the study underscores the need for adaptive and context-sensitive policymaking that can address the unintended consequences of institutional inputs and educational spending. Insights from these paradoxes can guide the design of flexible policy frameworks responsive to rapidly evolving urban contexts, especially in economies undergoing swift transformation. Third, the analysis highlights the tension between institutional stability and innovation. While institutions provide necessary stability, they can also become rigid, stifling entrepreneurial activity and innovation.

Balancing these forces is crucial for creating an environment conducive to sustainable urban competitiveness (de Souza et al., 2024; Doan, 2024; Marshall et al., 2024).

Afonso et al. (2024) evaluated the impact of the 2001 city master plan in Montes Claros, Brazil, finding that the plan effectively reduced the spatial concentration of economic activities and promoted moderate urban decentralization across planning regions. Alp (2024) explored the Cittaslow movement in Abbiategrasso, Italy, and Seferihisar, Turkey, showing that while Cittaslow policies promote sustainable urban development, implementation challenges could threaten the distinctive local identities of these cities. Mens et al. (2023) assessed the social, environmental, and economic contributions of bottom-up urban development in the Netherlands, revealing that such approaches accelerate placemaking, spatial growth, and innovation while influencing local policies. Baudino (2021) developed a dynamic model linking rural-to-urban migration and urban development, demonstrating that rural land rents significantly impact urban agglomeration levels and steady-state urban growth, providing valuable insights for urban planning.

The evolution of this topic is marked by key theoretical and policy milestones (see Figure 1). In the 1980s and 1990s, endogenous growth theory, developed by Paul Romer and Robert Lucas, introduced the idea that internal factors—such as knowledge spillovers, human capital, and technological advancement—are essential for long-term economic growth. This theory offered a framework for understanding how urbanization and institutional investments could drive sustained economic expansion. However, the emergence of paradoxical outcomes in recent years has challenged the universality of these principles, underscoring the need for a more nuanced approach to policy formulation.

Schumpeterian innovation, with its focus on creative destruction, introduced by Joseph Schumpeter in the early 20th century and revitalized in the 1990s, provides crucial insights into urban economic dynamics. Schumpeter's theory highlights how innovation disrupts established industries, driving growth while causing labor market upheavals. Cities like Shenzhen exemplify this process, where technological advancements and the rise of innovative sectors have reshaped traditional economic models, leading to unintended disruptions, such as workforce displacement.

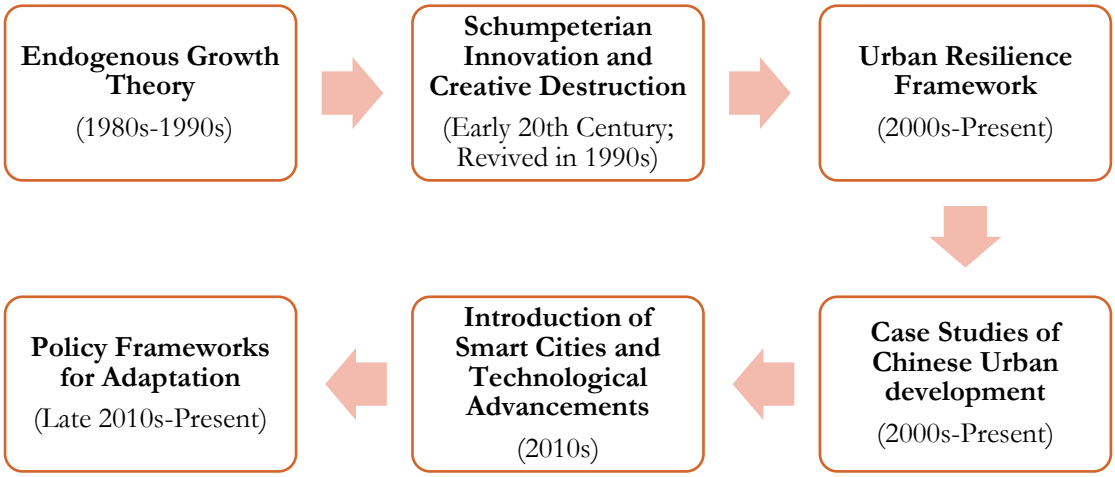

Figure 1. Major Milestones in the Evolution of Urban Development and Its Paradoxes

The urban resilience framework gained prominence in the 2000s as cities faced sustainability and social inclusiveness challenges. This framework emphasizes the capacity of urban systems to adapt to external shocks, including economic disruptions caused by paradoxical policy outcomes. The resilience perspective has helped understand how cities like Beijing and Guangzhou adjust to rapid growth and its unintended effects, such as over-education and labor displacement, necessitating a reevaluation of policy interventions to balance growth with social equity.

Empirical studies of urban competitiveness in Chinese cities, particularly Beijing, Shanghai, and Chengdu, illustrate the unforeseen consequences of rapid institutional investments. The establishment of special economic zones (SEZs) in the 1980s and 1990s marked a significant milestone in urban development, yet these zones also heightened regional inequalities and triggered socio-economic issues that were initially overlooked. Similarly, the educational expansion of the 2000s, aimed at enhancing productivity, paradoxically led to considerable skill mismatches and underemployment, especially in sectors unable to absorb the influx of highly educated individuals. These outcomes reflect the complexity of aligning human capital investments with labor market requirements.

Smart city initiatives and technological advancements in the 2010s aimed to optimize urban management through innovations like big data analytics and the Internet of things (IoT). Despite their potential, these technologies have also produced unintended effects, including heightened unemployment among low-skilled workers due to automation, as observed in Shenzhen. This development highlights the challenge of ensuring that technological progress promotes inclusivity rather than deepening socio-economic disparities.

In the late 2010s, there was a shift toward developing adaptive policy frameworks to address the evolving urban landscape. Concepts such as urban economic resilience labs were proposed as innovative mechanisms for real-time data monitoring and

adaptive policymaking. These labs aim to facilitate continuous strategy adjustments in response to changing conditions, reflecting the recognition of a need for governance models that can address the paradoxical dynamics of urban development. Fang and Alrefaei (2024) reveal that institutional investors and political incentives are critical drivers of corporate social responsibility and environmental practices in China, enhancing firms' investment appeal and promoting sustainable development. Hanni and Rao (2024) examine residential location choices in Pune's Integrated Township, noting that factors such as mixed land use, rental value, and car ownership significantly influence decisions, suggesting that promoting mixed land use and regulating rental prices could reduce work-related travel.

2.2 Social, Cultural, and Environmental Dimensions of Urban Competitiveness

From Table 2, urban competitiveness is increasingly recognized as a multidimensional construct that extends beyond traditional economic indicators (Atta et al., 2024; Hou et al., 2024; Carvache-Franco et al., 2023; Wu et al., 2023; Miron et al., 2022; Rajnoha & Lesnikova, 2022). Huang et al. (2024) highlight the growing role of culture in urban competitiveness, emphasizing how historic cities preserve and protect spatial structures, which serve as carriers of urban culture. Such cultural spaces not only enhance city branding but also attract creative talent, indirectly fostering economic growth. Tan et al. (2023) propose the cultivation of urban cultural brands to stimulate innovation, combining cultural memory with urban cultural identity, thus advancing urban development.

Table 2. The Urban Competitiveness Factors

Dimension	Key Points	Researchers
Cultural	• Historic urban spaces • Cultural spaces as carriers of urban spirit • Cultural brand building	• Huang et al. (2024) • Tan et al. (2023)
Environmental	• Integration of folk culture with technology • Sustainable urban construction • Environmental sustainability	• Wu et al. (2024)
Social	• Citizen participation in governance • Social capital accumulation	• De Filippi & Coscia (2024)
Major Events	• Multiple impacts on urban competitiveness • Tourism resources and transport • Cultural image enhancement	• Tai et al. (2023)
Creative Economy	• Cultural assets as foundation • Development plans, creative spaces • Sustainable development	• Punpeng (2024)
Digital Transformation	• New opportunities for development • Mobility, energy, IT, environment • Culture and circular economy	• Khendriche & Cechák (2023)
Local Identity	• Increased appreciation in globalization • Distinctive elements in tourism • Urban-rural system competitiveness	• Battino et al. (2024)

Environmental factors also significantly shape urban competitiveness. Wu et al. (2024) demonstrate that integrating local folk culture with modern information technology in smart city community development can significantly boost regional competitiveness, with an annual growth rate of up to 17.11%. This underlines the strong link between environmental sustainability and long-term economic competitiveness. De Filippi and Coscia (2024) emphasize the role of citizen participation in public space governance, noting that this enhances social cohesion and innovation through the accumulation of social capital.

The impact of major events on urban competitiveness has been examined as well. Tai et al. (2023), studying the 2016 G20 Hangzhou Summit, find that such events elevate not only the city's tourism image but also its cultural and social identity, thereby enhancing urban competitiveness in various dimensions. Punpeng (2024) suggests that cultural assets form the foundation of the creative economy, advocating for the integration of creative industries into development plans to foster urban development, city competitiveness, and social inclusion.

Khendriche Trhlínová and Cechák (2023) show that digital transformation creates new opportunities for addressing urban and rural development challenges, such as environmental issues and mobility. Their analysis of Czech regions reveals that mobility, energy, and IT projects are the most supported domains, while culture and the circular economy receive less attention, indicating the growing importance of social and environmental factors in competitiveness. Battino et al. (2024) explore how Italian street food, as a cultural asset, strengthens local identity and enriches tourism offerings, helping to reinforce urban-rural competitiveness and create sustainable tourism paths.

2.3 Institutional and Human Capital Dynamics in Urban Growth

Government policies and institutional investments significantly influence urban competitiveness, with initiatives such as special economic zones (SEZs) playing a pivotal role in attracting foreign investment and fostering industrial growth. In China, SEZs in Shenzhen and Shanghai have been instrumental in driving rapid urbanization and economic expansion. However, comparative studies show that similar policies yield varied results in different contexts. For example, SEZs in India have not consistently delivered the expected growth, highlighting the importance of local governance, regulatory environments, and socio-political factors (Kongrode et al., 2023; Kristof & Virag, 2022; Parmar et al., 2022).

Human capital investments, particularly in education, are often seen as key drivers of urban competitiveness by enhancing the productivity of the workforce. However, in cities like Chengdu and Chongqing, such investments have led to unintended consequences such as over-education and skill mismatches. These cities saw a surplus of university graduates without a corresponding increase in appropriate job opportunities, leading to underemployment and, paradoxically, a decrease in overall productivity. This emphasizes the importance of aligning educational investments with local economic needs.

Across emerging economies, government policies aimed at fostering industrial clusters or innovation have led to divergent outcomes. In Latin American countries such as Brazil and Mexico, institutional support has resulted in different growth trajectories compared to Asian nations, underscoring the challenges of applying uniform growth models across diverse socio-economic landscapes. The role of context-sensitive institutional mechanisms is crucial, as similar policies can yield both successes and setbacks depending on local conditions.

Skills mismatches represent a significant structural issue in labor markets, caused by the misalignment between educational systems and market demands. Many academic programs, particularly in universities and vocational schools, fail to adapt to shifting industrial structures driven by technological advancements. This results in a surplus of graduates in declining fields and a shortage of professionals in emerging sectors. Additionally, educational institutions often emphasize theoretical knowledge over practical, job-ready skills, further exacerbating the skills gap.

The slow pace of curricular updates, relative to technological advancements, worsens this mismatch. As industries evolve, the knowledge imparted by traditional educational models quickly becomes outdated. Many academic programs fail to integrate cutting-edge technological developments, leaving graduates unprepared for modern workplace challenges. This not only affects employability but also limits a city's capacity for innovation, which is dependent on a skilled workforce to drive technological advancement. The static nature of traditional education models is inadequate for preparing a workforce capable of addressing the dynamic demands of today's economy.

Beyond the supply-demand misalignment in education, another critical issue is the imbalance between specialized knowledge and interdisciplinary skills. While specialized expertise is essential, modern economies increasingly require workers with cross-disciplinary competencies, problem-solving abilities, and innovative thinking. Educational systems that fail to foster these broader skills produce graduates who struggle to adapt to the rapidly changing demands of the labor market. This mismatch not only reduces labor market efficiency but also hampers a city's ability to sustain its competitive edge and foster innovation, ultimately limiting long-term economic success.

Institutional flexibility is crucial for developing innovation ecosystems. However, institutional rigidity often hampers the flow of resources essential for innovation, such as capital, talent, and technology. Rigid organizational structures, bureaucratic barriers, and misaligned incentive mechanisms reduce innovation efficiency and motivation. This paper explores the ways in which institutional rigidity suppresses innovation through administrative hurdles, inefficient resource allocation, and counterproductive incentives. These rigid structures prevent organizations from adapting to market changes and hinder the innovative capacity of micro-level entities like startups and researchers.

The suppressive effects of institutional rigidity are manifested in several ways: (1) multi-dimensional suppressive mechanisms, where administrative barriers hinder the

allocation of innovation resources, rigid structures impede responsiveness to market changes, and misaligned incentives stifle creativity; (2) specific paths of innovation suppression, including bureaucratic resource allocation, negative academic incentives, and restrictive market entry barriers, which limit the competitiveness of emerging firms; and (3) deep-rooted impacts, such as path dependence and innovation inertia, where outdated technologies and practices become entrenched, slowing technological development and industrial transformation.

2.4 Regional Results and International Comparison

The relationship between educational expenditure and economic growth in Chinese cities is complex and requires an international comparative perspective. Analysis of experiences from different economies offers valuable insights into the effects of educational investment on urban competitiveness and economic development.

In East Asia, the link between educational investment and economic growth shows both commonalities and differences. A study by Ngoc et al. (2024) on Vietnam found that public education expenditure positively impacts economic growth, promoting growth with a probability of 53.19%. However, similar to China, the effectiveness of education spending is moderated by human capital levels, particularly literacy rates and labor force growth, which influence the impact of education spending on growth.

In contrast, Japan and South Korea demonstrate that the impact of educational investment is closely tied to institutional quality. Cooray and Nam (2025) found that government effectiveness mediates the relationship between social spending, including education, and economic growth. In high-income countries like Japan and South Korea, higher government effectiveness enhances the positive impact of educational investment, whereas in China's eastern regions, education spending has a lower-than-expected effect, indicating the importance of institutional effectiveness in translating educational investments into growth.

In rapidly urbanizing emerging economies, such as Kenya, education spending has a negative short-term impact but a positive long-term effect on economic development, consistent with findings in China's central and western regions. This suggests that educational investments in emerging economies often require time to yield tangible benefits. India's experience highlights the synergistic role of health and education in economic growth. Srivastava et al. (2024) found that secondary enrollment positively influences growth, but life expectancy (as a proxy for human capital) has the greatest impact on GDP growth, underscoring the importance of a broader view of human capital.

Brazil's experience illustrates the challenges of fiscal sustainability in education spending. De Medeiros et al. (2024) noted that Brazil's national education plan failed to meet its targets under fiscal austerity, and education spending in 2024 was far below expectations. This mirrors the inefficient education spending observed in some regions of China, emphasizing the importance of both the quantity and quality of educational investments.

The experiences of developed countries also offer valuable insights. Ponzetto and Troiano (2025) found that the level of social capital influences public education spending, with regions possessing higher social capital investing more effectively in education. This suggests that institutional quality and social capital are critical for ensuring the effectiveness of educational investment. Furthermore, a study on the European Union by Stamegna et al. (2024) indicates that public investments in education, health, and the environment have a more significant stimulative effect on the economy than military spending, supporting the argument for prioritizing educational investment.

Clements et al. (2025) studied developing Asian countries and found that targeted health and education spending significantly enhances the chances of achieving inclusive growth, which resonates with our findings in China. The study suggests that redistributive spending helps reduce income inequality, emphasizing the importance of differentiated educational investment strategies for regions at different stages of development.

Key insights from this comparative analysis include the following. (1) The critical role of institutional effectiveness: in high-income countries, the success of education spending is closely tied to effective governance, a factor that may explain the lower-than-expected performance of education investment in some Chinese regions. (2) Time lag effects: education spending generally requires a long-term horizon to yield significant economic returns, consistent with findings in both China and other emerging economies. (3) Regional differences in educational effectiveness: regional disparities in educational outcomes are common internationally, supporting the need for region-specific strategies in China. (4) Synergistic investment: coordinating educational investment with other sectors, such as health and the environment, maximizes its impact on economic and social development. (5) Social capital and education: social capital can facilitate effective educational investments by mitigating short-term political incentives, forming a virtuous cycle of development.

2.5 Research Gaps and the Need for Nuanced Analysis

Despite extensive research on urban competitiveness, significant gaps persist in understanding the unintended consequences of institutional and educational investments. Traditional growth models assume linear positive relationships between investments in human capital and economic outcomes, yet paradoxes observed in Beijing, Shanghai, and Guangzhou—where increased educational spending has not translated into proportional productivity gains—challenge these assumptions. Hao and Li (2024) demonstrate how economic policy uncertainty reduces institutional investments across markets, particularly where information asymmetries exist.

Key research gaps include the following: (1) insufficient attention to the unintended socioeconomic impacts of educational investments, which have paradoxically resulted in skill mismatches and productivity stagnation in various urban

centers; and (2) inadequate analysis of how rigid institutional structures inhibit cities' adaptive potential despite rapid socioeconomic transformation in emerging economies.

This study addresses these gaps by analyzing the paradoxes emerging from institutional inputs and human capital investments in urban competitiveness. By challenging linear growth assumptions, the research deepens understanding of the conditions under which policies succeed or fail, contributing to the development of adaptive, context-sensitive frameworks better suited to navigating the complex dynamics of urban economic development.

3. METHODOLOGY

3.1 The Variables and Data Sources

Urban competitiveness emerges from the synergistic integration of technological innovation, education, and economic restructuring. Technological innovation functions as the primary driver, with advanced technologies (AI, digital systems, big data) enhancing productivity and catalyzing new sectors. Education builds the essential human capital foundation, while economic restructuring optimizes resource allocation across productivity sectors.

This study employs an innovative methodological approach using "subsequent-year term frequency of urban development" as a quantitative proxy for growth sentiment and policy focus. The dataset is comprised of government work reports from provincial authorities between 2011 and 2024, processed through term frequency analysis using Stata 17.0. This technique evaluates keyword prevalence (e.g., "technological innovation," "artificial intelligence") to reveal policy priorities and developmental focus shifts.

The comprehensive data collection spans 2011-2024, encompassing China's significant economic transformation period across all provinces. The subsequent-year frequency measure provides more accurate evaluation of achievements while mitigating collection lag biases compared to same-year or prior-year metrics.

Urban competitiveness is assessed through multiple data sources: (1) economic indicators (GDP, employee wages) from the National Bureau of Statistics, China Statistical Yearbook, and provincial yearbooks; (2) employment metrics focused on tertiary sector engagement from provincial and national reports; and (3) educational metrics (average schooling years, educational expenditures, student structure data) from statistical bureaus, educational yearbooks, and fiscal reports.

The dataset covers all provincial regions (2010-2023), with regional heterogeneity addressed through stratification into eastern, central, western, and northeastern regions. Temporal effects are controlled using year-specific variables to capture dynamic changes accurately. Panel data regression techniques implemented in Stata 17.0 enable robust analysis of relationships between variables while controlling for endogeneity.

3.2 Empirical Research Process and Hypothesis Testing

The empirical analysis follows a systematic process (Figure 2), beginning with data standardization using Z-score transformation to enhance regression analysis comparability. Moderator variables were centered to minimize multicollinearity. Missing data was addressed through linear interpolation, maintaining dataset continuity.

The study employs a multiple regression model specified as:

$$UD_{i,t+1} = \beta_0 + \beta_1 GDP_{i,t} + \beta_2 Wa_{i,t} + \beta_3 Te_{i,t} + \beta_4 Ed_{i,t} + \beta_5 EF_{i,t} + \beta_6 SS_{i,t} + \gamma_i R_i + \delta_t Y_t + \epsilon_{i,t} \quad (1)$$

Where $UD_{i,t+1}$: urban development (dependent variable). $GDP_{i,t}$: gross domestic product. $Wa_{i,t}$: wages of on-post employees. $Te_{i,t}$: tertiary sector employment ratio. $Ed_{i,t}$: average years of education. $EF_{i,t}$: educational funding intensity. $SS_{i,t}$: student enrollment structure. R_i, Y_t: regional and year fixed effects. $\epsilon_{i,t}$: error term.

The research examines variable significance through hypothesis testing:

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$, $\gamma_i = 0$, $\delta_t = 0$.

H_1:At least one $\beta_i \neq 0$ or $\gamma_i \neq 0$, $\delta_t \neq 0$.

(1) GDP impact, $H_{0,GDP}$: $\beta_1 = 0$; $H_{1,GDP}$: $\beta_1 \neq 0$. Endogenous growth theory suggests a direct connection between economic growth and productivity enhancement, emphasizing the role of technological advancement and knowledge accumulation as drivers of growth. GDP growth improves resource efficiency, labor productivity, and innovation activities, contributing positively to urban competitiveness.

(2) Wages of on-post employees, $H_{0,Wa}$: $\beta_2 = 0$; $H_{1,Wa}$: $\beta_2 \neq 0$. According to human capital theory, higher wages attract skilled labor and encourage existing workers to upgrade their skills, thereby boosting enterprise productivity and fostering urban competitiveness. A high-wage environment promotes knowledge sharing and technological progress, leading to significant positive impacts on urban development. (Okuneviciute Neverauskiene et al., 2024)

(3) Tertiary sector employment ratio, $H_{0,Te}$: $\beta_3 = 0$; $H_{1,Te}$: $\beta_3 \neq 0$. Industrial upgrading theory argues that a higher proportion of tertiary employment, particularly in service and high-tech sectors, enhances productivity. These sectors, heavily reliant on knowledge and innovation, support efficient production methods and contribute to human capital development, thus driving urban economic growth.

(4) Average years of education, $H_{0,Ed}$: $\beta_4 = 0$; $H_{1,Ed}$: $\beta_4 \neq 0$. Education enhances labor quality, innovation capacity, and overall productivity. Longer average years of schooling are expected to improve adaptability, creativity, and problem-solving skills, thus promoting urban competitiveness through a well-prepared workforce.

(5) Educational funding intensity: $H_{0,EF}$: $\beta_5 = 0$; $H_{1,EF}$: $\beta_5 \neq 0$. Investment in education directly affects the quality of human capital formation. Increased funding improves educational infrastructure, teaching quality, and accessibility, creating a skilled and innovative workforce capable of driving technological advancements and productivity gains.

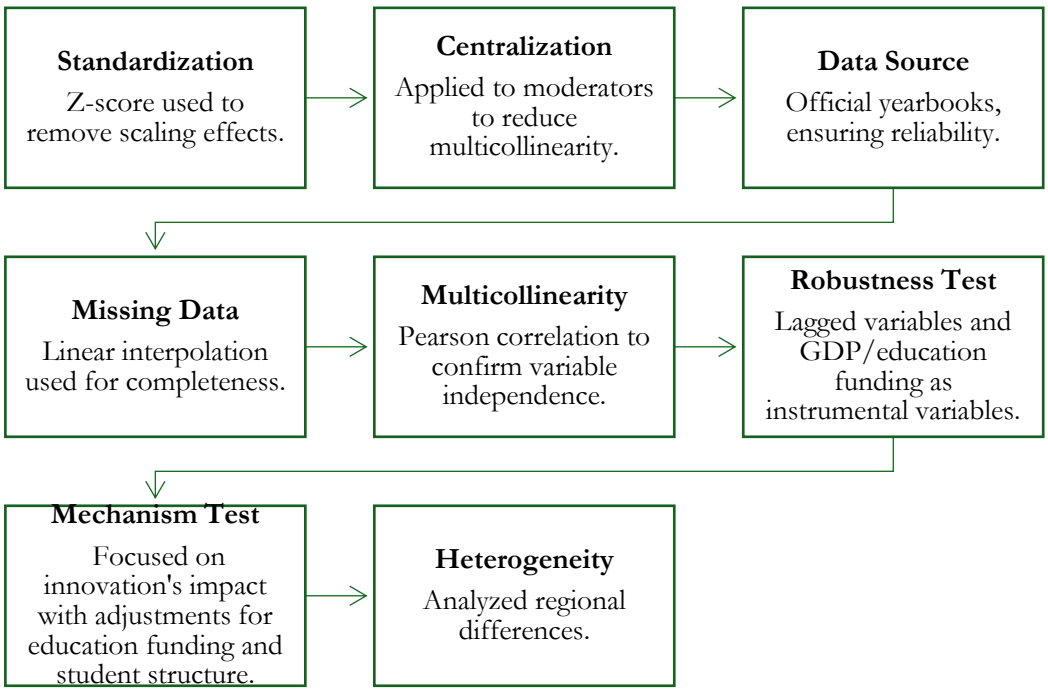

Figure 2. Empirical Research Flowchart

(6) Student enrollment structure: $H_{0,SS}$: $\beta_6 = 0$; $H_{1,SS}$: $\beta_6 \neq 0$. Educational structure theory posits that a balanced student enrollment across disciplines ensures a talent pool suited to various industries, enhancing innovation and economic diversification. A well-distributed educational structure contributes to effective resource allocation and strengthens societal innovation capacity.

(7) Regional fixed effects: $H_{0,R}$: $\gamma_i = 0$; $H_{1,R}$: $\gamma_i \neq 0$. Regional economics theory suggests that development levels, infrastructure, and policy environments differ across regions, impacting productivity and urban competitiveness. Regional fixed effects account for these variations, allowing the model to capture the unique contributions of localized factors to urban economic outcomes.

(8) Year fixed effects: $H_{0,Y}$: $\delta_t = 0$; $H_{1,Y}$: $\delta_t \neq 0$. Year fixed effects capture shifts in policy, technology, and economic contexts, reflecting the dynamic nature of urban competitiveness. By accounting for year-to-year changes, the model identifies long-term trends and short-term fluctuations that influence urban development.

3.3 Testing Methodology and Robustness Analysis in Urban Development Study

From Figure 2, the analysis employs both overall and individual significance tests to assess the impact of various factors on urban competitiveness. The F-test evaluates the joint significance of all variables, while the t-test examines the significance of individual variables. Robustness testing ensures the stability and reliability of the model, addressing potential biases. To capture the temporal dynamics, lagged terms for independent variables are incorporated, with student enrollment structure lagged by three periods and other variables lagged by one. Lagged GDP and educational funding

intensity are used as instrumental variables, each lagged by two periods, to reflect their indirect influence. The DIFF-GMM method addresses endogeneity, improving parameter estimation and model robustness. This approach provides a comprehensive analysis of the long-term dynamics of urban competitiveness, incorporating delayed effects of independent variables for a more nuanced understanding of urban development over time.

Given that urban competitiveness is a cumulative process, independent variables likely have delayed effects on outcomes. Initial analysis revealed static correlations but lacked dynamic depth. Introducing lagged terms for independent variables ensures a more comprehensive evaluation of urban development. The updated model is specified as follows:

$$\begin{aligned} UD_{i,t+1} = {} & \beta_7 + \beta_8 GDP_{i,t} + \beta_9 GDP_{i,t-1} + \beta_{10} Wa_{i,t} + \beta_{11} Wa_{i,t-1} + \\ & \beta_{12} Te_{i,t} + \beta_{13} Te_{i,t-1} + \beta_{14} Ed_{i,t} + \beta_{15} Ed_{i,t-1} + \beta_{16} EF_{i,t} + \beta_{17} EF_{i,t-1} + \\ & \beta_{18} SS_{i,t} + \beta_{19} SS_{i,t-1} + \gamma_i R_i + \varepsilon_{i,t} \end{aligned} \quad (2)$$

Innovation is a core component of urban competitiveness, reflecting high-value production capacity aligned with contemporary growth models. R&D expenditure (RDE) from large-scale industrial enterprises serves as a proxy for innovation capacity and moderates the relationship between innovation and urban competitiveness. Interaction terms between innovation and independent variables reveal whether innovation amplifies or diminishes the effects of other factors: a positive interaction coefficient suggests that higher innovation capacity enhances the independent variable's positive influence, while a negative coefficient indicates that innovation may reduce its positive impact or exacerbate negative effects.

Although initial findings offer a broad understanding of the selected variables' impacts on urban competitiveness, the uneven nature of regional development in China warrants further investigation. Regional characteristics may lead to significant variations in how these factors affect urban competitiveness. Accordingly, this study follows the National Bureau of Statistics' classification, dividing 31 provinces into three major regions: (1) Eastern Region: Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. (2) Central Region: Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan. (3) Western Region: Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang. A fixed effects model is employed for grouped regression analysis to explore intra-regional heterogeneity, enhancing understanding of how each variable influences urban development in different contexts.

The study's methodology integrates both quantitative and qualitative analyses, combining text frequency analysis with panel data regression. This approach allows for a comprehensive framework of urban competitiveness, identifying core themes in government policies and providing qualitative insights into strategic priorities. Additionally, the DIFF-GMM addresses endogeneity issues, correcting biases commonly found in panel data regression and capturing the dynamic relationships between variables, thus enhancing the robustness of the results.

However, the study faces limitations, particularly regarding regional bias in the sample. Data primarily from major cities like Beijing, Chengdu, and Guangzhou may not fully represent other areas of China, potentially limiting the external validity of the findings. Future research could include a broader range of regions, especially smaller cities and underdeveloped areas, to further validate and generalize the findings.

4. EMPIRICAL ANALYSIS

4.1 Descriptive Statistical Analysis and Multicollinearity Diagnosis

Table 3 presents key indicators revealing significant regional disparities in urban competitiveness across China. Urban competitiveness references range from 0-40, while substantial variability exists in GDP (mean: 26,418.57, SD: 23,783.72), employee wages (mean: 75,423.78, SD: 33,704.8), educational attainment (mean: 9.78 years, SD: 1.08), and R&D expenditure (mean: 95,023.1, SD: 139,130).

Table 3. Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
UD	434.00	6.45	8.43	0.00	40.00
GDP		26418.57	23783.72	512.87	135673
Wa		75423.78	33704.8	27102	238673
Te		0.43	0.11	0.17	0.83
Ed		9.78	1.08	4.22	12.59
EF		0.16	0.03	0.10	0.23
SS		0.14	0.03	0.06	0.21
RDE		95023.1	139130	-33.7	836051

The data reveals several counterintuitive insights: (1) Higher GDP does not ensure balanced regional competitiveness, as economically affluent regions still face disparities in education and innovation; (2) Higher wages do not consistently correlate with improved labor quality or innovation capacity; (3) Educational attainment does not automatically translate to enhanced innovation activity, suggesting the importance of education quality and market alignment; (4) Substantial R&D investments do not guarantee balanced economic growth, as regions focusing on high-risk technologies may experience short-term volatility; and (5) Growing academic discourse on urban competitiveness has not eliminated persistent regional disparities in development capabilities and resource allocation. Fu et al. (2024) note that long-term institutional investors help mitigate risks in China’s firms by enhancing governance and transparency, supporting sustainable competitiveness.

This study applies the Pearson correlation coefficient to assess linear associations among independent variables. Table 4 presents correlation analysis results, confirming all coefficients remain below this threshold, ensuring model parameter estimation stability. The analysis reveals several counterintuitive relationships: (1) education and wages show significant negative correlation (-0.30), suggesting elevated wages do not

necessarily correspond with higher educational attainment; (2) while tertiary sector employment strongly correlates with wages (0.75), this does not uniformly translate to enhanced innovation across regions; (3) educational funding correlates positively with student enrollment (0.31) but negatively with tertiary sector employment (-0.27), indicating uneven impacts of education spending; (4) GDP and student structure exhibit a negative correlation (-0.15), suggesting economic growth might prioritize industrial upgrading over educational diversification; and (5) R&D expenditure shows mixed correlations with variables, indicating innovation investment alone cannot resolve regional innovation capacity imbalances.

Table 4. Multicollinearity Diagnosis

	GDP	Wa	Te	Ed	EF	SS
GDP	1					
Wa	0.32*** （7.13）	1				
Te	0.18*** （3.83）	0.75*** （23.36）	1			
Ed	0.15*** （3.08）	-0.30*** （-6.47）	-0.28*** （-6.11）	1		
EF	0.44*** （10.08）	-0.20*** （-4.34）	-0.27*** （-5.84）	0.34*** （7.56）	1	
SS	-0.15*** （-3.08）	-0.26*** （-5.66）	-0.48*** （-11.22）	0.03 （0.63）	0.31*** （6.79）	1

Note: ***, **, and * represent significance at 1%, 5%, and 10% levels, respectively; t-values are given in parentheses. The same notation applies to all subsequent tables.

4.2 Baseline Regression Analysis

This study employs a regional fixed-effects model, which effectively controls for unobserved regional heterogeneity and enhances the robustness of the results. Table 5 presents the baseline regression results, elucidating the influence of various factors on urban competitiveness. It also provides a comprehensive view of the baseline regression results, offering nuanced insights into the impact of key variables on urban competitiveness, denoted as UD. The positive and significant relationship between GDP and urban competitiveness supports the acceptance of the alternative hypothesis $H_{1,GDP}$. This finding aligns closely with the core principles of endogenous growth theory, which posits that economic growth extends beyond simple capital accumulation and labor expansion, acting as a catalyst for technological advancement and innovation. As GDP rises, resource optimization is achieved, and both enterprises and individuals are incentivized to pursue higher efficiency. This drives technological innovation, fosters new business models, and enhances productivity, creating fertile ground for urban competitiveness.

Table 5. The Results of Baseline Regression

Variable	UD
GDP	0.55***（0.10）
Wa	0.57***（0.07）

Te	0.20*（0.10）
Ed	-0.13**（0.05）
EF	-0.007（0.07）
SS	0.06（0.08）
Constant	2.93×10^{-11}（0.03）
Regional Fixed Effects	YES
Time Fixed Effects	NO
Observations	434
$\mathbf{R^2}$	0.66

The impact of on-post employee wages (Wa) on urban competitiveness also proves significant, validating the alternative hypothesis $H_{1,Wa}$. Higher wages not only attract and retain high-quality labor but also motivate employees and foster a culture of innovation, which leads to skill enhancement and efficiency gains. In a high-wage environment, employees are more inclined to invest in personal development, and firms are similarly incentivized to offer training and development opportunities. This collective drive for growth strengthens innovation capacity and boosts overall productivity—crucial contributors to robust urban competitiveness.

The significant positive relationship between the proportion of employment in the tertiary sector (Te) and urban competitiveness lending support to the alternative hypothesis $H_{1,Te}$. In the knowledge economy, the tertiary sector—especially service industries dependent on knowledge and innovation—has become a vital driver of economic growth. These sectors integrate advanced technologies and innovative management practices to modernize production processes and optimize management systems, substantially enhancing economic efficiency and productivity, thereby opening substantial opportunities for urban competitiveness.

Unexpectedly, the relationship between average years of education (Ed) and urban competitiveness is negative significantly. Although the alternative hypothesis $H_{1,Ed}$ is accepted, this result contradicts theoretical expectations. This anomaly may stem from the historical evolution of China's education system, where, before the implementation of the nine-year compulsory education system in 1986, educational attainment was generally low and access inequitable. Consequently, the broader workforce's limited educational level may have restricted the potential productivity contributions of education, limiting its impact on urban competitiveness.

The regression coefficient for educational funding intensity (EF) is not statistically significant, supporting the null hypothesis $H_{0,EF}$. This result diverges from theoretical expectations. Educational investment, by nature, often requires an extended timeframe to produce measurable productivity benefits. The effectiveness of educational spending depends heavily on how well it translates into high-quality educational resources and outcomes; without efficient allocation, the impact on productivity and urban competitiveness remains limited.

Similarly, while student structure (SS) has a positive effect on urban competitiveness is not significant, supporting the null hypothesis $H_{0,SS}$. This outcome

suggests that variations in student composition have not yet made a discernible contribution to urban competitiveness. Since students represent the future workforce, the transition of their educational achievements into productivity gains requires time. While they remain within the education system, their skills and knowledge are still in formation, delaying their impact on productivity.

The findings underscore the complexity of the relationships between education, wages, innovation, and urban competitiveness, challenging traditional economic theories. Several key insights are highlighted:

(1) Negative correlation between education and urban competitiveness: contrary to conventional wisdom, higher educational attainment does not automatically lead to improved urban competitiveness. The negative relationship between years of education and urban competitiveness suggests that the mismatch between education quality and labor market demands may hinder the potential benefits of education.

(2) Limited impact of educational funding: while education is widely considered a driver of long-term growth, the study reveals that increased educational funding does not directly translate into immediate productivity gains. This points to inefficiencies in resource allocation and emphasizes the need for strategically targeted educational investments.

(3) No significant impact of student structure on competitiveness: the expected positive relationship between educational composition and urban competitiveness is not supported. Changes in student structure do not result in immediate productivity improvements, highlighting the long-term nature of educational investments' impact on labor markets.

(4) Tertiary sector growth and urban competitiveness: although the growth of the tertiary sector is associated with urban competitiveness, the effect is modest. The quality and nature of services, rather than just their expansion, play a pivotal role in driving competitiveness.

(5) GDP growth and education/workforce quality: the positive correlation between GDP and urban competitiveness does not consistently extend to education or workforce quality. This finding challenges the belief that economic growth alone fosters human capital development, emphasizing the need for targeted educational investments.

(6) Skills mismatch: the study indirectly verifies the phenomenon of skills mismatch, where educational qualifications do not align with labor market needs. This discrepancy suggests that educational systems may not adequately prepare students for the demands of modern industries, highlighting the need for alignment between education content and market requirements.

(7) Short-term and long-Term effects of education spending: education spending often does not yield immediate productivity gains due to institutional inefficiencies and market misalignments. However, over the long term, investments in education lead to a more skilled workforce, fostering innovation, adaptability, and economic resilience. The key to successful education spending lies in improving education quality, aligning curricula with market demands, and optimizing the institutional environment.

4.3 Robustness Test

The robustness test, as presented in Table 6, rigorously evaluates the effectiveness of the DIFF-GMM estimator, a crucial step to ensure the reliability of the model's specification and regression results. The AR(1) p-value is below 0.1, while the AR(2) p-value exceeds 0.1. This result indicates the presence of first-order autocorrelation but rules out concerns regarding second-order autocorrelation, confirming that the model setup aligns with the characteristics of a dynamic panel model and meets the essential requirements for DIFF-GMM estimation.

Table 6. The Results of Robustness Test

Variables	$\mathbf{UD_{t+1}}$
$\mathbf{GDP_t}$	1.06**（0.41）
$\mathbf{Wa_t}$	0.41***（0.11）
$\mathbf{Te_t}$	-0.24（0.26）
$\mathbf{Ed_t}$	-0.05（0.08）
$\mathbf{EF_t}$	-0.17**（0.09）
$\mathbf{SS_t}$	0.11（0.27）
$\mathbf{GDP_{t-1}}$	-0.58（0.46）
$\mathbf{Wa_{t-1}}$	0.51***（0.07）
$\mathbf{Te_{t-1}}$	0.65***（0.20）
$\mathbf{Ed_{t-1}}$	0.18**（0.07）
$\mathbf{EF_{t-1}}$	0.15***（0.03）
$\mathbf{SS_{t-1}}$	0.45**（0.18）
Regional Fixed Effects	YES
Time Fixed Effects	NO
Sample Size	310
AR（1）	8.8×10^{-3}***
AR（2）	0.27
Hansen	0.27

Notes: AR(1), AR(2), and Hansen rows report p-values for the corresponding tests.

The Hansen test (p>0.1) confirms appropriate instrumental variable selection, strengthening regression estimate credibility. Table 6 validates the DIFF-GMM estimator's effectiveness, with most variables maintaining consistency from baseline models despite the tertiary sector employment coefficient diverging.

The analysis reveals several significant temporal dynamics: (1) tertiary sector employment shows negative immediate effects but positive lagged coefficients, indicating knowledge-intensive industries initially face productivity challenges as new entrants struggle with skill application, before expertise accumulation enables productivity gains; (2) education-related variables (average years of education, educational funding intensity, student structure) shift from significant negative immediate effects to positive lagged effects, demonstrating education's delayed impact on urban competitiveness.

These counterintuitive findings highlight complex, non-linear relationships between investment and outcomes: (1) tertiary sector expansion produces negative short-term impacts on urban competitiveness, contradicting assumptions of immediate

productivity gains from service sector growth; (2) educational funding shows negative immediate effects, suggesting resource allocation efficiency determines impact more than investment volume; (3) educational attainment initially exhibits negative effects, potentially reflecting misalignment between education content and market needs; (4) student structure optimization yields benefits only in the long term, as productivity gains emerge after workforce integration; (5) GDP growth shows positive immediate but negative lagged effects, suggesting potential resource distribution inefficiencies; (6) education investments transform from negative short-term to positive long-term impacts, highlighting delayed educational reform payoffs and challenging expectations of immediate returns.

5. MECHANISM EXPLORATION

5.1 Mechanism Analysis

Table 7 reveals significant interaction effects between innovation and key economic factors. The interaction coefficient between innovation and GDP is positive and significant (Column 1), demonstrating innovation's synergistic role in amplifying economic growth's impact on urban competitiveness.

The innovation-wage interaction (Column 2) shows positive significance, indicating innovation enhances wage effects on competitiveness by fostering skilled labor retention and employee motivation. Similarly, the innovation-tertiary sector employment interaction (Column 3) is positive and significant, highlighting innovation's role in optimizing employment structures and enhancing service sector value.

Notably, the innovation-education interaction (Column 4) is significant but amplifies education's negative impact, suggesting innovation may exacerbate challenges for less-educated workers during industrial transformation. Meanwhile, the innovation-educational funding interaction (Column 5) is positive and significant, demonstrating how innovation magnifies educational investment benefits through improved resource allocation and efficiency.

The innovation-student structure interaction (Column 6) aligns with the student structure coefficient but lacks statistical significance, indicating that while innovation may enhance skill acquisition, student workforce transition depends primarily on education-market alignment rather than innovation processes.

Table 7 The Results of Mechanism Analysis

Variables	（1）	（2）	（3）	（4）	（5）	（6）
	UD					
GDP	0.64***	0.57***	0.72***	0.60***	0.68***	0.52***
	（0.11）	（0.11）	（0.12）	（0.11）	（0.11）	（0.11）
Wa	0.31***	0.26***	0.42***	0.38***	0.26***	0.28***
	（0.06）	（0.06）	（0.06）	（0.06）	（0.06）	（0.07）
Te	-0.01	0.005	0.01	-0.03	-0.003	-0.02

	（0.06）	（0.06）	（0.07）	（0.06）	（0.06）	（0.06）
Ed	-0.0008	-0.004	0.003	-0.10**	0.02	-0.007
	（0.04）	（0.04）	（0.04）	（0.05）	（0.04）	（0.04）
EF	0.02	0.02	-0.009	-0.05	0.04	0.01
	（0.05）	（0.05）	（0.05）	（0.05）	（0.05）	（0.05）
SS	0.09*	0.09**	0.13***	0.17***	0.09**	0.10**
	（0.05）	（0.04）	（0.05）	（0.05）	（0.04）	（0.04）
RDE	-0.52***	-0.43***	-0.51***	-0.29***	-0.61***	-0.29***
	（0.13）	（0.10）	（0.11）	（0.11）	（0.12）	（0.11）
GDP×RDE	0.05*					
	（0.02）					
Wa×RDE		0.11***				
		（0.04）				
Te×RDE			0.15**			
			（0.06）			
Ed×RDE				-0.27***		
				（0.08）		
EF×RDE					0.18***	
					（0.05）	
SS×RDE						0.07
						（0.05）
Constant	-0.04	-0.02	-0.02	0.03	-0.08	0.01
	（0.06）	（0.06）	（0.05）	（0.05）	（0.06）	（0.06）
Region Fixed Effect	YES	YES	YES	YES	YES	YES
Time Fixed Effect	YES	YES	YES	YES	YES	YES
Sample Size	434	434	434	434	434	434
$\mathbf{R^2}$	0.25	0.21	0.36	0.30	0.23	0.20

The mechanism analysis reveals seven counterintuitive insights challenging conventional urban development assumptions: (1) innovation amplifies education's negative impact on urban competitiveness in certain contexts, contradicting beliefs that education uniformly enhances productivity. Without alignment between educational systems and market demands, educational attainment alone fails to support innovation-driven growth. Tawfik et al. (2024) similarly demonstrate complex investment patterns where Sharia compliance attracts family investors while deterring institutional ones; (2) wages require innovation to drive competitiveness, challenging views that higher wages inherently enhance workforce efficiency. Without innovation, wage increases alone cannot sustain long-term productivity growth; (3) tertiary sector expansion produces initial productivity declines as new workers require time to acquire industry-specific skills, contradicting assumptions that service sector growth immediately accelerates urban competitiveness; (4) educational funding shows delayed competitiveness impacts, requiring innovation-driven mechanisms to ensure efficient resource allocation for effectiveness; (5) innovation potentially disadvantages low-skilled workers during rapid technological transformation when not paired with skill development initiatives, challenging the belief that innovation benefits all societal segments equally; (6) student structure optimization offers delayed benefits, contradicting expectations of immediate

productivity gains from educational curriculum alignment; (7) education, innovation, and growth exhibit non-linear relationships, requiring strategic coordination rather than isolated investments. Long et al. (2024) similarly find that digital transformation in Chinese enterprises enhances low-carbon development through multiple interconnected mechanisms.

The institutional environment plays a crucial regulatory role in innovation activities. Both formal institutions, such as laws, regulations, and policies, and informal institutions, including organizational culture and the innovation climate, significantly influence the incentives, costs, and efficiency of innovation. A conducive institutional environment supports innovation by reducing costs and increasing the capacity of businesses and organizations to innovate. This paper analyzes the multi-dimensional mechanisms through which the institutional environment affects innovation, compares the institutional environments across regions, and explores how institutional settings regulate innovation through various pathways to promote economic and technological growth.

The institutional environment regulates innovation through three key mechanisms: (1) multidimensional influence mechanisms include formal institutions (laws, regulations, policy frameworks), informal institutions (organizational culture, innovation climate), and institutional execution flexibility; (2) regional variation reveals distinct patterns: Eastern regions demonstrate strong innovation capabilities through advanced infrastructure and policy frameworks; Central regions undergo transformative institutional reforms while transitioning to knowledge economies; Western regions rely on exogenous drivers through national policies and external investments; (3) key regulatory pathways include lowering innovation costs through subsidies and tax incentives, providing institutional protection via intellectual property rights, and building incentive mechanisms that reward creativity and risk-taking.

Education spending plays a crucial role in driving economic growth and innovation, but its effects manifest differently in the short and long term. In the short term, education investments often do not immediately translate into productivity gains, while in the long term, they contribute to human capital accumulation, skill upgrading, and innovation capacity development. Understanding how education spending translates into these outcomes over time is essential for effective policy-making. This paper explores the mechanisms behind the short-term negative effects and long-term positive effects of education spending, as well as the key regulatory factors that influence the conversion of these effects into tangible results.

Education spending exhibits different effects across timeframes: (1) Short-term negative effects stem from time misalignment between investment and productivity improvements, structural inefficiencies in education systems, and lags in innovation capability development. (2) Long-term positive effects emerge through cumulative human capital investment, workforce skill upgrading, and gradual innovation ecosystem improvement, enabling adaptability to technological advancements. (3) Effectiveness conversion requires continuous education quality improvement, deeper

industry-education integration to align outputs with market demands, and optimized innovation incentive mechanisms to encourage creativity and entrepreneurship.

5.2 Heterogeneity Analysis

An in-depth examination of Table 8 reveals significant heterogeneity in the effects of regional economic growth, employee wages, tertiary sector employment, average years of education, educational funding intensity, and student structure on urban competitiveness. These findings offer critical insights into the multi-layered dynamics of regional economic development and the underlying mechanisms driving urban competitiveness, providing a novel perspective on the forces shaping urban growth.

Table 8 The Results of Heterogeneity Analysis

Variables	(1)	(2) UD	(3)	Coefficient Differences		
Control	Eastern (E)	Central (C)	Western (W)	E vs W	E vs C	C vs W
GDP	0.15** (0.07)	0.33** (0.16)	0.58*** (0.13)	**	***	**
Wa	0.70*** (0.11)	1.18*** (0.20)	0.81*** (0.10)	***	-	***
Te	-0.28** (0.13)	0.24 (0.20)	-0.03 (0.10)	***	-	***
Ed	-0.15* (0.09)	0.69*** (0.20)	0.20*** (0.05)	***	**	***
EF	0.07 (0.08)	-0.13 (0.11)	-0.12 (0.08)	***	***	-
CSS	0.34*** (0.09)	0.05 (0.10)	0.30*** (0.08)	***	**	***
Constant	0.13 (0.12)	0.16 (0.09)	0.15 (0.08)			
Regional Effects	YES	YES	YES			
Temporal Effects	YES	YES	YES			
Sample Size	168	112	168			
R^2	0.49	0.64	0.49			

A comprehensive analysis of regional variations reveals six key differentiated impacts: (1) Economic growth effects: The Eastern region shows moderate impact due to diminishing returns and high baseline constraints, while central and western regions experience stronger effects due to lower economic baselines and strategic emerging industries (AI, quantum computing, clean energy) that generate positive supply chain spillovers; (2) Wage influence: Eastern region employees prioritize work-life balance over wage increases in saturated markets, limiting wage effectiveness as productivity incentives. The Central region, with its significant migrant workforce, shows strongest wage-productivity relationship, while the Western region experiences positive but limited wage impacts; (3) Tertiary sector impact: the Eastern region experiences negative effects from service sector growth due to oversaturation and low-efficiency roles. The Central region shows positive but statistically insignificant effects, while the

Western region has limited impact due to insufficient skilled labor and weak industrial foundations; (4) Educational attainment effects: the Eastern region shows negative relationship between education years and competitiveness due to skills mismatches in markets favoring practical experience. The Central and Western regions demonstrate significant positive impacts, with education investment generating higher returns; (5) Educational funding effectiveness: the Eastern region shows positive effects from educational funding, while the Central and Western regions experience negative impacts due to fiscal constraints and inefficient resource allocation for major research initiatives; (6) Student structure contributions: student structure positively affects competitiveness in the Eastern and Western regions, significant due to practical industry experience opportunities (East) and high marginal returns on educational investment (West). The Central region lacks significance due to limited practical experience opportunities and uneven resource distribution.

These counterintuitive findings reveal a complex interplay between education, wages, industrial structure, and urban competitiveness. Policymakers should move beyond traditional linear models and adopt strategies that account for regional differences, alignment with market demand, and efficient resource allocation to foster a balanced and sustainable model of urban competitiveness.

Six key counterintuitive findings challenge conventional urban development assumptions: (1) diminishing growth returns in the advanced Eastern region contradict beliefs that economically developed areas exhibit stronger growth drivers. Eastern China's high development level, coupled with technological bottlenecks and resource constraints, limits growth potential, while the Central and Western regions benefit from emerging industries and lower economic baselines; (2) high Eastern wages yield limited productivity gains as workers prioritize leisure over increased pay in saturated labor markets, challenging the assumption that wages directly correspond with productivity. The Central and Western regions demonstrate stronger wage-productivity relationships due to higher wage sensitivity; (3) tertiary sector growth negatively impacts eastern competitiveness due to oversaturation and inefficiencies where new entrants perform low-value tasks, contradicting expectations that service sector expansion uniformly benefits development; (4) extended education negatively affects eastern competitiveness, revealing disconnects between academic credentials and practical skills needed in competitive environments, challenging assumptions that more education inherently provides greater benefits; (5) educational funding produces negative impacts in central/western regions due to operational-focused budget allocation rather than innovation-oriented investment, refuting the belief that increased educational spending inevitably fosters development; (6) student structure optimization shows limited impact in the Central region due to examination pressures, insufficient practical training, and uneven resource distribution.

These findings reflect deeper regional structural differences: the Eastern region faces boundary constraints with diminishing innovation returns despite concentrated resources, structural bottlenecks in industrial transformation, and declining innovation

ecosystem efficiency. The Central region enjoys strategic transitional opportunities for industrial upgrading, advantages in absorbing industries relocating from eastern areas, and high marginal returns on infrastructure investments. The Western region possesses substantial natural and strategic resources for green industry development, significant infrastructure investment potential, but faces challenges in talent attraction and retention.

6. DISCUSSIONS AND POLICY IMPLICATIONS

6.1 Summary of Hypothesis Testing Results

Based on hypothesis testing results (Table 9), several key patterns emerge regarding urban competitiveness drivers: (1) GDP positively impacts urban competitiveness across all regions, aligning with endogenous growth theory. This effect varies regionally, with stronger impacts in the Central and Western regions due to their lower economic baselines. These areas benefit from technology spillovers from strategic emerging industries (AI, clean energy), creating synergistic growth and positive externalities across related sectors; (2) wage effects show regional divergence. The Central and Western regions demonstrate strong positive relationships between wages and competitiveness, as wage incentives effectively motivate workers with higher labor mobility. Eastern regions, despite higher wages, show diminished returns due to labor market saturation and worker prioritization of work-life balance over income maximization; (3) tertiary sector employment positively affects competitiveness in the Central and Western regions by fostering adaptive economic environments and resource efficiency. However, the Eastern region experiences negative impacts from service sector overconcentration, creating inefficiencies and intra-sectoral competition that stagnates productivity.

Table 9 Hypothesis Testing

Variable	Conclusion	Significance	Common-Sense	Counterintuitive Findings
GDP Impact (β_1)	Reject $H_{0,GDP}$	1%	GDP positively drives urban development, enhancing productivity and efficiency.	In some regions, diminishing marginal returns may limit GDP's impact. High initial development levels might face constraints like resource limitations.
Wages of On-Post Employees (β_2)	Reject $H_{0,Wa}$	1%	Higher wages attract skilled labor and increase productivity.	In developed regions like the East, higher wages may not significantly boost productivity if workers prioritize leisure over increased pay.
Tertiary Sector Employment Ratio (β_3)	Mixed Results	5% in some regions	A larger service sector fosters urban growth through innovation.	In the East, tertiary employment contributes negatively due to labor oversupply and inefficiencies in low-skilled service roles.
Average Years of Education (β_4)	Mixed Results	10% in specific regions	Education contributes to human capital, enhancing labor productivity.	In the East, prolonged education may be mismatched with market needs, limiting effectiveness due to a focus on academic rather than practical skills.
Educational Funding Intensity (β_5)	Mixed Results	5% in select regions	Increased funding enhances human capital quality.	In the Central and Western regions, inefficiencies in fund allocation have led to negative outcomes, suggesting a failure in optimizing resource use.
Student Enrollment Structure (β_6)	Reject $H_{0,SS}$ in East and West	5%	A well-balanced educational structure supports economic diversity.	In the Central region, an imbalanced student structure shows minimal impact due to inadequate practical training and career guidance.
Regional Fixed Effects (γ_i)	Reject $H_{0,R}$	1%	Regional characteristics significantly influence urban growth.	In some underdeveloped regions, local institutional inefficiencies dampen potential positive impacts of regional factors.
Year Fixed Effects (δ_t)	Reject $H_{0,Y}$	5%	Changes over time reflect economic and policy shifts.	Not all temporal changes benefit growth—economic crises and policy missteps can hinder progress in specific years.

The analysis emphasizes three critical considerations for policy development: (1) regional heterogeneity significantly influences how economic factors drive urban competitiveness, with development stage determining sensitivity to various stimuli. (2) economic baseline conditions shape growth dynamics, with less-developed areas benefiting more from incremental growth due to untapped opportunities. (3) policy frameworks strongly mediate tertiary sector impacts, with insufficient supportive

structures for skill development and employment practices potentially turning service sector expansion into a negative factor for competitiveness.

6.2 The Paradox of Education Spending and Economic Growth

These findings underscore the context-dependent nature of urban competitiveness drivers, highlighting that economic and educational investments must align with regional conditions for sustainable growth. (1) Diminishing impact of GDP in developed regions: in the Eastern region, GDP growth shows diminishing returns due to resource constraints, technological saturation, and institutional rigidities. High-growth regions face bottlenecks, such as rising labor costs and limited resources, which hinder further productivity gains despite positive GDP trends; (2) Limited effect of high wages in the Eastern region: contrary to human capital theory, high wages in the Eastern region do not significantly boost productivity. Workers prioritize work-life balance over financial incentives, reducing the effectiveness of wage increases in motivating higher productivity; (3) Negative effect of tertiary sector employment: in the Eastern region, expanding tertiary sector employment, particularly in low-skilled services, negatively impacts urban competitiveness. The growth of non-productive services leads to sectoral crowding, emphasizing the need for innovation-driven sectors to enhance urban economic growth; (4) Negative impact of educational attainment: longer average years of education in the Eastern region are linked to a negative effect on urban competitiveness, highlighting the mismatch between educational outputs and labor market needs. Practical skills are prioritized over academic qualifications, suggesting the need for adaptive education systems that integrate vocational training and lifelong learning; (5) Educational funding's limited impact in the Central and Western regions: increased educational funding in the Central and Western regions does not enhance urban competitiveness due to inefficient fund utilization. Funds often focus on basic operational expenses rather than high-return areas like teacher training or curriculum development, underscoring the need for improved governance and institutional frameworks; (6) Limited impact of student structure in the Central region: changes in student composition do not significantly boost urban competitiveness in the Central region, where a lack of practical training and uneven resource distribution prevent students from acquiring market-relevant skills. This highlights the importance of balanced education systems that integrate both theoretical and practical learning to effectively contribute to urban growth.

6.3 The Multidimensional Interpretation of Urban Competitiveness: Beyond Economic Considerations

This study explores the multifaceted nature of urban competitiveness, emphasizing not only economic factors but also social, cultural, and environmental dimensions. The empirical results highlight how institutional inputs and educational spending influence these various aspects of urban development.

(1) Social dimension: the negative correlation between years of education and urban competitiveness in the Eastern region points to challenges beyond economic efficiency, such as social inclusivity. Education systems that prioritize academic credentials over practical skills may exacerbate social stratification and contribute to unemployment and social discontent. The skills mismatch, where education does not align with labor market needs, further undermines social resilience, making cities more vulnerable to economic shocks. These findings align with the work of De Filippi and Coscia (2024), which underscores the role of citizen participation in enhancing social capital and urban cohesion.

(2) Cultural dimension: regional differences in innovation's impact on urban competitiveness reflect varying levels of cultural capital and institutional environments. In the Eastern region, robust industry-university collaborations foster a workforce capable of meeting the demands of urban competitiveness, contributing to the city's cultural capital. This aligns with Huang et al. (2024), who highlight the growing importance of culture in urban competitiveness and the role of urban spaces in preserving and promoting cultural heritage. Similarly, Tan et al. (2023) show how cultural branding contributes to a city's economic growth.

(3) Environmental dimension: the impact of tertiary sector employment on urban competitiveness also raises concerns about environmental sustainability. Service-dominated economies, often more environmentally sustainable than manufacturing-driven ones, enhance urban quality and long-term growth. Wu et al. (2024) emphasize the integration of local culture with modern technology in smart city development, showing how environmental sustainability boosts regional competitiveness. Liu et al. (2024) further confirm the role of ecosystems in enhancing well-being, illustrating how urban areas balance environmental and economic factors.

(4) Institutional inputs: the regional variations in institutional governance, cultural resource allocation, and environmental management highlight the diverse ways in which cities address challenges. As Khendriche Trhlínová and Cechák (2023) suggest, digital transformation offers opportunities to solve urban problems, including environmental and social issues, through targeted regional support for smart city initiatives.

This study's findings emphasize the need for policies that address the interconnectedness of these dimensions. The paradox between educational investment and economic growth extends beyond efficiency, encompassing social equity, cultural innovation, and environmental sustainability. Policy recommendations should, therefore, balance economic development with the broader goals of fostering inclusivity, cultural vitality, and environmental resilience. Proposed actions, such as vocational training focused on market-oriented skills, the creation of urban economic resilience labs, and initiatives to encourage technological curiosity, should all be aligned with these multidimensional goals (Audretsch & Belitski, 2021; De Filippi & Coscia, 2024; Huang et al., 2024; Tan et al., 2023; Wu et al., 2024; Liu et al., 2024; Khendriche Trhlínová & Cechák, 2023).

6.4 International Comparative Perspective on Empirical Results

This study places the empirical findings within an international comparative framework to better understand the relationship between education expenditure and urban competitiveness in China, revealing both common trends and region-specific characteristics that inform policy formulation.

The research shows that education-related variables, such as years of education, educational funding intensity, and student structure, have a negative short-term impact but become positive in the long term. This pattern, which aligns with global findings, suggests that educational investments require time to translate into productivity improvements. Ngigi et al. (2024) found similar time-lag effects in Kenya, where education spending initially hampers economic development but yields positive long-term results. This resonates with China's experience, particularly in its Central and Western regions. Jungo (2024) also found that increased education spending positively impacts economic growth, though its effects are often delayed.

The lower-than-expected impact of educational spending in China's developed eastern regions may be attributed to differences in institutional effectiveness. Cooray and Nam (2025) found that government effectiveness significantly mediates the relationship between public social spending and economic growth. High-income countries like Japan and South Korea show more pronounced positive effects from education spending, whereas China's Eastern region reveals a gap in institutional effectiveness. This observation is further supported by Ullah et al. (2024), who note differential impacts of sectoral public expenditures on growth across developing countries, emphasizing the need for China to improve the efficiency of educational investments.

Regional imbalances in the effectiveness of educational investments are evident in both China and globally. The differential effects of education spending across China's Eastern, Central, and Western regions are comparable to findings in Clements et al. (2025), who show varying impacts of targeted education and health spending across Asian countries. Ponzetto and Troiano (2025) further highlight how regions with higher social capital invest more effectively in education, a factor that should be considered in China's regional strategies.

The negative correlation between education investment and economic growth in China's developed Eastern region is particularly notable. This contrasts with global trends, where higher educational investments generally lead to increased competitiveness. Similar issues are observed in Brazil, where education spending failed to meet expectations (De Medeiros et al., 2024). In China, this discrepancy may be due to talent mobility constraints, rapid industrial restructuring, and a disconnect between educational content and labor market needs.

International experience suggests that educational investments should be integrated with investments in health, environment, and other sectors. Stamegna et al. (2024) found that combined investments in education, health, and the environment have

greater economic and employment benefits than focusing on education alone. Ashraf et al. (2024) also emphasize the importance of multi-dimensional investments for sustainable economic growth, demonstrating how indicators like education, health expenditures, and gender equality collectively shape growth quality.

Based on these international insights, the study suggests several policy recommendations for China: first, China should recognize the long-term benefits of education spending, despite short-term challenges; second, improving the institutional effectiveness of education spending is crucial, focusing on resource allocation and outcome evaluation; third, differentiated strategies should be developed based on regional characteristics: the Eastern region needs to align education content with labor market demands, while the Central and Western regions require increased investment in basic education. Finally, multi-dimensional, synergistic investments that include education, health, environment, and innovation should be prioritized to foster comprehensive urban competitiveness.

6.5 Policy Recommendations for Balanced Urban Development

This analysis highlights significant inefficiencies and regional disparities within China's educational and institutional frameworks, underscoring the need for transformative policy reforms aimed at enhancing education, innovation, and urban governance. Several key policy recommendations emerge from the findings: (1) Reorient education funding toward vocational and market-oriented skills training: the study suggests that generalized education funding in the Central and Western regions has not significantly boosted urban competitiveness. A shift towards vocational and market-oriented training aligned with local economic needs is crucial. By focusing on skills training that directly addresses workforce requirements, educational investments can help close the skills gap, enhance productivity, and bolster regional economic resilience; (2) Targeted skill development initiatives in the Eastern region: despite high wages, productivity gains remain limited. Therefore, incentives should be introduced to support targeted skill development programs that align educational qualifications with current and future labor market needs. This will help maintain competitiveness and adaptability in rapidly evolving sectors, ensuring that the workforce remains flexible and ready for emerging economic challenges; (3) Establish urban economic resilience labs: to improve institutional responsiveness to economic fluctuations and social changes, it is recommended to establish urban economic resilience labs. These labs would function as real-time monitoring and assessment units, enabling local governments to adapt policies swiftly when conventional approaches prove ineffective. Reducing bureaucratic rigidity and cultivating innovation-friendly environments, particularly in underdeveloped areas, will be essential to sustain urban growth; (4) Foster a culture of innovation through incentive structures: to address inefficiencies in education and the tertiary sector, the introduction of initiatives like the Technological Curiosity Award is recommended. This would recognize and reward technological innovations, thereby fostering a culture of creativity and progress. By incentivizing

innovation across all sectors, the initiative would stimulate growth and address the disconnect between education and market needs; (5) Regional policy pathways: A. Eastern region: focus on innovation-driven development and stock optimization. The Eastern region should optimize existing innovation resources and encourage the transformation of outdated industries. Establishing an innovation ecosystem evaluation mechanism will help better allocate resources and identify areas for improvement, while policies should support the renewal of innovation factors and encourage cross-sector collaboration in emerging industries. B. Central region: prioritize industry collaboration and capability enhancement. In the Central region, fostering industry collaboration and improving the overall industrial capability will be key. By building collaborative innovation platforms, industries can share knowledge and resources, enhancing productivity and innovation. Tailoring talent development to the needs of transforming industries will also ensure long-term growth. C. Western region: invest in infrastructure development and unique growth. The Western region should focus on infrastructure development, particularly in transportation, energy, and communication, to unlock economic potential. The development of regional ecosystems based on local specialties, such as eco-tourism or renewable energy, will diversify the economy and enhance its competitive edge; (6) Address skills mismatch: the study emphasizes the need to align the education system with labor market demands to resolve the skills mismatch. To achieve this, a dynamic system for adjusting academic programs to market trends should be implemented, ensuring that curricula align with the skillsets required by employers. Educational resources should increasingly focus on practical, hands-on skills rather than theoretical knowledge; 7) Strengthen school-industry collaboration: strengthening the collaboration between educational institutions and industries is crucial. Schools and businesses should actively work together to develop curricula that reflect the evolving needs of industries. Internships and practical training programs should be integrated into academic structures, providing students with real-world experience that aligns with industry challenges; (8) Promote lifelong learning and skills retraining: lifelong learning and skills retraining programs are essential to ensure that workers can adapt to changes in the job market. Governments should implement flexible skill conversion channels, offering certifications in emerging technologies like AI, renewable energy, and digital marketing, to support workforce adaptability and improve employability; (9) Institutional innovation to enhance entrepreneurial ecosystems: to optimize the entrepreneurial environment, institutional reforms such as deregulation and market-oriented reforms are needed. Simplifying administrative processes, lowering market entry barriers, and promoting a fair market environment will allow startups to thrive. Additionally, creating innovation-driven institutional frameworks that support knowledge exchange and provide diverse financing channels will stimulate entrepreneurship and economic development; (10) Phased investment strategy for education: a phased investment strategy is crucial to balance short-term and long-term outcomes of education spending. Regular performance evaluations will allow policymakers to adjust investments based on the specific needs of each stage of

economic and educational development. Resource allocation should be tailored to the needs of each phase to maximize the long-term benefits of education investments; (11) Continuous improvement of education quality: to ensure long-term success, education quality must be continuously improved. This requires a dynamic monitoring system that tracks educational standards and aligns curricula with market needs. Feedback from industries and educational institutions will facilitate real-time updates to course content and teaching methods, ensuring that graduates possess the skills employers require; (12) Innovation-oriented talent development: developing talent focused on innovation is key to long-term economic success. A long-term talent tracking system will ensure that educational outcomes align with economic needs. Cross-cycle development programs should provide continuous learning opportunities throughout individuals' careers, ensuring that the workforce can adapt to evolving industries and drive innovation across sectors.

7. CONCLUSION AND FUTURE DIRECTIONS

7.1 Summary of Key Findings and Their Implications

This study examines the inefficiencies and regional disparities within China's urban development framework, particularly in the educational and institutional sectors. The analysis reveals paradoxical effects of traditional investments in human capital and institutional frameworks. Key findings show diminishing returns in developed regions, inefficiencies in educational investments, and limited productivity gains from wage increases under specific conditions. These insights challenge the conventional belief that investments in education, wages, and institutional support uniformly enhance urban development. Instead, they emphasize the need for region-specific strategies tailored to the dynamic nature of urban ecosystems.

To align educational outcomes with urban economic demands, a shift from generalized education funding to vocational and market-oriented skills training is essential. In regions like the Central and Western parts of China, increased education funding has not consistently led to urban development improvements. Redirecting investments towards vocational training programs that provide workforce-ready skills specific to local economies will bridge the skills gap, boost productivity, and enhance regional resilience by aligning education with market needs. In the economically advanced Eastern region, despite high wage levels, the subdued productivity response calls for targeted skill development programs that align educational qualifications with current and future labor market demands. This would promote labor mobility and adaptability, ensuring a competitive workforce in rapidly evolving sectors.

Addressing urban development challenges also requires the creation of adaptable and resilient institutional frameworks. The establishment of urban economic resilience labs is proposed to enable local governments to respond flexibly to socio-economic changes. These labs would serve as real-time monitoring and evaluation units, providing continuous feedback and enabling timely policy adjustments, especially

where traditional approaches fall short. Additionally, flexible governance models, particularly in the Eastern and Central regions, should prioritize policies that foster innovation-friendly environments, promoting sustained urban growth, especially in underdeveloped areas.

The paradoxical outcomes observed in this study point to the need for a rethinking of incentive structures. Initiatives such as the technological curiosity award could help cultivate a culture of innovation by recognizing and rewarding technological advancements and creative contributions to urban development. This initiative would foster an innovation-driven environment and address inefficiencies in education and the service sector, encouraging problem-solving and creativity across economic domains. Moreover, targeted retraining programs, particularly in the East, are vital for resolving skills mismatches, facilitating the transition of labor from oversaturated industries to high-growth sectors. These programs should combine vocational education with hands-on experience, ensuring alignment with market demands and improving workforce adaptability.

The study also emphasizes the counterintuitive nature of traditional investments in human capital and institutional support. In developed regions, diminishing returns on GDP growth, limited productivity gains from high wages, and the negative impacts of certain educational investments challenge the assumption that such investments will automatically result in positive outcomes. These results highlight the importance of understanding regional characteristics and contextual dynamics in shaping urban growth. Sustainable urban development depends on balancing educational quality, institutional resilience, and socio-economic adaptability.

7.2 Multidimensional Pathways for Enhancing Urban Competitiveness

To enhance urban competitiveness, we must extend beyond economic considerations and construct pathways that integrate social, cultural, and environmental dimensions. Socially, this study's findings indicate that in the Eastern region, educational investment without a focus on practical skills exacerbates social stratification. Therefore, a more inclusive educational system is recommended, emphasizing both vocational and academic learning. By providing flexible training programs that align educational outcomes with market demands, urban labor productivity can be improved, and social cohesion strengthened.

Culturally, the study reveals significant regional variations in how student structure impacts urban competitiveness, pointing to imbalances in cultural capital accumulation. To foster a competitive cultural ecosystem, creative economy initiatives should be integrated into urban development planning. Creating spaces for collaboration and establishing creative coalitions will help build sustainable urban competitiveness. Additionally, preserving historic urban spatial structures, as pointed out by Huang et al. (2024), can nurture unique urban identities, contributing to a city's cultural appeal and competitiveness.

Environmentally, urban competitiveness can be enhanced through a "smart-ecological" dual-track development model. Integrating digital technologies into environmental monitoring, resource optimization, and ecosystem management can achieve a synergy between economic growth and environmental sustainability. For the Eastern region, leveraging technological advantages in environmentally friendly tertiary industries can help mitigate environmental pressures during industrial upgrades. This approach aligns with Wu et al. (2024), which emphasizes the potential of smart cities in improving regional competitiveness.

Institutional innovation is crucial for enhancing multidimensional competitiveness. Building on the concept of urban economic resilience labs, an adaptive governance framework should be developed. This framework would include mechanisms for cross-departmental coordination, performance-based resource allocation, and platforms for citizen participation. Such a design, as highlighted by De Filippi and Coscia (2024), ensures that decision-making is inclusive and responsive, aligning policies with urban development needs.

Cross-sector collaboration is essential for enhancing competitiveness across dimensions. The study finds that the interaction between education and innovation has complex effects on urban competitiveness. To promote knowledge flow and technology transfer, an industry-academia-research-application collaborative system should be established. This system would help align vocational education with industrial demands, optimize innovation resource allocation in the East, and foster cross-regional cooperation to address the challenges of diminishing returns on R&D investments.

7.3 Limitations and Future Directions

This study has several limitations that must be addressed in future research. Firstly, the focus on economic dimension indicators limits the full consideration of social, cultural, and environmental factors. A more comprehensive indicator system that includes these dimensions is needed to capture the full scope of urban competitiveness. Secondly, the proxy variables used in this study, such as urban development term frequency, may not fully reflect the multidimensional nature of competitiveness. Future research should explore more precise metrics and combine quantitative and qualitative methods to provide a more nuanced analysis.

Additionally, the study's regional classification is relatively broad, failing to capture intra-provincial variations. Future research should adopt a more refined regional classification system that accounts for economic structure, development stage, and local characteristics. Furthermore, exploring the mobility of labor, capital, and knowledge across regions and analyzing spillover effects would provide deeper insights into the interconnectedness of regional economies.

Future studies should also focus on developing a dynamic model to assess the long-term effects of educational investments, differentiating the impacts across primary, secondary, and tertiary education levels. Longitudinal tracking studies are necessary to capture the evolving impact of education spending and institutional reforms, providing

valuable insights for policy adjustments. Cross-national comparative research could further validate the findings, identifying universal principles and local variations in urban development strategies.

Research into institutional innovation should be expanded to include both formal and informal institutions, focusing on the path-dependent nature of institutional change and the role of social norms. Developing more robust quantitative methods for assessing institutional innovation would allow for clearer insights into their impact on urban development. Future research should also consider cross-regional and cross-institutional comparative studies to assess how different contexts influence institutional innovation processes.

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