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The Impact of Digital Economy Development on the Efficiency of Fiscal Expenditure — Based on Human Capital and Government Governance Capacity

Tianxiang Gao

College of Economics and Management, Southwest Petroleum University, Chengdu 610500, China

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***Corresponding Author:** Tianxiang Gao

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Abstract **Original Research Article**

Based on the dual perspectives of human capital and government governance capacity, this paper adopts panel data of 285 prefecture-level cities in China from 2010 to 2023. It constructs a comprehensive evaluation index system to measure the development level of the digital economy and empirically examines its influencing mechanism on fiscal expenditure efficiency. The results show that digital economy development significantly improves fiscal expenditure efficiency with prominent regional heterogeneity. For central and western regions, the empowering effect of the digital economy is mainly released by improving government governance, while eastern regions enhance efficiency through optimizing human capital allocation, both of which present significant positive moderating effects. Accordingly, this paper proposes implementing regionally differentiated strategies, improving digital governance and talent supply tailored to local conditions, and accelerating the construction of digital infrastructure and digital government to sustainably promote fiscal expenditure efficiency and empower high-quality economic development.

Keywords: Digital Economy Development, Fiscal Expenditure, Human Capital, Government Governance.

1. Introduction

As the foundation and core pillar of national governance, public finance undertakes essential functions in resource allocation, income distribution, and economic stability. The operational quality of public finance is crucial for high-quality socioeconomic development and national governance stability. The Third Plenary Session of the 20th Central Committee of the Communist Party of China has emphasized the improvement of a modern fiscal and taxation system adapted to high-quality development, providing a fundamental guideline for fiscal reform and efficiency enhancement. In the context of slowing economic growth, Chinese governments have continuously expanded fiscal expenditure to stabilize economic growth, adjust industrial structures, deepen institutional reforms, improve people's livelihoods, and prevent systemic risks, resulting in rigid expenditure growth. As the growth rate of fiscal expenditure consistently outpaces that of fiscal revenue, the fiscal deficit rate has risen year by year, imposing mounting fiscal pressure. Although optimizing expenditure structure can alleviate fiscal pressure to a certain extent, the excessive expansion and inefficient allocation of fiscal funds remain prominent obstacles to sustainable fiscal

development[1].

With the rapid iteration of digital technology, the digital economy has emerged as a core driving force for reshaping socioeconomic patterns and public governance, exerting a transformative impact on traditional fiscal and taxation systems [2]. Existing studies have verified that digital economic growth can boost regional economic development, expand tax sources, and increase fiscal revenue. By virtue of its flexibility and technological advantages, the digital economy facilitates technological innovation and knowledge accumulation, and restructures the modes of market transactions and public governance [3]. According to the 2023 Government Work Report, China's fiscal deficit rate has approached the international warning line, leaving limited room for debt expansion to ease fiscal constraints. In this context, improving fiscal expenditure efficiency through digital economic development has become a vital approach to alleviate fiscal pressure and resolve fiscal imbalances. Therefore, systematically exploring the influence and mechanism of the digital economy on fiscal expenditure efficiency is of great theoretical and practical significance for promoting sustainable fiscal operations and high-quality socioeconomic development.

Existing scholarship has extensively investigated the socio-economic effects of the digital economy, primarily focusing on economic growth and high-quality development [4][5][6], innovation and entrepreneurship[7][8], household consumption [9], efficiency and equity[10], and carbon emissions[11]. Against the backdrop of persistently strained local public finances, a growing number of scholars have begun to examine the impact of digital economy development on government public service performance and local fiscal conditions. Jiang Xiaojuan argues that the pervasive nature of the internet makes differentiated and personalized public service demands more easily identifiable, thereby effectively improving the quality of government public services [12]. Liu Ao and Zhang Shuanglong suggest that the digital economy can enhance government fiscal transparency through two pathways: increasing government willingness to disclose information and advancing technological progress [13]. Shangguan Zeming et al., as well as Hui Ning and Nan Ning, similarly conclude that digital development can effectively improve fiscal transparency, thereby contributing to higher-quality public services[14][15].

2. Theoretical Mechanism

2.1 Digital Economy and Fiscal Expenditure Efficiency

The rapid advancement of information technology has facilitated the in-depth integration of digital technology into economic operations and social governance, giving rise to new digital forms including digital trade, digital finance, digital government affairs, and digital security [16]. These emerging formats have reconstructed the operational logic of traditional economic activities, improved trade facilitation, and optimized total factor productivity through the market-oriented allocation of data factors. More importantly, the technological spillover effect of the digital economy has reshaped government governance models, providing new momentum for the improvement of fiscal resource allocation efficiency.The implementation of the "Internet + Government Services" strategy has institutionalized the integration of digital technology and public governance. Relying on cloud computing, blockchain and other underlying technologies, integrated cross-level and cross-departmental government service platforms have achieved multi-dimensional governance optimization. First, digital reconstruction of business procedures streamlines redundant administrative links and reduces institutional transaction costs. Second, big data realizes full-chain supervision of fiscal funds from budgeting and implementation to supervision, restraining moral hazards in fund allocation. Third, artificial intelligence-based governance tools identify gaps in public service supply and demand, optimizing the spatial allocation of transfer payments and reducing redundant government construction expenditures [17].Such efficiency improvement effects stem from two core characteristics of the digital economy. On the one hand, the increasing returns to scale of data elements elevate the marginal benefits of fiscal expenditure alongside data accumulation. On the other hand, algorithm-driven precise decision-making eliminates information

asymmetry and reduces errors in public service supply. Accordingly, this study proposes the core hypothesis:

H1: The development of the digital economy can significantly improve the efficiency of fiscal expenditure.

2.2 Digital Economy, Government Governance Capacity and Fiscal Expenditure Efficiency

The digital economy can significantly improve the efficiency of governmental public service governance through data integration, process optimization, and technological empowerment[18]. From the perspective of public goods supply theory, digital technologies break the constraints of traditional information processing. By adopting big data to accurately identify residents' demand preferences for public goods, digital technologies effectively alleviate the voting paradox, reduce information transaction costs, and improve the allocation efficiency of fiscal expenditure in fields such as public education and healthcare.Based on fiscal decentralization theory, digital sharing platforms eliminate governmental information silos and mitigate the mismatch of regional policy externalities. The digital twin-based economic monitoring system accurately captures economic cycle fluctuations, enabling governments to implement counter-cyclical regulation and optimize the structure of fiscal expenditure. Meanwhile, the multi-dimensional digital performance evaluation system strengthens result-oriented constraints on fiscal expenditure, forcing local governments to standardize budget formulation and implementation procedures.From the perspective of public choice theory, digital government affairs reduce the transaction costs of public participation in policy-making, prompting fiscal decisions to target the maximization of social welfare. The blockchain-based transparent budget mechanism effectively restrains rent-seeking behaviors, alleviates soft budget constraints, and improves the allocation efficiency of fiscal resources. In summary, by reshaping the information interaction mechanism among the government, market, and society and upgrading the government governance model, the digital economy facilitates the efficient and equitable allocation of fiscal expenditure. Accordingly, this study proposes the following hypothesis:

H2: Digital economy development improves fiscal expenditure efficiency by enhancing government governance capacity.

2.3 Digital Economy, Human Capital and Fiscal Expenditure Efficiency

Relying on emerging digital infrastructures such as online education platforms and virtual simulation laboratories, the digital economy breaks the temporal, spatial and disciplinary barriers of traditional education. It realizes the inclusive supply of high-quality knowledge resources at nearly zero marginal cost, effectively improving residents' knowledge accumulation and comprehensive literacy, and further optimizing the stock and quality of regional human capital. From the perspective of public choice theory, groups with higher human capital can scientifically evaluate the effectiveness of fiscal policies based on cost-benefit logic and participate in public governance through digital government platforms, forming effective external supervision that forces local governments to optimize fiscal expenditure structure. By constructing the transmission path of "digital empowerment of education—human capital improvement—governance efficiency optimization", the digital economy improves the Coase efficiency and Pareto optimality of fiscal resource allocation, and achieves the coordinated improvement of government governance and fiscal fund utilization efficiency. Accordingly, the hypothesis is proposed as follows:

H3: The development of the digital economy improves fiscal expenditure efficiency by enhancing human capital and government governance capacity.

3. Empirical Model and Data Sources

3.1 Model Settings

1) Benchmark model

$$Y_{it} = \alpha_0 + \alpha_1 Dig_{it} + \sum \alpha_2 Con_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (1)$$

Yit stands for fiscal expenditure efficiency; α0 is the intercept term, and α1represents the influence

coefficient of digital economy development on fiscal expenditure efficiency. If α1>0, the digital economy helps improve fiscal expenditure efficiency; otherwise, it exerts a negative effect. Digitit refers to the development level of the digital economy, and Conitdenotes control variables. μiis the individual effect, νtis the time effect, and εitis the random error term. Subscripts i and t represent provinces and periods respectively.

2) Moderating Effect Model

To further explore the influencing mechanism of the digital economy on fiscal expenditure efficiency, this paper extends the benchmark Model (1). We introduce the interaction terms between the digital economy and human capital, between the digital economy and government governance capacity, as well as the three-way interaction among the above three variables, so as to further analyze the impact of digital economy development on fiscal expenditure. The specific models are presented as follows:

$$Y_{it}=\alpha_0+\alpha_1 Dig_{it}+\alpha_2 aedu_{it}+\alpha_3 Dig_{it}\times aedu_{it}+\sum\alpha_j Con_{it}+\mu_i+\nu_t+\varepsilon_{it} \quad (2)$$

$$Y_{it}=\alpha_0+\alpha_1 Dig_{it}+\alpha_2 Gov_{it}+\alpha_3 Dig_{it}\times Gov_{it}+\sum\alpha_j Con_{it}+\mu_i+\nu_t+\varepsilon_{it} \quad (3)$$

$$Y_{it}=\alpha_0+\alpha_1 Dig_{it}+\alpha_2 aedu_{it}+\alpha_3 gov_{it}+\alpha_4 Dig_{it}\times aedu_{it}\times gov_{it}+\sum\alpha_j Con_{it}+\mu_i+\nu_t+\varepsilon_{it} \quad (4)$$

In Model (2), $Dig_{it}\times aedu_{it}$ denotes the product of digital economy development and human capital. In Model (3), $Dig_{it}\times Gov_{it}$ refers to the product of digital economy development and government governance capacity. The interaction term in Model (4) $Dig_{it}\times aedu_{it}\times gov_{it}$ represents the three-way interaction among digital economy development, human capital and government governance capacity. The coefficient corresponding to each interaction term captures the joint moderating effect of the relevant variables.

3.2 Variable Definition and Description

1) Explained Variable:Fiscal expenditure efficiency is measured by the ratio of urban fiscal expenditure to regional GDP in this study.

2) Explanatory Variable: The core explanatory variable is the digital economy development index. Referring to the research frameworks of Zhao et al. (2020) and Zhang et al. (2017), this study constructs a comprehensive digital economy indicator system covering five dimensions: internet penetration rate, internet-related employees, internet-related output, mobile internet users, and inclusive digital finance development. The entropy method is adopted to calculate the comprehensive digital economy development level. See Figure 1 for the indicator system framework.

Figure 1

First-level Indicator	Second-level Indicator	Third-level Indicator	Indicator Attribute
Comprehensive Development Index	Internet Penetration Rate	Number of Internet Users per 100 People	+

of Digital Economy	Number of Internet-related Employees	Proportion of Employees in Computer Services and Software Industry	+
	Internet-related Output	Per Capita Total Telecommunications Business Volume	+
	Number of Mobile Internet Users	Number of Mobile Phone Users per 100 People	+
	Inclusive Development of Digital Finance	China Digital Inclusive Finance Index	+

3)Control Variables:Six control variables are selected in this study, including economic development level, fiscal decentralization, population size, urbanization level, opening-up degree, and educational expenditure. Specifically, economic development level is represented by the logarithm of per capita regional GDP; fiscal decentralization is measured by the ratio of general fiscal revenue to general fiscal expenditure; population size is denoted by the logarithm of registered population; urbanization level is defined as the ratio of non-agricultural population to registered population; opening-up degree is measured by the proportion of actually utilized foreign capital in regional GDP; educational expenditure is represented by the ratio of educational expenditure to general public fiscal expenditure.

4.)Mechanism Variables:Human capital and government governance capacity are adopted as mechanism variables. Human capital is measured by the logarithm of urban average years of schooling. Government governance capacity is represented by the logarithm of the ratio of regional GDP to general public budget fiscal expenditure.

5. Data Sources

This study employs panel data of 285 prefecture-level cities in China from 2010 to 2023 as the research sample. Cities in Inner Mongolia with severe data missing and samples from Hong Kong, Macao and Taiwan are excluded. The primary data are collected from the China Urban Statistical Yearbook, Peking University Digital Inclusive Finance Index, and statistical yearbooks of corresponding provinces and prefecture-level cities. The descriptive statistics of all core variables are presented in Table 1.

Table 1 Descriptive Statistics of Main Variables

VARIABLES	Observations	Mean	Std. Dev.	Min	Max
Fiscal expenditure efficiency	3962	0.296	0.149	0.0536	1.652
Digital economy development index	3960	0.0608	0.0795	0	0.940
Economic development level	3962	2.597	1.249	0.588	21.30

VARIABLES	Observations	Mean	Std. Dev.	Min	Max
Fiscal decentralization	3962	0.200	0.101	0.0439	0.916
Population size	3962	5.891	0.699	2.970	8.136
Urbanization level	3962	0.397	0.213	0.0750	1
Opening-up level	3962	0.00242	0.00267	0	0.0294
Educational expenditure	3962	0.175	0.0391	0.0146	0.356
Human capital	3962	2.216	0.0875	1.879	2.514
Government governance capacity	3962	1.320	0.439	-0.502	2.927
Number of cities	283	283	283	283	283

4. Analysis of Empirical Test Results

4.1 Benchmark Regression

The empirical results (Table 2) show that digitalization (digi) has a significant positive impact on fiscal expenditure efficiency (y). Specifically, for every 1 unit increase in the degree of digitalization, fiscal expenditure efficiency will significantly rise by 0.0251 units. This effect is statistically significant at the 5% level, indicating that the development of the digital economy has significantly improved the efficiency of government fiscal expenditure, thus verifying the research hypothesis H1.

4.2 Robustness Tests

To eliminate the bias exerted by special municipalities directly under the Central Government and extreme outliers on the benchmark regression results, this paper excludes municipal samples and applies winsorization to the dataset. The processed regression outputs are presented in Table 2. The coefficient of the digital economy development index remains significantly positive, which verifies the robustness of the benchmark regression findings.

After dropping samples of municipalities directly under the Central Government, the coefficient on digitalization (digi) stands at 0.0317*** and is statistically significant at the 1% level, which proves that the positive impact of digitalization on fiscal expenditure efficiency still holds robustly. After winsorizing extreme values, the coefficient of digi equals 0.0346***, also significant at the 1% level. The two robustness strategies—removing municipality samples and winsorization—jointly confirm that the positive effect of the digital economy on fiscal expenditure efficiency is robust.

4.3 Moderating Mechanism Analysis

To further explore how human capital and urban governmental governance capacity shape fiscal expenditure efficiency, this paper constructs two-way interaction terms between the digital economy index and human capital, between the digital economy index and urban governance capacity, as well as a three-way interaction term of the three variables. The moderating effects of human capital and urban governmental governance capacity are analyzed, with regression results shown in Table 3.

The impact of digital development (digi) on fiscal expenditure efficiency is significantly moderated by governmental governance level (gov) and average years of schooling (aedu). The coefficient of the interaction term digi×gov is significantly positive, indicating that governmental governance level positively moderates the relationship between

digitalization and fiscal expenditure efficiency. In other words, cities with stronger governance capacity witness a more pronounced facilitating effect of digitalization. The coefficient of digi×aedu is 0.0221, revealing that human capital exerts a positive promoting effect on fiscal expenditure efficiency. The three-way interaction term digi×gov×aedu carries a significantly positive coefficient, which suggests that the coexistence of high-quality governmental governance and abundant human capital can greatly amplify the improvement effect of digitalization on fiscal expenditure efficiency.

Table 2. Results of Benchmark Regression, Robustness Test Results, Moderating Mechanism Estimation

Variable	Fiscal Expenditure Efficiency	Excluding Municipalities	Winsorization	Fiscal Expenditure Efficiency		
	(1)	(2)	(3)	(4)	(5)	(6)
digi	0.0251**	0.0317***	0.0346***	-0.267***	0.592**	-0.174***
	-0.0113	-0.0123	-0.0131	-0.0282	-0.255	-0.0255
digi×gov				0.145***		
				-0.0176		
digi×aedu					0.0221	
					-0.00639	
digi×gov×aedu						0.0845***
						-0.0016
Control Variables	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
City Fixed Effects	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Time Fixed Effects	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Observations	3997	3904	3960	3960	3960	3960
Number of city_id	286	279	283	283	283	283
R-squared	0.072	0.618	0.616	0.834	0.617	0.833

Note: *, **, *** indicate statistical significance at the 10%, 5%, and 1% test levels, respectively; the values in parentheses are heteroskedasticity-robust standard errors, the same applies below.

4.4 Heterogeneity Analysis

This paper divides the full sample into three subgroups: the Eastern region, Central region and Western region, and conducts grouped regressions to carry out heterogeneity analysis. The estimation results are reported in Table 3.

The coefficients on the interaction term between digital economy development and human capital are significantly positive for the Eastern region sample, while the coefficients on the interaction term of digital economy and governmental governance capacity are significantly positive for the Central and

Western region samples. These findings indicate that Central and Western regions with relatively underdeveloped economies need to increase investment in human capital to improve the efficiency of government fiscal expenditure. By contrast, Eastern regions with higher levels of economic development ought to enhance governmental governance capacity, so as to lift the efficiency of fiscal spending.

Table 3. Results of Heterogeneity Analysis

VARIABLES	(1) Eastern Region	(2) Central & Western Regions	(3) Eastern Region	(4) Central & Western Regions
digi	0.000742	0.305	-0.0112***	-0.495***
	-0.00518	-0.572	-0.00356	-0.0517
digi*gov			-0.00112	0.286***
			-0.00222	-0.0348
digi*aedu	0.0696***	-0.101		
	-0.00253	-0.249		
Control Variables	Controlled	Controlled	Controlled	Controlled
City Fixed Effects	Controlled	Controlled	Controlled	Controlled
Time Fixed Effects	Controlled	Controlled	Controlled	Controlled
Observations	1,204	2,756	1,204	2,756
Number of city_id	86	586	86	843
R-squared	0.882	0.197	0.944	0.197

Conclusions and Policy Recommendations

5.1Conclusions

This paper focuses on the impact of digital economy development on fiscal expenditure efficiency. Based on panel data covering 285 prefecture-level cities across China from 2010 to 2023, this study establishes an indicator system for the digital economy and adopts the entropy method to quantify the level of digital economic development. Further empirical analyses are conducted to explore the functional mechanism through which the digital economy acts on fiscal expenditure efficiency.

The research yields the following findings. First, the development of the digital economy can significantly improve fiscal expenditure efficiency. Moreover, such an impact presents obvious regional heterogeneity: central and western regions rely more on the improvement of governmental governance capacity to amplify the positive effects of digitalization, while eastern regions can further raise fiscal expenditure efficiency by optimizing the allocation of human capital. Second, both governmental governance capacity and human capital level exert significant moderating effects on the boosting impact of the digital economy. This indicates that during the digital transformation, coordinated improvements in governmental governance and human capital are required to maximize fiscal expenditure efficiency.

5.2 Policy Recommendations

1)Strengthen Government Governance Capacity and Optimize the Implementation Environment of Digitalization.Given the relatively backward development of the digital economy in central and western regions, local governments should prioritize

enhancing governance capacity in the initial stage of digital transformation. Specifically, authorities need to strengthen policy enforcement to guarantee the precise rollout and effective implementation of all digital economy policies. It is also essential to boost fiscal transparency, standardize the utilization of fiscal funds for digital construction, and ensure rational capital allocation. In addition, governments should launch digital management training programs to improve civil servants' digital literacy and technical capabilities. These measures help tackle adverse challenges emerging in the early digitalization phase, such as high technology adaptation costs and widening digital divides. By fully unlocking the synergistic effect of government governance and digitalization, central and western regions can achieve steady progress in digital economy development.

Eastern regions possess a sound foundation for digitalization. Local governments shall further streamline administrative service procedures to eliminate redundant investment in digital projects. They should concentrate on refined governance to raise digital implementation efficiency and realize high-level integration between digital technologies and governmental governance.

2)Enact Regionally Differentiated Policies and Support Matching Human Capital Development.Leveraging their advantage of high average educational attainment, eastern regions should actively develop an innovative talent cultivation model integrating digitalization and education to foster interdisciplinary professionals who meet the demands of digital economic growth, thereby improving the efficiency of technology adoption. To this end, deeper industry-university-research cooperation between universities and enterprises should be promoted through integrated platforms, aligning educational curricula closely with industrial demands. Local governments should vigorously develop digital-related majors and courses, update teaching materials, and incorporate cutting-edge digital knowledge and technologies. Meanwhile, enterprises should be encouraged to provide customized internal training, and exchanges of talent across firms should be facilitated to build a thriving ecosystem for digital professionals.

Central and western regions suffer from weaker educational foundations. Authorities must increase investment in basic education and digital skill training to compensate for the insufficient moderating role of human capital and prevent human resource shortages from constraining digital reforms. Governments can upgrade educational infrastructure to supply hardware support for digital teaching and deliver targeted digital skill training to lift residents' overall digital literacy. These actions will create solid human capital reserves to underpin digital transformation in central and western cities.

3)Advance the Implementation of Digital Economy Strategies and Accelerate the Construction of Digital Infrastructure.Against the backdrop of booming digital economy development, China must unswervingly push forward and reinforce its national digital economy strategy launched in 2015 to continuously unlock the enormous potential of digital industries. This strategy lays a foundational framework for the long-term growth of China's digital economy and requires further deepening and expansion based on current progress.

In terms of infrastructure construction, authorities should accelerate the nationwide rollout of 5G networks to build a high-speed, stable and secure internet environment that underpins all forms of digital economy applications. Simultaneously, greater investment should be directed toward information technology projects including big data and cloud computing, as well as cutting-edge initiatives centered on artificial intelligence. Technological innovations and breakthroughs derived from these projects will strengthen the core competitiveness of the domestic digital economy.

Policies such as smart city programs should be fully promoted and enforced. Guided by these policies, digital technologies can be deeply applied across urban planning, traffic administration, public services and other sectors to drive large-scale expansion of the digital economy.

Furthermore, the pace of digital infrastructure construction needs to be expedited via increased internet investment and incentives for social capital participation, creating a diversified investment landscape that fully taps the growth potential of the

digital economy. Efforts to build digital governments should be intensified to facilitate deep integration between digital technologies and public governance. Leveraging big data analytics, artificial intelligence and other digital tools, governments can deliver more scientific and precise policy decisions, streamline public service workflows and boost service efficiency. These steps will amplify the digital economy's improvement effect on fiscal expenditure efficiency and advance high-quality economic and social development.

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