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The Impact of Government Financial Support on Digital Economy: The Moderating Role of Industrial Structure

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Abstracts

This research explores how government financial support impacts the growth of the digital economy, emphasizing the influence of industrial structure as a moderating factor and the variation across different regions. Analyzing panel data from 30 Chinese provinces (2013–2022), the Two-Way Fixed Effects (TWFE) model demonstrates that government fiscal expenditures on science and technology significantly boost digital economic growth. Robustness tests confirm the reliability of these findings, and endogeneity issues are addressed by utilizing lagged government financial support as an instrumental variable. The analysis identifies regional disparities, with the eastern region demonstrating the most pronounced policy effects, followed by the central and western regions, reflecting variations in digital infrastructure and resource utilization. Furthermore, the moderating effect analysis underscores that a higher share of the tertiary sector strengthens the effectiveness of financial support, emphasizing the need for optimizing industrial structures. These findings provide valuable insights for promoting balanced and sustainable digital economic growth, addressing regional inequalities, and advancing a modern economic system.

Keywords: Government Financial Support, Industrial Structure, Digital Economy, Moderating Role.

Introduction

China's economy stands at a pivotal moment, transitioning from rapid expansion to a focus on high-quality development. On a global scale, economic uncertainties remain significant (United Nations Department of Economic and Social Affairs, 2023), while urbanization and

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industrial-driven growth models have reached their limits (Wu et al., 2020; Huang et al., 2023; Li et al., 2023). Challenges such as a shrinking demographic advantage (Zhao et al, 2024) and mounting resource and environmental pressures (Liu et al., 2024) further complicate this transition. To achieve high-quality development, China urgently requires fresh drivers of growth. Meanwhile, the ongoing technological revolution has positioned the digital economy as a key force propelling global economic progress. As the second-largest global economy, China has witnessed rapid expansion in its digital sector in recent years. Data from the 2023 White Paper on China's Digital Economy shows that by 2022, the sector had grown to RMB 50 trillion, contributing over 40 percent to GDP. In fields like e-commerce, artificial intelligence, and 5G, China not only holds a leading position globally but also serves as a vital catalyst for economic transformation and modernization.

In this context, the digital economy emerges as both a new engine for economic growth and a key strategy for steering China's economy toward high-quality development. Ensuring the sustained growth of the digital economy holds significant importance. To this end, the Chinese government has implemented various policies to accelerate its development. At the strategic level, the State Council's 14th Five-Year Plan for Digital Economy Development, released in 2022, targets core digital industries contributing 10% to GDP by 2025. On a regional scale, provincial governments have crafted their own plans based on local economic conditions and industrial strengths. For instance, Guangdong, a leading province in China's economy, outlines in its Digital Economy Development Plan (2021-2025) that by 2025, the core digital industries should generate over RMB 5 trillion in value, representing 25% of the province's GDP. Against this backdrop, this paper investigates how government initiatives influence the growth of the digital economy.

The relationship between government support and digital economy development remains unclear. Current research primarily focuses on measuring the digital economy's scale and scope (Brynjolfsson & Collis, 2019; Oloyede et al., 2023) or assessing its influence on green productivity (Liu et al., 2024; Deng et al., 2022). Some scholars analyze how the digital economy shapes employment patterns (Zhao & Said, 2023) or drives economic growth with higher quality (Zhang et al, 2021; Ding et al, 2021; Ma et al, 2022). Other studies evaluate the effects of fiscal measures like tax cuts (Li & Yang, 2021) or fintech investment strategies (Zhang et al., 2022) in fostering digital transformation. Limited attention, however, has been directed toward understanding how government policies promote innovation within digital enterprises and industries. Deng et al (2021) shows that R&D subsidies from the government significantly enhance innovation activities in digital firms. Yu et al. (2021) highlights that government support and industry entry regulations strongly influence patenting activities and invention rates in digital industries. In contrast, tax benefits and credit access have shown weaker impacts on advancing innovation in this sector. Gaps remain in understanding how government support operates across different regions and how industrial structure shapes its influence on the digital economy's development.

This study makes several significant contributions. First, it develops a thorough theoretical framework to explore how government support influences digital economy development across multiple dimensions, offering empirical insights into both direct impacts and underlying mechanisms at the provincial scale. Second, it adopts a geographical perspective by dividing provinces into eastern, central, and western regions, enabling an analysis of the varied effects of government support and highlighting regional differences, which provides

valuable guidance for achieving balanced regional growth. Finally, the study uses the instrumental variable approach to resolve potential endogeneity issues in the relationship between government support and digital economy development, enhancing the precision and credibility of the results.

This paper is organized as follows: Section 2 provides a theoretical analysis and formulates the research hypotheses, constructing the theoretical framework and explaining the mechanisms by which government financial support stimulates digital economic growth. Sections 3 and 4 focus on model design, parameter estimation, model validation, and the presentation of analytical results. Finally, Section 5 summarizes the key findings and offers policy recommendations.

Theoretical Analysis and Research Hypotheses

Government Financial Support and the Digital Economy

Government financial support refers to policy-driven interventions aimed at fostering emerging or strategic industries through targeted fiscal investments (Liang& Li, 2023). This support seeks to optimize resource allocation and mitigate market failures, particularly during the nascent stages of digital economic development, when substantial infrastructure investment is essential (Wang & Zhang, 2022). The digital economy has become a pivotal driver of global economic growth, relying not only on market mechanisms but also on strategic governmental involvement in resource distribution, infrastructure development, and technological innovation. However, the development of the digital economy involves intricate and multifaceted processes, characterized by dynamic interactions among technological advancements, industrial integration, and data flows. This inherent complexity leads to considerable variability in the effectiveness of government financial support, shaped by factors such as regional economic conditions, industrial structures, and market environments.

Ongoing debates revolve around the efficiency and transmission mechanisms of government financial support, particularly concerning the ways in which fiscal expenditures on science and technology, industrial subsidies, and other policy measures can be optimized to maximize their impact on digital economic growth. Investigating the effects of government financial support on the development of the digital economy in China is thus essential. Such analysis not only helps to quantify the effectiveness of these policies and enhance resource allocation but also offers critical insights for evidence-based policymaking, enabling the design of more targeted and impactful strategies.

Research has extensively validated the role of government financial support in advancing digital infrastructure. Strategic investments in areas such as 5G networks, data centers, and smart city initiatives have been instrumental in accelerating the growth of the digital economy (Bing et al., 2024). These projects enhance regional competitiveness while fostering an environment that supports technological innovation and industrial upgrading. Additionally, measures like tax incentives, R&D subsidies, and venture capital funding have encouraged enterprises to embrace digital transformation and pursue technological breakthroughs. In advanced domains such as artificial intelligence, blockchain, and big data, government policies have offered both strategic direction and essential resources. These interventions have effectively mitigated innovation risks while significantly boosting the efficiency of technological progress (Gholipour et al., 2022).

Based on the above discussion, this paper proposes the following hypothesis:
Hypothesis 1: Government financial support has a significant positive impact on the development of the digital economy.

The Moderating Role of Industrial Structure in the Relationship between Government financial Support and the Digital Economy
Industrial structure, which refers to the organization and allocation of resources and production activities within an economy, plays a pivotal role in shaping the development of the digital economy (Zhang et al., 2022). As a key determinant of economic dynamism, industrial structure not only reflects the level of economic advancement but also influences the effectiveness with which fiscal policies and government financial support are absorbed and utilized. Multiple theoretical perspectives underpin the understanding of industrial structure's moderating role in the interplay between government financial support and the digital economy, offering valuable insights into this complex relationship.

Structural Economics Theory posits that an advanced industrial structure, characterized by the expansion of high-tech and knowledge-intensive industries, improves resource allocation efficiency and enhances technological absorption capacity. These attributes enable regions with more advanced industrial structures to fully capitalize on government fiscal expenditures, such as investments in infrastructure and innovation subsidies, thereby amplifying their impact on the digital economy. Conversely, regions dominated by traditional industries often experience limited policy effectiveness due to insufficient demand for digital technologies and weaker absorptive capacities (Chen et al., 2023).

Innovation-Driven Growth Theory further reinforces the moderating role of industrial structure by emphasizing the significance of high-tech industry clusters. Regions with dense concentrations of technology-intensive industries are better equipped to leverage government financial support, facilitating the rapid diffusion of technological innovation and fostering digital economic growth. For example, government investments in digital infrastructure, such as 5G networks and data centers, tend to generate higher returns in regions with strong technological foundations, whereas low-tech regions may struggle to realize comparable benefits (Zhao et al., 2022).

Policy Effectiveness Theory highlights the heterogeneity in the impact of government financial support across regions with differing levels of industrial development. Economically advanced regions with well-developed industrial structures are better positioned to transform fiscal expenditures into drivers of digital economic growth. In contrast, less developed regions with weaker industrial structures and limited innovation capacity may need to prioritize structural optimization to enhance the effectiveness of government financial support. This underscores the critical role of industrial structure in conditioning how government interventions translate into digital economic progress (Lei et al., 2024).

In summary, industrial structure serves as a key moderator in the relationship between government financial support and the digital economy. By influencing the efficiency of fiscal expenditures on science and technology, industrial structure determines the extent to which government interventions can successfully promote digital transformation and economic growth. Regions with advanced and diversified industrial structures are more capable of

leveraging government financial support to foster digital innovation, whereas regions with less developed industrial foundations encounter greater difficulties in realizing comparable outcomes. Guided by these theoretical insights, the study proposes the following hypothesis:
Hypothesis 2: Industrial structure moderates the relationship between government financial support and the digital economy.

Research Methodology

Model Construction

To assess the direct impact of government financial support on digital economic development and explore how industrial structure moderates this relationship, this study defines the digital economy as the dependent variable, government financial support as the main explanatory variable, and industrial structure as the moderating variable. To ensure the robustness of the analysis, control variables related to digital economic development are also included. Building on the framework provided by Liang & Li (2023), the following models are formulated:

$$De_{i,t} = \beta_0 + \beta_1 Gs_{i,t} + \beta_2 Sc_{i,t} + \beta_3 Ow_{i,t} + \beta_4 Ti_{i,t} + \beta_5 Gdp_{i,t} + \mu_i + V_t + \varepsilon_{i,t} \quad (1)$$

$$De_{i,t} = \beta_0 + \beta_1 Gs_{i,t} + \beta_2 Sc_{i,t} + \beta_3 Ow_{i,t} + \beta_4 Ti_{i,t} + \beta_5 Gdp_{i,t} \beta_6 Is_{i,t} + \beta_7 Gs * Is_{i,t} \mu_i + V_t + \varepsilon_{i,t} (2)$$

In this model, Digital Economy (De) serves as the dependent variable. Government financial support (Gs), reflecting expenditures on science and technology by the government, acts as the key explanatory variable. Industrial structure (Is) functions as the moderating factor. Control variables include social consumption levels (Sc), openness to international markets (Ow), transport infrastructure development (Ti), and economic growth levels (Gdp). μ_i captures the fixed effects related to individual province. V_t represents fixed effects tied to specific years. $\varepsilon_{i,t}$ denotes the random error term accounting for unobserved influences.

Variable Descriptions

Independent Variable

Drawing on previous studies (Wei & Liu, 2015; Wang et al. 2015; Li & Yang, 2021; Wang & Zhang, 2022), this research measures the intensity of government financial support using the ratio of government science and technology expenditures to total local fiscal expenditures.

Dependent Variable

Building on earlier studies on the digital economy (Zhao et al., 2020; Guo et al., 2020; Wang et al., 2021), this research uses a composite indicator system combined with the entropy weight method to compute development indices for the digital economy across provinces. This methodology enables a thorough assessment of digital economy progress. Specifically, based on the connotations and practical context of the digital economy, four primary indicators are established: digital infrastructure, digital industrialization, digital technology application, and digital innovation environment. These indicators reflect the critical elements of digital economic development at the macro level. Each primary indicator is further broken down into ten secondary indicators. These include traditional infrastructure and new digital infrastructure to represent digital economy infrastructure, industrial scale to represent digital industrialization, enterprise digitalization and digital inclusiveness to reflect technology application, and research and development (R&D) levels and innovation capacity to capture the digital innovation environment. To ensure scientific rigor and hierarchy, while considering data availability, this study ultimately selects 23 variables to support the aforementioned

indicator system. The detailed selection of variables is shown in the table 1. By employing the entropy weight method to assign weights to these variables, this approach objectively reflects the comprehensive development level of the digital economy, avoiding potential biases associated with subjective human judgment.

Table1
Digital Economy Evaluation Indicator System

Dimensions	Sub-index	Basic indicators
Digital infrastructure	Internet penetration	Number of Internet broadband access ports
		Number of Internet broadband access users
		Number of Internet domain names
	Mobile phone penetration	Density of mobile phone base stations
		Mobile phone penetration rate
	Information transmission breadth	Length of long-distance optical cable per unit area
Digital industrialization	Software and information technology service industry	Ratio of software business revenue to GDP
		Number of employees in information transmission, software and information technology services
	Electronic information manufacturing industry development level	Ratio of information technology service revenue to GDP
		Ratio of total telecommunications business to GDP
		Total telecommunications business per capita
	Postal and telecommunications industry development level	Total postal business per capita
		Express delivery volume
		Enterprise e-commerce transaction volume
Industrial digitization/digital technology application	Enterprise digital development level	Proportion of enterprises with e-commerce transaction activities
		Number of computers used per 100 employees in an enterprise
		Number of websites owned by every 100 enterprises
	Digital inclusive finance	Digital inclusive finance index
Digital innovation capabilities	Research and experimental development level	Full-time equivalent of R&D personnel in industrial enterprises above designated size
		R&D expenditure of industrial enterprises above designated size
		Number of R&D projects (topics) of industrial enterprises above designated size
	Technological innovation capability	Total transaction amount of technical contracts
		Number of patent applications authorized

Moderating Variable

Shifts in industrial structure alter the relative contributions of the manufacturing and service sectors, influencing the growth of ICT and other digital industries, and subsequently shaping the trajectory of digital economic development. Adopting the approach outlined by Zhang et al. (2022), this study quantifies industrial structure using the ratio of the value added by the tertiary sector to that of the secondary sector in each province. This measure captures the

degree of transition toward a service-oriented economy and its implications for digital economic growth.

Control Variables

Based on the research of Kotler & Keller (2016); Brynjolfsson & McAfee (2014); Grossman & Helpman (1991); Gordon & Porter (1990); Chinn & Fairlie (2007); Aghion et al (2005); Liang & Li (2020); Magazzino & Mele (2020), the following control variables are incorporated into the model: **Social Consumption (Sc):** Measured as the ratio of total retail sales of consumer goods to GDP. **Degree of Openness:** Measured as the total value of imports and exports (converted using the USD to RMB exchange rate) divided by regional GDP. **Transport Infrastructure (Ti):** Measured as the logarithm of highway mileage. **Economic Development Level (Gdp):** Measured as the logarithm of nominal GDP. All variables are summarized in Table 2.

Table 2
Variable Summary

Variable	Name	Measurement
Independent Variable	Digital Economy(De)	Digital Economy Development Index
Dependent Variable	Government financial support (Gs)	Ratio of government expenditure on science and technology to local fiscal expenditure
Moderating variable	Industrial Structure (Is)	Tertiary sector output divided by secondary sector output
Control Variable	Social Consumption (Sc)	Total sales of consumer goods / GDP
	openness to the outside world (Ow)	(Total amount of import and export of goods*USD to RMB exchange rate)/Gross Regional Product
	Transport Infrastructure (Ti)	Logarithm of road mileage
	Economic Development (Gdp)	Nominal gdp in logarithmic terms

Data Sources

This research analyzes yearly panel data from 30 provinces in China covering the period from 2013 to 2022. Key data sources include the China Statistical Yearbook, China Industrial Statistical Yearbook, China Civil Affairs Statistical Yearbook, and various provincial statistical yearbooks. The Digital Inclusive Finance Index comes from the Digital Finance Research Center at Peking University. The dataset focuses on mainland China and excludes Tibet due to data limitations.

Result and Discussion

Descriptive Statistical Analysis

The descriptive statistical analysis reveals significant heterogeneity among regions in the sample, particularly regarding variables such as digital economic development (de), openness to the outside world (ow), and industrial structure (is). The digital economy shows substantial variability, with values ranging from 0.018 to 0.599, indicating that some regions are

significantly more advanced than others. Government financial support (gs) has an average of 0.022, with relatively low variation, though there are notable differences in support intensity within regions. Social consumption (sc) appears relatively concentrated, with values ranging from 0.18 to 0.504. However, openness to the outside world exhibits remarkable disparity, with a maximum value of 1.257 and a minimum of 0.008, highlighting substantial differences in openness levels across regions. Similarly, economic development (GDP) and transport infrastructure (ti) levels are relatively evenly distributed, suggesting a degree of balance in economic growth and infrastructure development. In contrast, the high standard deviation of industrial structure (is) indicates significant regional differences in the ratio of tertiary to secondary sector value added. These findings underscore the varying regional characteristics in government financial support, economic openness, and consumption levels, which are likely to influence digital economic devel opment. The observed disparities provide critical context for subsequent empirical analysis and policy recommendations.

Table3
Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
de	300	.127	.106	.018	.599
gs	300	.022	.015	.005	.068
sc	300	.391	.06	.18	.504
ow	300	.259	.256	.008	1.257
gdp	300	9.947	.881	7.446	11.768
ti	300	11.726	.852	9.444	12.913
is	300	1.417	.757	.67	5.28

The Impact of Government Financial Support on the Digital Economy

Regression results for OLS, RE, and TWFE models appear in the table below. The TWFE model emerges as the most appropriate based on the Hausman test, which produces a p-value under 0.001. Within the TWFE framework, government financial support (gs) yields a coefficient of 2.236, showing strong significance at the 1% level (t = 5.966). These outcomes clearly demonstrate that government financial support plays a pivotal role in enhancing digital economic development (DE). Specifically, an increase in government financial support corresponds to significant growth in the digital economy. Theoretically, this result is consistent with existing studies on the role of government financial support in economic development. Fiscal expenditures on science and technology allow governments to address market failures by compensating for insufficient private sector investments in areas with high risks or costs. Additionally, government financial support enhances resource allocation by directing funds toward critical infrastructure projects such as 5G networks, data centers, and digital platforms. Moreover, it serves as a catalyst for technological innovation by offering R&D subsidies, tax incentives, and venture capital, thereby mitigating the risks and costs associated with innovation and fostering sustained economic progress.

This empirical finding validates Hypothesis 1, affirming that government financial support is a crucial driver of digital economic growth. The results highlight the essential role of government intervention, especially in tackling the challenges associated with the early stages of digital economy development, where reliance on market forces alone may fall short of achieving optimal outcomes. Through strategic guidance and the provision of

targeted resources, government initiatives significantly improve the efficiency and inclusiveness of the digital economy, thereby fostering sustained economic transformation and technological innovation. These findings establish a robust foundation for further exploration of the moderating and heterogeneous effects of government financial support across different regional contexts.

Table 4
Effects of Government Financial Support on Digital Economy

	OLS	RE	TWFE
	de	de	de
gs	3.321***	2.791***	2.236***
	(8.978)	(6.579)	(5.966)
sc	-0.275***	-0.159***	0.126*
	(-4.907)	(-2.695)	(1.958)
ow	0.018	-0.217***	-0.254***
	(0.657)	(-7.618)	(-7.413)
gdp	0.060***	0.126***	0.061**
	(7.924)	(14.074)	(1.981)
ti	-0.017**	-0.088***	-0.228***
	(-2.152)	(-8.207)	(-7.309)
_cons	-0.236***	-0.041	2.121***
	(-4.208)	(-0.419)	(5.415)
N	300	300	300
R^2	0.753		0.799
F	179.531		72.595

***p<0.01, **p<0.05, *p<0.10

The influence of control variables on digital economic development demonstrates notable heterogeneity, offering deeper insights into the multifaceted nature of digital economy growth. First, social consumption (sc) reveals divergent effects across different models. In the OLS and RE models, sc exhibits a negative and significant impact on digital economic development, which may reflect the inertia of traditional consumption patterns hindering digital transformation. In these contexts, higher levels of social consumption tend to remain concentrated in conventional sectors, limiting the adoption and integration of digital technologies. However, in the TWFE model, the coefficient of sc turns positive and achieves significance at the 10% level (β = 0.126, t = 1.958). This shift suggests that over time, and with the proliferation of digital technologies, regions characterized by higher social consumption levels have progressively transitioned toward digital consumption models. This transformation includes the widespread adoption of e-commerce and online services, which play a critical role in boosting the performance and expansion of the digital economy.

Second, openness to the outside world (ow) exhibits a consistently negative relationship with digital economic development. While ow is positive but insignificant in the OLS model, it becomes significantly negative in both the RE and TWFE models (β = -0.254, t = -7.413 in the TWFE model). This finding suggests that in certain regions, heightened openness may expose local firms to external competitive pressures, thereby undermining their competitiveness in the digital economy. This adverse effect is likely more pronounced in regions with limited technological absorption capacity, where the potential benefits of openness, such as

technology transfer and innovation spillovers, may be insufficient to offset the challenges posed by intensified external competition.

In contrast, the level of economic development (gdp) consistently exhibits a positive and significant impact across all models, emphasizing the fundamental role of economic strength in driving digital economic development. Wealthier regions are better equipped to invest in digital infrastructure and technological innovation, fostering an environment conducive to the growth of the digital economy. In the TWFE model, while the coefficient for gdp is slightly lower than in other models ($\beta = 0.061$, $t = 1.981$), its positive effect remains significant. This finding reaffirms that regional economic strength is a critical enabler of digital economic progress.

Finally, transport infrastructure (ti) demonstrates a negative and significant coefficient across all models ($\beta = -0.228$, $t = -7.309$ in the TWFE model). Although unexpected, this outcome may indicate that traditional transport infrastructure primarily supports traditional industries and logistics rather than directly contributing to digital economic development. Moreover, it could suggest that prioritizing investments in transport infrastructure may inadvertently divert resources away from digital infrastructure development, especially in regions with constrained fiscal capacity.

In summary, these results underscore the diverse regional characteristics that shape digital economic development. Variables such as social consumption patterns, openness to trade, economic strength, and infrastructure priorities vary significantly across regions, reflecting the complex and multidimensional nature of digital economy growth. These findings highlight the necessity of considering regional heterogeneity and multiple influencing factors when analyzing and designing policies to advance digital economic development.

Robustness Tests: Adding Instrumental Variables and Replacing the Dependent Variable

The robustness tests validate the reliability of the model and consistently highlight how government financial support (gs) influences digital economic development. Two strategies ensure robustness: adding control variables and redefining the dependent variable. The first strategy incorporates two additional factors—human capital level (hc) and social security spending (ge)—to capture other variables that might shape digital economic growth. Even with these added controls, the model shows that gs maintains a positive and highly significant coefficient at the 1% level ($\beta = 1.729$, $t = 4.819$). These results emphasize that government financial support continues to drive digital economy expansion, regardless of additional influences, confirming its essential role in fostering growth.

The second strategy involves redefining digital economic development by substituting the dependent variable with an alternative metric. Following Zhao et al. (2020), this new measure evaluates five aspects: internet usage rate, employment tied to internet-related activities, output generated by internet-related industries, mobile internet users, and the Digital Inclusive Finance Index. Replacing the original variable (de1) with this recalibrated measure (de) allows for a deeper examination of the model's robustness. The results show that gs maintains a stable coefficient of 1.729, remaining highly significant at the 1% level ($t = 5.190$). These outcomes demonstrate that the relationship between government financial support

and digital economic development holds true regardless of how the dependent variable is defined, further solidifying the reliability of the findings.

Collectively, these robustness tests validate that the positive effect of government financial support on digital economic development is both consistent and stable, remaining unaffected by variations in control variables or the definition of the dependent variable. This underscores the soundness of the proposed relationship and provides compelling empirical evidence for the crucial role of government financial support in advancing digital economic growth.

Table 5
Robustness Tests

	(1) de	(2) de1
gs	1.729***	1.729***
	(4.819)	(5.190)
sc	0.144**	0.097*
	(2.294)	(1.688)
ow	-0.193***	-0.160***
	(-5.664)	(-5.266)
gdp	0.086***	0.093***
	(2.753)	(3.384)
ti	-0.193***	-0.114***
	(-6.315)	(-4.113)
hc	-7.078***	
	(-5.412)	
ge	0.033**	
	(2.492)	
Province FE	YES	YES
Year FE	YES	YES
_cons	1.543***	0.526
	(4.058)	(1.511)
N	300	300
R^2	0.826	0.959
F	75.540	431.252

***p<0.01, **p<0.05, *p<0.10

Heterogeneity Test

Heterogeneity analysis is an important method used to explore potential differences among research subjects. It divides the overall sample into multiple subsamples and conducts regression analyses for each group to examine whether the relationships between variables remain consistent under different conditions. Specific methods include grouping by geographical regions (e.g., urban vs. rural), time periods (e.g., before and after policy implementation), or individual characteristics (e.g., age, education level) to evaluate the applicability and consistency of the model. The main advantage of heterogeneity analysis lies in its ability to reveal diverse relationships between variables, helping to explain differences in causal relationships and marginal changes in effects (Baltagi et al., 2017). Additionally, heterogeneity analysis can validate the robustness of the main model and assist researchers in identifying unobserved inter-group characteristics and their possible economic implications (Shariff, 2012). In this study, the research subjects are categorized

into eastern, central, and western regions of China based on factors such as the level of regional economic development, geographical location, and resource endowment, following the classification provided by the National Bureau of Statistics of China. The eastern region includes coastal provinces with rapid economic growth; the central region consists of agricultural and traditional industrial bases; and the western region encompasses resource-rich provinces with relatively underdeveloped economies (Qu, 2009; Wang, 2013; Chen et al., 2014; Zhao, 2015).

The findings reveal pronounced regional disparities in the effectiveness of government financial support. In the eastern region, the coefficient for government financial support is 1.914, significant at the 1% level (t = 2.865). This indicates that fiscal expenditures on science and technology, particularly in technological innovation and digital infrastructure, have a substantial effect on driving digital economic growth in these more developed provinces. The eastern region benefits from advanced industrial bases, higher absorptive capacities for new technologies, and a well-established digital ecosystem, collectively amplifying the effectiveness of government financial support. In the central region, the coefficient is 1.745 (t = 6.788), reflecting a strong and positive impact. This may result from the region's active role in undertaking industrial transfers from the east, increasing investments in science and technology, and implementing innovation-enhancing policies. These efforts have likely contributed significantly to the promotion of digital economic growth in this area. By contrast, the western region demonstrates a lower coefficient of 1.340, though still significant at the 1% level (t = 2.960). The relatively weaker effect of government financial support in the western region may be attributed to its underdeveloped digital economy, limited technological infrastructure, and lower marginal returns on fiscal science and technology expenditures. These limitations highlight foundational gaps in the west's digital economic development, underscoring the need for increased efforts in capacity building and infrastructure improvement to enhance the efficiency and impact of government financial support.

Table 6
Heterogeneity Analysis

	(1) East	(2) Middle	(3) West
gs	1.914***	1.745***	1.340***
	(2.865)	(6.788)	(2.960)
sc	0.257**	0.036	0.150***
	(2.043)	(0.770)	(3.372)
ow	-0.203***	0.180***	0.148***
	(-4.034)	(3.123)	(3.532)
gdp	0.131	0.014	-0.006
	(1.648)	(0.778)	(-0.213)
ti	-0.316***	-0.013	0.015
	(-6.195)	(-0.681)	(0.569)
Province FE	YES	YES	YES
Year FE	YES	YES	YES
_cons	1.776**	-0.081	-0.304
	(2.08)	(-0.33)	(-0.77)
N	120	90	90
R^2	0.877	0.964	0.953

***p<0.01, **p<0.05, *p<0.10

Endogeneity Test

To address potential endogeneity concerns, particularly the possibility of reverse causality between government financial support (gs) and digital economic development (de), this study conducts an endogeneity test. Specifically, local governments may increase fiscal science and technology expenditures to promote digital economic development, which could bias the baseline regression results. To mitigate this issue, the study uses the lagged one-period value of government financial support (gs) as an instrumental variable and applies the Two-Stage Least Squares (2SLS) method.The results from the first-stage regression show that the lagged value of government financial support has a strong predictive relationship with current government financial support, with a coefficient of 0.987. The instrument passes both the weak instrumental variable test (F-statistic = 718.449) and the under-identification test (LM statistic = 61.920), confirming its validity and relevance as an instrumental variable. In the second-stage regression, government financial support, represented by its predicted value (gs_pre), shows a strong positive impact on digital economic development (de), with a coefficient of 0.872 and a t-value of 8.978, achieving significance at the 1% level. This demonstrates that even after resolving endogeneity concerns, government financial support continues to act as a key driver of digital economy growth. The stability of this result underscores the consistent and critical role played by fiscal expenditures on science and technology in advancing the digital economy.

Table 7
Endogeneity Test

	Phase One gs	**Phase Two** de
Lgs	0.987***	
	(35.750)	
gs_pre		0.872***
		(8.978)
control variable	Yes	Yes
LM Value （Underidentification Test）	61.920	
First Stage F Value (Weak Instrument Test)	718.449	
_cons	-0.008**	0.012
	(-2.054)	(0.188)
N	270	300
R^2	0.948	0.753
F	964.945	179.531

***p<0.01, **p<0.05, *p<0.10

Moderating Effect

Table 8 presents the estimated results of the moderating effect of industrial structure (is) on the relationship between government financial support (gs) and digital economic development (de). The model incorporates an interaction term between government financial support and industrial structure (gs × is) to assess potential moderating effects. The findings reveal that industrial structure (is) has not only an independent positive impact on digital economic development but also significantly enhances the marginal effect of government financial support on digital economic growth. The coefficient of the interaction

term (gs × is) is 0.839 ($p < 0.01$), indicating that optimizing industrial structure substantially amplifies the effectiveness of government financial support. Specifically, a higher proportion of the tertiary sector relative to the secondary sector improves the absorption and utilization of fiscal expenditures on science and technology, thereby magnifying the policy's effectiveness.Moreover, after accounting for the moderating effect, the direct impact of government financial support remains statistically significant, though its coefficient decreases from 2.236 to 1.911. This reduction implies that part of the policy effect is mediated through industrial structure, underscoring its indirect role in enhancing digital economic development. In summary, these results highlight the pivotal role of industrial structure in moderating the influence of government financial support on digital economic growth. The findings offer strong empirical support for Hypothesis 2, emphasizing that optimizing industrial structure is crucial for maximizing the effectiveness of government interventions and fostering sustainable and balanced growth in the digital economy.

Table 8
Moderating Effect Test Results

	(1) de	(3) de
Gs	2.236***	1.911***
	(5.966)	(5.130)
Is		0.026*
		(1.759)
Gs*Is		0.839***
		(2.673)
Control Variable	Yes	Yes
Province FE	YES	YES
Year FE	YES	YES
_cons	2.121***	1.871***
	(5.415)	(4.758)
N	300	300
R^2	0.799	0.812
F	72.595	68.398

***p<0.01, **p<0.05, *p<0.10

Conclusion

This study conducts a comprehensive empirical investigation into the mechanisms by which government financial support influences digital economic development, focusing on its moderating effects and regional heterogeneity. The baseline regression results, derived from the Two-Way Fixed Effects (TWFE) model, indicate that government fiscal expenditures on science and technology significantly enhance digital economic growth, with a coefficient of 2.236, statistically significant at the 1% level. These results underscore the critical role of government financial support in advancing the digital economy. Robustness tests further validate these findings, demonstrating that the positive impact of government financial support remains stable and consistent, regardless of the addition of control variables or changes to the operationalization of the dependent variable.

The heterogeneity test highlights significant regional disparities in the effects of government financial support. The policy impact is strongest in the eastern regions, moderate in the

central regions, and relatively weaker in the western regions, reflecting differences in the foundational development and resource utilization capacities of the digital economy across regions. Endogeneity tests, using lagged government financial support as an instrumental variable, indicate that reverse causality does not significantly influence the empirical findings, reinforcing the robustness of the positive effect of government financial support on digital economic development.

The moderating effect analysis demonstrates that industrial structure significantly enhances the marginal effect of government financial support on digital economic growth. The interaction term's coefficient (0.839, significant at the 1% level) indicates that an increased share of the tertiary sector relative to the secondary sector better absorbs and utilizes fiscal expenditures, amplifying policy effectiveness. These results underscore the critical role of industrial structure optimization in strengthening the impact of government interventions.

Based on these findings, future policy design should fully consider regional development foundations and differences in industrial structure to implement targeted measures. This approach would not only advance high-quality digital economic development but also narrow the regional digital divide, fostering more balanced and equitable regional economic growth. First, the government should increase fiscal science and technology expenditures, particularly in regions where the digital economy is still in its early stages. By improving digital infrastructure and promoting technological research and innovation, the growth potential of the digital economy can be further unlocked. Second, given the significant regional disparities in policy effectiveness, policies must be tailored to local conditions. In eastern regions, governments should focus on advancing the digital economy's sophistication by fostering innovation and optimizing institutional frameworks to enhance the marginal benefits of policies. In central and western regions, efforts should prioritize strengthening infrastructure development and human capital investments to improve technology absorption capacities, thereby maximizing the benefits of policy support and reducing regional disparities in digitalization.

Additionally, optimizing industrial structure should be a key focus of government financial support for digital economic development. The findings indicate that an increased share of the tertiary sector significantly enhances the effectiveness of government policies. Therefore, future policies should actively promote the transition of traditional industries toward service-oriented and knowledge-intensive sectors, accelerating the advancement and rationalization of industrial structure.

By implementing these measures, government financial support can not only facilitate high-quality digital economic development but also contribute to coordinated and balanced regional growth, providing robust support for the construction of a modernized economic system.

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