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Does the Development of New-Quality Productive Forces Promote Regional Cultural "Literacy"? — Evidence from the Equalization of Primary Education in Urban and Rural China

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Abstract. New-quality productive forces, driven primarily by technological innovation, optimize the allocation of educational resources through digital means, thereby advancing the equalization of education between urban and rural areas. This research demonstrates that the development of new-quality productive forces significantly narrows the gap in primary school advancement rates between urban and rural areas, particularly when controlling for variables such as digital infrastructure. The findings also reveal a significant lag effect, with the most pronounced impact observed in the first lag period. Robustness tests further confirm that the positive effect of developing new-quality productive forces on reducing urban-rural educational disparities is both stable and significant, highlighting its critical role in addressing educational inequality. To maximize these benefits, efforts should focus on cultivating new-quality productive forces, optimizing digital infrastructure, fostering innovation in educational technology, and implementing targeted, region-specific policies. Promoting balanced resource sharing and establishing comprehensive evaluation and adjustment mechanisms are also crucial to ensuring the long-term effectiveness of these efforts. These measures collectively contribute to achieving regional cultural "literacy."

Keywords: new-quality productive forces, urban-rural educational equalization, educational disparity, digital infrastructure

1. Introduction

In the era of rapid advancements in information technology, digital education has become a vital means of driving educational modernization and achieving educational equity. In recent years, the Chinese government has prioritized the development of digital education, formulating and implementing a series of policies to accelerate the digital transformation of education, thereby promoting the equalization of urban and rural education.

New productivity, characterized by technological innovation as its core driving force, represents an advanced form of productivity that deeply integrates cutting-edge technologies such as big data, artificial intelligence, cloud computing, and the Internet of Things. Through digital means, new productivity intervenes in the educational domain, optimizing the allocation of educational resources. Closely linked with the advancement of digital education, it breaks the geographical constraints of traditional education models, making educational services more personalized and precise. To some extent, it also alleviates the imbalance in educational development between urban and rural areas. However, issues of unequal distribution of educational resources between urban and rural regions persist, hindering the realization of educational equity and restricting the socio-economic development of these areas. Against this backdrop, how to leverage new productivity to promote the equalization of urban and rural education has become an urgent issue in the field of education.

This study aims to deeply analyze the impact mechanism of new productivity on the equalization of urban and rural education, exploring how the development of new productivity and the digital economy can facilitate the equitable distribution of educational resources, enhance educational quality, and achieve educational fairness. By reviewing existing literature and conducting empirical research, this paper reveals the current application status of new productivity in education, evaluates its potential impact on educational equalization, and proposes relevant policy recommendations.

2. Theoretical Foundation and Hypothesis

2.1. Educational Resource Allocation and Innovation-Driven Development

The theory of an information society suggests that the development of information technology reshapes social structures and organizational practices, including those in education. Advancing new productivity, particularly through the application of digital educational technologies, fosters a shift from traditional teaching methods to approaches that are more open, flexible, and inclusive, thereby reducing disparities in educational resources between urban and rural areas. The Strategic Action Plan for Promoting Digital Education explicitly highlights the goal of leveraging new technologies to promote educational equity and balanced development. Additionally, the 20th National Congress of the Communist Party of China emphasized that "science and technology are the primary productive forces, talent is the primary resource, and innovation is the primary driver," providing theoretical and policy support for applying new productivity in the education sector.

Educational resource allocation is a complex and critical social issue directly tied to the quality and equity of education. Urban-rural disparities have been a persistent challenge in this context. Traditional allocation models, often influenced by geographical and economic factors, have led to imbalances in educational resources between urban and rural areas. Since the 1990s, China has sought to bridge these gaps by promoting information technology in education and implementing various policies and initiatives, such as the Education Informatization 2.0 Action Plan, the 14th Five-Year National Informatization Plan, and rural distance education programs, to enable students in remote areas to access quality resources. However, the uneven development of educational informatization has created a new cycle of urban-rural educational disparities.

Global trends in educational digital transformation emphasize the role of digital technology in reducing the digital divide, empowering students, promoting educational equity, and enhancing quality. As early as the early 21st century, studies proposed that multi-criteria decision analysis and the development of interactive computer-based decision support systems could better address the complexity of educational resource allocation, maximizing efficiency under limited resources. [1]

In the digital age, it is imperative to leverage digital technology to bridge urban-rural education gaps in resource allocation and technology application, ensuring the widespread accessibility and equity of educational resources. New productivity, characterized by innovation-driven development and high technology, efficiency, and quality, represents an advanced state of productivity that integrates innovation, knowledge, information, and technology. It signifies the transformation and upgrading of traditional productivity, providing a solid material foundation and technical support for educational digital transformation. New productivity plays a crucial role in fostering a more equitable, efficient, and sustainable educational environment and advancing social progress.

Thanks to the rapid development of new productivity, emerging technologies such as cloud computing and big data provide robust support for educational digital transformation. Furthermore, new productivity demands a shift in education from merely transmitting knowledge to cultivating students' innovative thinking and practical abilities. The education sector must gradually adapt to technological changes, fully leveraging new technologies to drive innovation in educational methods. Digital education platforms allow urban and rural schools to access cutting-edge data resources and rich teaching material libraries. On this foundation, integrating innovative technologies such as artificial intelligence into teaching software and curriculum content facilitates deep learning opportunities for students. Additionally, the promotion of new educational technologies strengthens collaboration and exchanges between urban and rural teachers. These advancements contribute to narrowing urban-rural educational disparities and fostering educational equity. The interdependencies among decision-making processes at various resource allocation levels also warrant attention. [2] New technologies can be employed to deeply understand and evaluate the specific impact of decisions in one domain on other domains, enabling the efficient utilization of educational resources. Based on the above analysis, the following hypothesis is proposed:

Hypothesis 1: The development of new productivity contributes to fostering urban-rural educational equity.

2.2. New Productivity and Educational Technology

The development of new productivity drives the educational system to gradually transition towards digitalization and intelligentization across various dimensions, including teaching methods, management models, learning resources, and evaluation systems, thereby accelerating the modernization and reform of the educational system. This transformation enhances educational quality and promotes the realization of educational equity. The educational equity fostered by new productivity is not a short-term effect but a sustainable, long-term impact. With technological advancements, the balanced allocation of educational resources and the provision of personalized education will become more stable and enduring. A study based on panel data from 30 Chinese provinces from 2009 to 2019 found a "U-shaped" relationship between digital economic development and urban-rural income disparities—narrowing disparities in the initial stages but potentially widening them in later stages. Therefore, it is necessary to adopt differentiated policies to address urban-rural educational disparities during various phases of digital economic development. The study also revealed that pilot projects such as "Broadband for Rural Areas" have positively contributed to narrowing urban-rural income disparities. Similarly, governments can implement pilot education policies to enable the digital economy to facilitate the equitable distribution of educational resources and reduce urban-rural educational disparities. [3]

The impact of new productivity on educational equity is not merely an immediate improvement but also a guarantee for sustainable development in the future. Through technological innovation, it gradually drives the reform and digital transformation of educational policy systems, laying the foundation for comprehensive and enduring educational equity. Based on this analysis, the following hypothesis is proposed:

Hypothesis 2: The impact of new productivity on educational equity is sustainable.

3. Research Design and Variable Selection

In this study, data on the urban-rural enrollment gap (RUG) were obtained from the China Educational Statistics Yearbook. This metric encompasses the enrollment rates of primary schools in rural and urban areas. Data for the new productivity index (NQPI) were sourced from the China Statistical Yearbook. Indicators related to the digital economy, including digital infrastructure, industrial digitalization, digital industrialization, new economic models, and the global digital economy development index (TIMG), were derived from the China Digital Economy Development Research Report. All data span the period from 2013 to 2022. Among these digital economy indicators, the study selected representative indicators closely related to urban-rural educational disparities for in-depth analysis. These include digital infrastructure (DI), digital industrialization (IOD), industrial digitalization (ID), and digital innovation capability (DIC).

As education is closely linked to economic development, the advancement of the digital economy can help reduce urban-rural income disparities. This influence exhibits regional heterogeneity, while new productivity can break geographical barriers, optimize the allocation of educational resources, and enhance educational quality. Controlling for the digital economy as a variable facilitates a more accurate assessment of the specific impact of new productivity on urban-rural educational equity.

To further elucidate the influence of new productivity on urban-rural educational equity, the study employs the new productivity index (NQPI) as the explanatory variable, the urban-rural enrollment gap (RUG)—represented by $\mathrm{RUG}_{i,t}$, and $\mathrm{RUEG}_{i,t}$ — as the primary dependent variable, and the digital economy indicators (DI, IOD, ID, and DIC) as control variables.

4. Empirical Process and Results Analysis

4.1. Descriptive Statistics

Table 1. Descriptive Statistics of Variables

Variable	Min	Max	Mean	SD
Urban-Rural Enrollment Gap (RUG)	0.1839	1.0455	0.5804	0.1636
New Productivity Index (NQPI)	0.1080	0.7190	0.2338	0.0999
Digital Infrastructure (DI)	-2.1733	7.0931		1.7610
Digital Industrialization (IOD)	-1.6331	10.2844		2.0698
Industrial Digitalization (ID)	-2.7361	6.1472		1.4565
Digital Innovation Capability (DIC)	-1.4811	10.7884		2.0113

The descriptive statistics reveal that the urban-rural enrollment gap (RUG) has a mean of 0.5804, indicating a significant disparity in enrollment rates between urban and rural areas. The standard deviation of 0.1636 reflects that this disparity is relatively concentrated across different regions. The mean of the new productivity index (NQPI) is 0.2338 with a standard deviation of 0.0999, suggesting that the current level of new productivity is relatively low and uniformly distributed. For digital infrastructure (DI), the mean value of 1.7610 shows a positive average level of infrastructure development, but the negative minimum value suggests that certain regions lag significantly. The mean of digital industrialization (IOD) is 2.0698, reflecting positive progress in this area, although the negative minimum value highlights regional disparities. Industrial digitalization (ID) has a mean of 1.4565, indicating a generally positive trend in digital transformation, but the minimum value of -2.7361 points to significant differences between regions. The mean of digital innovation capability (DIC) is 2.0113, with a maximum value of 10.7884, showing remarkable advancements in some regions, despite disparities. These statistics illustrate both the gaps and potential opportunities for development in various regions.

4.2. Baseline Regression Analysis

Table 2. Does the Development of New Productivity Narrow the Urban-Rural Enrollment Gap in Primary Schools?

	(1)	(2)
	Urban-Rural Enrollment Gap	Urban-Rural Enrollment Gap
New Productivity Index	0.0835 (0.1639)	-0.9582*** (0.2060)
Internet Access Ports		0.0831 (0.0594)
Number of Domains		-0.0377*** (0.0125)
Mobile Base Station Density		0.0248*** (0.0034)
Mobile Phone Penetration Rate		-0.1323 (0.0933)
Province Fixed Effects	√	√
Year Fixed Effects	√	√
R^2	0.2460	0.1905
N	300	300

*Note: *p < 0.1, **p < 0.05, **p < 0.01

In Model (1), the coefficient for the new productivity index is 0.0835, indicating that when considered alone, the index does not show a statistically significant impact on narrowing the urban-rural enrollment gap. In Model (2), after including control variables such as internet access ports, the number of domains, mobile base station density, and mobile phone penetration rate, the coefficient for the new productivity index becomes -0.9582 and is statistically significant at the 1% level ($p < 0.01$). This indicates that, after accounting for digital infrastructure-related variables, improvements in the new productivity index have a significant negative effect on the urban-rural enrollment gap, meaning that the development of new productivity effectively reduces educational disparities between urban and rural areas.

Analyzing the control variables:

The number of domains has a coefficient of -0.0377, significant at the 1% level ($p < 0.01$), suggesting that an increase in the number of domains helps narrow the urban-rural enrollment gap, likely due to improved accessibility to educational resources through internet proliferation. The mobile base station density coefficient is 0.0248, significant at the 1% level ($p < 0.01$), indicating that higher base station density tends to widen the gap, possibly because base stations are concentrated in economically developed areas, further strengthening urban advantages. Internet access ports show a positive but insignificant coefficient, while mobile phone penetration rate displays a negative but insignificant coefficient, suggesting that their effects on the enrollment gap may be less stable than expected.

From the model fit perspective, Model (1) has an R^2 of 0.2460, while Model (2) has an R^2 of 0.1905. Although the explanatory power of the model decreases slightly after adding more digital infrastructure-related variables, the effect of the new productivity index becomes significant, indicating that its impact on reducing the urban-rural enrollment gap becomes more evident when controlling for digital infrastructure factors.

Thus, Hypothesis 1 is confirmed.

4.3. Lag Period Test

Table 3. Lagged Effects of New Productivity Development on the Urban-Rural Enrollment Gap

Variable	(1)	(2)	(3)
	RUG	RUG	RUG
L1.NQPI	-0.8651*** (0.2266)		
L2.NQPI		-0.4838* (0.2734)	
L3.NQPI			-0.6499* (0.3307)
Control Variables	√	√	√

Table 3. (continued).

Fixed Province	√	√	√
Fixed Year	√	√	√
R2	0.2260	0.1931	0.2087
N	270	240	210

*Note: *p < 0.1, **p < 0.05, **p < 0.01

Table 4 presents the lagged effects of the new productivity index (NQPI) on the urban-rural enrollment gap (RUG). The results demonstrate that the development of new productivity exhibits significant lagged effects on reducing the urban-rural enrollment gap, but these effects vary across different lag periods.

In Lag 1 (L1.NQPI), the regression coefficient is -0.8651 and is statistically significant at the 1% level ($p < 0.01$). This indicates that the development of new productivity has the most pronounced impact on narrowing the enrollment gap within one year, suggesting that through resource allocation, technology dissemination, and policy implementation, new productivity can quickly enhance educational equity in the short term.

In Lag 2 (L2.NQPI), the regression coefficient is -0.4838, significant at the 10% level ($p < 0.1$), showing that the impact of new productivity persists into the second year but is weaker compared to the first lag. This could be attributed to diminishing marginal effects or external factors influencing the transformation of resources and policies.

In Lag 3 (L3.NQPI), the regression coefficient is -0.6499, also significant at the 10% level ($p < 0.1$). While the effect rebounds compared to the second lag, it remains lower than in the first lag, indicating that the influence of new productivity on the enrollment gap has some sustainability but may be affected by factors such as policy enforcement, economic restructuring, and resource distribution over the long term.

From the model fit (R^2), the first lag shows an R^2 of 0.2260, which decreases to 0.1931 in the second lag but increases to 0.2087 in the third lag. These results indicate that the impact of new productivity is most significant in the short term, diminishes over time, but retains a positive influence in the long run. Therefore, Hypothesis 2 is confirmed.

4.4. Robustness Test

Table 4. Instrumental Variable and Alternative Dependent Variable Regression Analysis Results

Variable	(1)	(2)	(3)
	NQPI	RUG	Urban-Rural Graduation Gap
Internet Users	0.0089*** (0.0116)		
NQPI		-1.2378*** (0.2764)	-0.0945*** (0.2141)
Control Variables	Yes	Yes	Yes
Fixed Province/Year	Yes	Yes	Yes
Obs	300	300	300

Table 4 examines robustness through an instrumental variable approach and alternative dependent variable analysis. The results indicate that the impact of new productivity development on urban-rural educational disparities is robust and significant.

In Model (1), the coefficient for Internet Users is 0.0089 and significant at the 1% level ($p < 0.01$), suggesting that internet proliferation facilitates the development of new productivity. This validates the reasonableness of using internet users as an instrumental variable, as it is highly correlated with the development of new productivity but has a weaker direct impact on urban-rural educational disparities. In Model (2), the coefficient for NQPI is -1.2378, significant at the 1% level ($p < 0.01$), indicating that the development of new productivity significantly reduces the urban-rural enrollment gap. This effect remains significant even with the inclusion of instrumental variables, confirming the robustness and reliability of the results. In Model (3), the dependent variable is replaced with the urban-rural graduation gap. The regression coefficient for NQPI is -0.0945, also significant at the 1% level ($p < 0.01$), demonstrating that new productivity development significantly reduces the graduation gap, further validating its broad impact on promoting educational equity. These findings confirm the reliability of the conclusion that new productivity development plays a vital role in reducing urban-rural educational disparities.

5. Conclusion and Policy Implications

5.1. Main Findings

This study examines data on urban-rural educational disparities, the development of new productivity, and the digital economy in 31 Chinese provinces from 2013 to 2022 to verify the impact of new productivity on the equalization of urban-rural education. Through baseline regression analysis, lag effect tests, and robustness checks, the following conclusions were drawn:

Baseline Regression Results

Initial models show that the development of new productivity does not exhibit a significant impact. However, after incorporating control variables such as digital infrastructure, it significantly promotes the reduction of the urban-rural primary school enrollment gap. This suggests that the development of new productivity needs to be combined with the optimization of digital infrastructure to effectively improve the equalization of urban-rural education. Additionally, internet-related indicators, such as the number of domains, play an important role in narrowing the educational gap, while the influence of infrastructure elements like mobile base station density requires further guidance to ensure equitable resource distribution.

Lag Effect Test Results

The lag effect test indicates that the development of new productivity has a significant delayed impact on narrowing the urban-rural enrollment gap, with the most pronounced effect occurring in the first lag period. This demonstrates that new productivity can effectively address urban-rural educational inequality in the short term. However, in the long term, further optimization of resource allocation and policy guidance is required to ensure the sustained effect of new productivity on reducing educational disparities and to consolidate its role in promoting educational equity.

Robustness Test Results

Robustness tests confirm that the development of new productivity significantly and reliably reduces urban-rural educational disparities. Both instrumental variable approaches and alternative dependent variables show consistent results, highlighting the critical role of new productivity in narrowing urban-rural educational inequality. These findings also indicate that the empirical analysis is highly reliable and explanatory, providing strong empirical support for promoting the development of new productivity to enhance educational equity and achieve regional “literacy.”

5.2. Policy Implications

5.2.1. Cultivate New Productivity to Promote Balanced Educational Development

The empirical results indicate that the development of new productivity significantly reduces urban-rural educational disparities, particularly when digital infrastructure variables are controlled. This suggests that enhancing new productivity can promote educational equity, but this process must be combined with optimizing digital infrastructure. Education is also key to developing new productivity, as it enhances human capital, fosters talent, and improves overall societal quality, ultimately increasing productivity. It is crucial to recognize the mutually reinforcing relationship between education and new productivity and leverage new productivity to drive systematic changes in educational concepts, goals, content, methods, systems, and governance. This approach will improve human capital and educational quality in rural areas.

Policy should focus on supporting the cultivation and development of new productivity, particularly in promoting balanced development between urban and rural areas to avoid exacerbating existing disparities. Emphasizing the enhancement of new productivity as a critical tool for advancing educational equity, policymakers should utilize technological innovation and digital transformation to improve the allocation and quality of educational resources. Priority should be given to improving digital infrastructure to provide high-quality educational resources in rural areas, narrowing the urban-rural education gap, and advancing educational equity.

5.2.2. Optimize Digital Infrastructure to Promote Balanced Resource Sharing

Regression results show that digital infrastructure significantly affects the urban-rural enrollment gap. When controlling for other variables, the role of new productivity becomes more pronounced. This indicates that, when developing digital infrastructure, it is vital to avoid excessive resource concentration that could lead to a "winner-takes-all" imbalance, ensuring that the benefits of digital transformation reach rural areas.

Policies should prioritize increasing investments in digital infrastructure, especially in rural areas. Optimizing internet access, mobile communication facilities, and remote education platforms can ensure that rural students have equal access to high-quality educational resources. Efforts should focus on improving the connectivity rates of rural primary and secondary schools and enhancing digital teaching levels. Strengthening the national public service system for digital educational resources will further bridge the urban-rural information gap and promote the equitable distribution and efficient utilization of educational resources.

5.2.3. Emphasize Educational Technology Innovation and Implement Targeted Differentiated Policies

The development of new productivity, particularly the innovation and application of educational technology, effectively narrows urban-rural educational disparities. Policies should actively promote the development of online education platforms, remote education systems, and similar technologies to enhance the personalization and efficiency of education. Differentiated educational policies should be implemented based on the varying levels of economic development in different regions, ensuring the precise allocation of educational resources. In economically underdeveloped areas, policies should prioritize increasing resource allocation and improving local educational infrastructure to enhance educational quality and reduce the urban-rural education gap. To address regional imbalances in economic and educational development, long-term educational development plans should be formulated. These plans should align with local needs to optimize resource allocation and gradually achieve educational equity.

5.2.4. Establish a Comprehensive Evaluation and Adjustment Mechanism to Ensure Policy Effectiveness

The lag effect test results show that the development of new productivity significantly improves the urban-rural enrollment gap, with the most pronounced effects occurring in the short term. To ensure the sustained effectiveness of policies, policymakers should establish a long-term monitoring and evaluation system to regularly assess policy outcomes and adjust measures as needed. Dynamic monitoring of the interaction between new productivity and educational equity should be conducted. Policies should be adjusted flexibly according to the specific circumstances of different regions to ensure they continue to promote urban-rural educational equity over the long term.

6. Research Limitations

Due to the limited explanatory power of the models used in this study, future research could explore additional factors that may influence urban-rural educational disparities, such as sociocultural factors and the effectiveness of policy implementation. More empirical studies are needed to validate these findings and investigate the mechanisms of influence under specific regional conditions.

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