

Digital Government, New Quality Productive Forces and High-quality Development of State-owned Enterprises: Evidence from Listed Companies in China

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Abstract. The establishment of digital government aligns closely with enterprises' need for open and transparent data, providing new opportunities for technological revolution and industrial transformation of state-owned enterprises. This research confirms the positive impact of digital government on the high-quality development of state-owned enterprises, based on reliable data from A-share listed state-owned enterprises. And the more advanced the level of high-quality productive forces is, the more prominent their link becomes. The depletion of major shareholders, investment in enterprise innovation, and the business environment act as intermediaries. The study suggests that state-owned enterprises should leverage information transparency opportunities through digital government initiatives. This entails improving corporate governance practices and utilizing information strengths to increase investments in innovative research, to promote high-quality development.

Keywords: Digital government; Reform of state-owned enterprises; New quality productive forces.

1. Introduction

The economy is transitioning towards a digital and intelligent trajectory due to the swift advancement and commercial utilization of technologies such as big data, cloud computing, and artificial intelligence. The progression of the digital economy and the implementation of a digital government are essential components of the digital transformation within the economic landscape. A digital government can utilize its distinctive advantages to enhance the well-being of individuals, bolster businesses, and foster inclusive and high-caliber economic progress. The concept of "digital government" is derived from the idea of "digital earth," which was initially introduced by former U.S. President Al Gore in his speech in 1998. Over the course of several decades marked by technological advancements and theoretical progress, data elements have become intricately woven into every facet of governmental organizational operations. The establishment of a digital government can synergize with the advancement of the digital economy to bolster the high-quality progression of state-owned enterprises. Nevertheless, the production, operation, and management frameworks of state-owned enterprises are not entirely congruent with the demands of digital development. Immediate reconstruction is imperative to foster a holistic digital mindset within organizations. The enhancement of the company's digital infrastructure is necessary to ensure seamless integration with traditional resources and to leverage new opportunities emerging from economic and social digital transformation. Emphasizing innovative vitality and cultivating new high-quality productive forces are crucial for attaining high-quality development. The establishment of digital government requires robust and well-organized coordination. The present scenario is marked by fragmented information repositories and duplicated responsibilities.

Previous research has shown that the digital economy can discourage significant shareholders' tunneling activities through information and competition mechanisms (Jiawei Zhang and colleagues, 2023). The integration of digital technologies in government governance has improved hierarchical governance among governmental bodies. The online approval platform implemented by provincial governments has standardized administrative approvals by limiting the discretion of local administrative agencies. This can increase entrepreneurs' willingness to invest and enhance transparency (Jie Tan and colleagues, 2020). It can also help reduce tunneling by major shareholders

in state-owned enterprises, promote innovation investment and support the high-quality development of these enterprises.

This paper proposes a theoretical hypothesis that will be explored by analyzing corporate internal governance, decision-making and the external development environment. It suggests that the implementation of digital government is essential for enhancing the high-quality development of state-owned enterprises. This progress is achieved by limiting tunneling activities of major shareholders in state-owned enterprises, promoting innovation investments, and improving the business environment. Additionally, since new quality productive forces rely on innovative technologies and data-driven processes, aligning with the information framework of digital government, this study suggests that these forces moderate the interaction between digital government and the high-quality development of state-owned enterprises.

2. Theoretical analysis and research assumptions

The functions and capabilities of digital government in relation to enterprises primarily encompass activities such as information disclosure, tax collection, qualification assessment, asset valuation, and business collaboration. The pivotal factor in the establishment of digital government lies in the transparency of government data, enabling enterprises across various scales and sectors to generate increased social and economic benefits (Han Xiao and Jinpeng Wu, 2020). The construction of digital government through the public sharing of government data has the potential to alleviate tensions between enterprises, public institutions, and market players (Guo Lei and Huang Ryan, 2021). From the standpoint of new institutional economics, the institutional context in which an organization operates significantly influences its developmental trajectory. The establishment of digital government can facilitate the restructuring of the government system. The equitable positioning of different parties and transparent negotiations enhance the effectiveness of information transfer and decentralization (Tao Yongliang and colleagues, 2024), eliminating external institutional obstacles to enterprise growth and fostering a just and inventive business atmosphere. Simultaneously, the significant benefits of digital technology in terms of time and space have the potential to reform the organizational structure of government, streamline business processes, and diminish disparities in the approval process. The government's digital platform is utilized to redesign the policy service process, optimize resource allocation between the government and enterprises through automated approval processes and simplified reporting materials. This initiative aims to decrease the institutional transaction costs for enterprises and foster an environment conducive to the high-quality development of businesses. Based on the aforementioned information, this paper introduces research hypothesis 1:

H1: The establishment of digital government infrastructure positively contributes to enhancing the high-quality development of state-owned enterprises.

The establishment of digital government is crucial for facilitating the digital transformation of the economy and society. The "Digital China" strategy and the "Internet Plus Plan" are crucial government initiatives that drive enterprises to enhance their digital transformation efforts to stay competitive globally. Against this backdrop, sophisticated technologies such as big data, mobile internet, and artificial intelligence have been widely utilized. The emergence of new qualitative productive forces with advanced productivity is essential to meet current demands and drive high-quality economic development.

The concept of "new quality" should be examined in terms of both its use value and intrinsic value. The emerging aspect of productivity is primarily manifested in the creation of novel high-quality data (Jiang Qiping, 2024). At the same time, the emergence of new quality productive forces necessitates the utilization of data as a catalyst to generate new quality value. New labor entities are depicted through virtual reality technology. New quality productive forces is achieved through the integration of novel workers, tools, and objects, with data digitization being a pervasive element throughout the entire process. The presence of a robust data flow is evident in the context of new quality productive forces, with its magnitude serving as an indicator of the overall smoothness of the data chain. The

establishment of digital government has created an open and transparent channel for data communication between the government and enterprises. The development of new quality productive forces is akin to a beacon on this pathway, illuminating and facilitating the identification of potential bottlenecks in data transmission. Enterprises exhibiting a high level of new quality productive forces demonstrate a greater capacity for digitization (Zhang Xiaoheng and Liu Caixia, 2024). The role of open and transparent government data in fostering the collaboration between digital government and enterprises is crucial for driving innovation across various facets of production, operations, and management, thereby steering them towards high-quality development during the digital transformation process. Based on the information provided, the following assumption is posited:

H2: New quality productive forces moderate the relationship between digital government and the high-quality development of state-owned enterprises.

The establishment of digital government enhances external supervision by providing public access to government information, improving transparency, reducing information asymmetry, and promoting efficient allocation of information resources (Shao Lei and Tangmeng, 2019). It also creates an internal governance oversight mechanism with external deterrence, reduces speculative behavior and shareholder value dilution, and prevents manipulation and fraud by large shareholders leveraging their informational advantage. From an internal governance perspective, digital government is a crucial aspect of the digital economy in government operations. The transparency of government information and the resulting optimization of the business environment have reduced corporate governance costs for internal managers (Yajuan Yu, 2023). Consequently, it can enhance the governance structure of state-owned enterprises, achieve equity structure diversification, and standardize governance mechanisms. The prevalence of tunneling behavior by major shareholders often results from corporate governance deficiencies. Government information transparency can boost regional market levels, impact enterprise innovation investment decisions, and prompt increased resource allocation to innovation. Based on the preceding discussion, this study proposes research hypothesis 3:

H3: The tunneling of major shareholders, innovation investments, and the business environment mediate how digital government supports the high-quality development of state-owned enterprises.

3. Empirical research design

3.1 Variable definitions and measures

3.1.1 Explained variable

In this study, the variable *Soe hqd* is used as the dependent variable, following Zhou Zejiang and colleagues' approach. The study applies the methodology by Levinsohn and Petrin (2003) and uses the LP method to estimate total factor productivity.

3.1.2 Explanatory variable

This study examines the level of digital government construction (*Digigov*) as the independent variable, measured using the online government service capability index of provincial governments outlined in the Investigation and Evaluation Report on Online Government Service Capability of Provincial Governments and Key Cities.

3.1.3 Moderator variable

In this study, *NPRO* is identified as a moderator variable based on the enterprise new quality productive forces measurement model developed by Song Jia and colleagues. Eleven three-level indicators from labor force and production tools are selected to create a new quality productive forces indicator using the entropy method. The calculated weight closely aligns with previous research.

3.1.4 Mechanism variable

This study investigates how tunneling, research and development (R&D) investment, and the business environment mediate the influence of digital government construction on the development quality of state-owned enterprises.

3.1.5 Control variable

Based on previous research (Yue Yujun and colleagues,2023), the study selected ten control variables. To address potential errors in regression outcomes and the loss of freedom from controlling individual effects, this study will include industry dummy variables based on the classification standard set by the China Securities Regulatory Commission in 2012.

3.2 Data sources and sample processing

As the Digital Government Construction Level Index only published data from 2015 to 2020 on the e-government center, this study initially selected listed companies with data available from 2015 to 2020 as the sample. The sample was then processed as follows:

ST and ST* enterprises were excluded; (2) listed companies with special characteristics, such as those in the financial and insurance industry, were removed; (3) listed companies with private property rights were excluded; (4) listed companies with missing values were eliminated; (5) To reduce the impact of outliers, all continuous variables underwent Winsorization by 1% on both ends.

3.3 Model building

In order to test hypothesis H1, this study establishes the following econometric regression model (1):

$$\text{Soe hq}_{i,t} = \alpha_0 + \alpha_1 \text{Digigov}_{i,t} + \alpha_i \text{Controls}_{i,t} + \delta_i + \mu_t + \varepsilon_{i,t} \quad (1)$$

Among them, "i" represents an enterprise, "t" represents a year. "Soe hq" refers to the total factor productivity of state-owned enterprises calculated using the LP method. "Digigov" represents the level of digital government construction, as indicated by the provincial government's manually compiled online government service capability index. "Controls" represent all control variables, " α_0 " represents the intercept term, " ε " represents the random interference term, " δ_i " is the industry fixed effect, and " μ_t " is the year fixed effect.

In order to test hypothesis H2, this study establishes the following econometric regression model (2):

$$\text{Soe hq}_{i,t} = \alpha_0 + \alpha_1 \text{Digigov}_{i,t} + \alpha_2 \text{NPRO}_{i,t} + \alpha_3 \text{Digigov}_{i,t} \times \text{NPRO}_{i,t} + \alpha_i \text{Controls}_{i,t} + \delta_i + \mu_t + \varepsilon_{i,t} \quad (2)$$

In this model, the interaction term "Digigov_{i,t} × NPRO_{i,t}" is calculated as the product of the variables Digigov and NPRO following centralized processing. This study focuses solely on analyzing the coefficient " α_3 " with positive or negative implications.

In order to test hypothesis H3, this study establishes the following econometric regression models (3) and (4):

$$\text{Med}_{i,t} = \alpha_0 + \alpha_1 \text{Digigov}_{i,t} + \alpha_i \text{Controls}_{i,t} + \delta_i + \mu_t + \varepsilon_{i,t} \quad (3)$$

$$\text{Soe hq}_{i,t} = \alpha_0 + \alpha_1 \text{Digigov}_{i,t} + \beta_1 \text{Med}_{i,t} + \alpha_i \text{Controls}_{i,t} + \delta_i + \mu_t + \varepsilon_{i,t} \quad (4)$$

The explained variables in model (3) encompass the mediating variable Med, which includes the tunneling behavior of the majority shareholder, innovation investment (RD), and the business environment (Busien). This paper primarily concentrates on the regression coefficient " α_1 " of Digigov in model (3) and the regression coefficient " α_1 " and " β_1 " in model (4). Empirical Findings and Analysis

4. Empirical Findings and Analysis

4.1 Results of the benchmark regression analysis

Table 2 presents a detailed analysis of the regression results on the link between digital government initiatives and the progress of state-owned enterprises towards high-quality development, indicating that establishing a high-level digital government positively influences the high-quality development of state-owned enterprises. Simultaneously, a higher level of new quality productive forces in enterprises enhances the impact of digital government initiatives on facilitating the high-quality development of state-owned enterprises. This finding validates the assumptions H1 and H2.

Table 2: Impact of Digital Government on High-quality Development of Enterprises

□variable	(1)	(2)	(3)	(4)
	OLS	FE	OLS	FE
	Soe hqd	Soe hqd	Soe hqd	Soe hqd
<i>Digigov</i>	0.006*** (0.001)	0.008*** (0.001)	0.001 (0.003)	-0.002 (0.002)
<i>NPRO</i>			-73.416** (36.778)	-18.318 (22.912)
<i>Digigov</i> × <i>NPRO</i>			0.945** (0.431)	0.453* (0.263)
<i>Controls</i>	Yes	Yes	Yes	Yes
industry	Yes	No	Yes	No
age	Yes	Yes	Yes	Yes
individual	No	Yes	No	Yes
<i>AdjR</i> ²	0.722	0.500	0.723	0.477

Note:corresponding standard errors are presented in brackets. Significance levels are denoted by *, **, and ***, indicating statistical significance at the 10%, 5%, and 1% levels, respectively.

4.2 Robustness test

4.2.1 Instrumental variable method

This study addresses endogeneity by using the instrumental variable method and conducting a two-stage least squares regression. It draws on research by Yuan Hang and Zhu Chengliang(2022), using terrain undulation (TRI) as an instrumental variable. Table 3 presents the results of the regression analysis and tests using this approach, indicating that digital government can indeed enhance the high-quality advancement of state-owned enterprises. This confirms the robustness of the benchmark regression results.

Table 3: Instrumental Variable Method

□variable	(1)	(2)
	Introduction of IV:TRI	
	first stage	second stage
	<i>Digigov</i>	Soe hqd
<i>Digigov</i>		0.022*** (0.005)
<i>TRI</i>	-2.175*** (0.128)	
<i>Controls</i>	Yes	Yes
Industry/year	Yes	Yes
<i>R</i> ²	0.376	0.791
<i>K-P rk LM</i>		166.287

KP Wald rk F

227.141

4.2.2 Modifying the Measurement Approach for the High-Quality Development of State-Owned Enterprises

In this paper, the total factor productivity calculated by ACF method(Ackerberg and colleagues, 2015), the total factor productivity calculated by GMM method (Wooldridge,2009) and ESG performance of enterprises(Han Yiming and colleagues, 2024) are used to replace the explained variable for the robustness test. The outcomes further confirm the assumptions stated in this paper.

Table 4:The robustness test results for substituting the measurement method of the explanatory variables

	(1)	(2)	(3)
□ variable	Calculating Total Factor Productivity using the ACF method Soe hqd	Calculating Total Factor Productivity using the GMM method Soe hqd	ESG performance ESG
<i>Digigov</i>	0.117*** (0.027)	0.007*** (0.001)	0.054*** (0.012)
<i>Controls</i>	Yes	Yes	Yes
<i>Industry/year</i>	Yes	Yes	Yes
<i>R²</i>	0.609	0.666	0.318

4.3 Heterogeneity test

4.3.1 Test of Industry Heterogeneity

High-tech enterprises show higher levels of innovation and have a workforce with unique qualities. Thus, high-tech companies may not prioritize the benefits of digital government services due to their strong innovation capabilities and skilled workforce. This study expects that digital government initiatives have a greater impact on improving the high-quality development of state-owned enterprises in non-high-tech companies compared to high-tech ones. The findings confirm that digital government significantly facilitates the high-quality development of non-high-tech state-owned enterprises.

Table 6: Industry Heterogeneity Test Results

	(1)	(2)
□ variable	Hi-tech Enterprise Group Soe hqd	Non-hi-tech Enterprise Group Soe hqd
<i>Digigov</i>	0.032* (0.019)	0.189*** (0.047)
<i>Controls</i>	Yes	Yes
<i>Industry/year</i>	Yes	Yes
<i>R²</i>	0.396	0.630
<i>chi2(p-value)</i>	13.550***	

4.3.2 Test of Regional Heterogeneity

State-owned enterprises operate in diverse economic and social contexts across regions, leading to variations in how digital government initiatives facilitate their high-quality development. The findings suggest that digital government initiatives have a significant impact on the high-quality development of state-owned enterprises, especially in the eastern region.

Table 7: Regional Heterogeneity Test Results

□variable	(1)	(2)	(3)
	Eastern region <i>Soe hqd</i>	Middle region <i>Soe hqd</i>	Western region <i>Soe hqd</i>
<i>Digigov</i>	0.150*** (0.002)	-0.012* (0.007)	0.016* (0.008)
<i>Controls</i>	Yes	Yes	Yes
Industry/year	Yes	Yes	Yes
R^2	0.630	0.761	0.759
<i>chi2(p-value)</i>		20.330***	

5. Results of the Mechanism Test

This paper suggests that implementing digital government can improve the progress of state-owned enterprises by influencing major shareholders' tunneling behavior, innovation investment in decision-making, and the overall business environment. The tests are conducted sequentially using the constructed mediating effect model. Columns 2 and 3 in Table 8 show the results of the mediating effect test on the tunneling behavior of large shareholders. Columns 4 and 5 show the results of the mediating effect tests for enterprise innovation input. Columns 6 and 7 show test results on the mediating effect of the business environment. The results indicate a mediating effect of major shareholders' tunneling behavior, enterprise innovation investment, and the business environment between digital government and the high-quality development of state-owned enterprises.

Table 8: Mediating Effect Test

□variable	<i>Soe hqd</i>	<i>Tunnel</i>	<i>Soe hqd</i>	<i>RD</i>	<i>Soe hqd</i>	<i>Busien</i>	<i>Soe hqd</i>
	Model (1)	Model (3)	Model (4)	Model (3)	Model (4)	Model (3)	Model (4)
<i>Digigov</i>	0.009*** (0.001)	-0.002* (0.001)	0.009*** (0.001)	0.0001** (0.000)	0.008*** (0.001)	0.006*** (0.000)	0.007*** (0.001)
<i>Tunnel</i>			- 0.187*** (0.021)				
<i>RD</i>					1.834*** (0.452)		
<i>Busien</i>							0.348*** (0.076)
<i>Controls</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry/year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.797	0.233	0.801	0.380	0.801	0.309	0.793

6. Findings and recommendations

This study examines state-owned listed enterprises from 2015 to 2020. The study empirically investigates how digital government initiatives promote the high-quality development of state-owned enterprises. It analyzes the impact from two perspectives: internal corporate governance and the external environment. To enhance the reliability of the research findings, the industry fixed effect has been replaced with the individual fixed effect, and the regression analysis has been redone. The study shows a significant positive correlation between digital government implementation and the improved growth of state-owned enterprises. The study utilized the tool variable method, variable

measurement changes, and sample range adjustments to evaluate robustness. Based on the test results, the research hypotheses remain valid. This study found that digital government has a greater impact on improving the development quality of non-high-tech enterprises compared to high-tech state-owned enterprises. State-owned enterprises in the eastern region show a more significant promotional impact compared to those in other regions. The analysis of mechanisms shows that implementing a digital government can improve the high-quality development of state-owned enterprises by preventing major shareholders' tunneling activities, promoting investment in innovation, and enhancing the business environment.

Based on the aforementioned research findings, this paper primarily presents the following three recommendations:

Firstly, it is crucial to actively advance the theoretical evolution and implementation of digital government. In the upcoming period, the advancement of digital governance requires a comprehensive exploration of enterprises' true needs. The information should exceed basic transparency requirements and aim to establish a genuine "dialogue with data." Additionally, it should facilitate seamless communication channels between state-owned enterprises and the government to bridge any potential "digital divide" that may exist between them.

Secondly, emphasizing the diverse roles of regions and state-owned enterprises is crucial for understanding how the digital government process affects the high-quality development of state-owned enterprises. It is essential to carefully design diverse development strategies that incorporate the unique regional attributes of the eastern, central, and western areas. Non-high-tech state-owned enterprises should leverage the opportunities provided by the digital government to drive their growth and development.

Finally, state-owned enterprises should capitalize on the transparency facilitated by the establishment of digital government, utilizing their informational edge to boost investments in innovative research and development, foster new high-quality productive forces, and lead the way in advancing high-quality development.

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