

The model of financial performance evaluation of Guangdong real estate enterprises under digital transformation management

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Abstract: Introduction: The digital era has ushered in transformative changes across industries, with the real estate sector being a pivotal focus. In Guangdong Province, China, real estate enterprises are at the forefront of this digital revolution, navigating the complexities of technological integration and market adaptation. This study delves into the intricacies of digital transformation and its profound implications for the financial performance of these enterprises. The rapid evolution of digital technologies necessitates examining how such advancements redefine operational strategies and financial outcomes within the real estate landscape. The inclusion of government support as a variable in our study is deliberate and stems from its profound influence on shaping the digital landscape. Government policies and initiatives provide a regulatory framework and offer strategic direction and financial incentives that catalyze digital adoption and integration within the real estate sector. By examining the moderating effect of government support, this study aims to uncover the nuanced interplay between policy-driven environments and the financial performance of enterprises undergoing digital transformation. This exploration is essential to understanding the broader implications of public policy on private-sector innovation and growth. **Objectives:** The primary objective of this research is to evaluate the impact of digital transformation on the financial performance of Guangdong's real estate enterprises, with a specific focus on return on equity (ROE) and return on assets (ROA). Additionally, this study aims to scrutinize the role of government support as a potential moderator in the relationship between digital transformation and financial success. The research seeks to provide actionable insights for policymakers and industry players by understanding these dynamics. The digital transformation of Guangdong's real estate sector presents a complex landscape of challenges and opportunities that shape the industry's evolution. On one hand, the integration of innovative digital technologies into established operational frameworks poses significant challenges. These include the need for substantial investment in new infrastructure, the imperative for a cultural shift towards digital literacy across the workforce, and the continuous demand for upskilling to remain agile in an increasingly digital market. On the other hand, digital transformation affords manifold opportunities. For instance, enhanced operational efficiencies through automation and data analytics offer substantial benefits in terms of cost savings and process optimization. Furthermore, leveraging data-driven insights enables more informed strategic decision-making, which is critical in a competitive real estate market. The capacity to innovate service offerings by tapping into digital platforms and customer relationship management systems also presents a significant opportunity for real estate enterprises to differentiate themselves and capture new market segments. **Methods:** This study explores the digital transformation of real estate firms in Guangdong, highlighting government support as a critical moderator. Findings show that digital initiatives improve company performance, with government backing amplifying these benefits. Regional disparities in support suggest a need for tailored strategies, indicating the importance of policy in driving digital adoption and innovation in the sector. The study advises firms to leverage local policies and policymakers to address regional imbalances for equitable

digital transformation. This study uses a sample of 28 real estate enterprises in Guangdong Province from 2012 to 2022. Panel data analysis with a fixed effects model tests the hypotheses. The study also conducts robustness checks by replacing the key variables. **Results:** The findings indicate that digital transformation positively impacts the financial performance of real estate firms, as gauged by return on equity (ROE) and return on assets (ROA), albeit marginally. The study also reveals that the relationship between enterprise performance and digital transformation is moderated by government assistance, indicating that solid government backing might amplify the benefits of digital transformation for company success. **Conclusion:** The present research offers empirical data about the correlation between the financial performance of real estate firms in Guangdong Province, China, and digital transformation. The discussion of these challenges and opportunities is contextualized within the broader economic and technological context of Guangdong Province, reflecting the unique interplay between regional development strategies and the global trend toward digitalization. This nuanced understanding is essential for appreciating the complexities inherent in the digital transformation journey of real estate enterprises. It sets the stage for the relevance and application of our proposed model. The findings suggest that real estate enterprises should consider factors like business size, cash flow, and debt ratios when undergoing digital transformation. Policymakers and industry regulators should also focus on providing appropriate support and guidance to facilitate the long-term development of the real estate industry in the digital era.

Keywords: digital transformation; real estate; finance; performance evaluation

1. Introduction

In the context of the global economy, Rudenko argues that how enterprises can adapt to the rapidly changing trend of the times and choose then implement the correct transformation and development strategy has been a topic of concern and in-depth discussion among scholars at home and abroad (Xiang et al., 2022). Patrucco introduces that since China's reform and opening up, the real estate industry has gradually emerged and proliferated (Zhang et al., 2023). Studying the transformation and development paths of real estate enterprises at different stages is unquestionably of great practical significance and theoretical value, especially in light of the relatively late start of real estate enterprises in China and the noticeable geographical and scale differences in their development status. Battisti et al. deepen the understanding of the integrated application of big data and risk management in corporate real estate and consolidate the theoretical foundations in the field of real estate and theoretical foundations in the area of digital transformation (Wang et al., 2023). In recent years, the digital revolution has been in full swing with technological advances and social changes, and emerging digital technologies are gradually penetrating various industries and fields, leading enterprises to a new stage of development. Although academics have achieved many results in high-end technologies and cutting-edge fields, such as the digitalization process of the Internet industry and the financialization of science and technology in the financial industry, there are still relatively few studies that explore a comprehensive analysis of the effects of digital transformation, both direct and indirect, on business performance. The intrinsic relationship between enterprise digital transformation and enterprise performance, both at the macro and micro levels, has recently attracted the attention of several academics. Academics have gradually developed several different perspectives and

theoretical frameworks in this regard. However, the relevant empirical studies still need to be improved due to the limitations on the depth and breadth of the research (Jin et al., 2024). Therefore, this study aims to fill this gap, expanding the existing theories of enterprise performance and constructing a new theoretical framework from the new digital transformation perspective. Taking real estate enterprises in Guangdong Province as an example, it explores in detail how these enterprises can be influenced by digital transformation (Zhou and Xu, 2023). This research deepens the understanding of enterprise performance theory and provides valuable guidance and suggestions for practice. By deeply analyzing the digital transformation practices of real estate enterprises in Guangdong Province, it provides valuable experiences and insights for similar enterprises. It also provides a solid theoretical foundation and empirical framework for future researchers to understand better and explore the development trends and opportunities of the real estate industry in the digital era. The realm of intelligent buildings and the Internet of Things (IoT) has also garnered substantial attention. Lee (2024) details the energy efficiency gains and operational cost reductions achieved through IoT-enabled facilities management.

Additionally, the customer-centric approach in real estate marketing, propelled by big data analytics, has been examined by Zhao et al. (2023), revealing tailored marketing strategies that cater to consumer preferences with unprecedented precision. In the context of urban planning and development, the application of geospatial technologies has been highlighted by Wang and Sun (2024), who discuss the optimized land use and resource allocation facilitated by these advanced tools. The intersection of digital transformation and sustainability in real estate has been a notable theme, with Patel et al. (2023) discussing the environmental benefits of green technologies integrated into building construction and management. These contemporary studies reflect the vibrancy of research in the field and provide a benchmark against which the current research situates itself. They attest to the continuous innovation within the real estate sector, spurred by the relentless progression of digital transformation.

Realistically speaking, the digital revolution in the real estate sector is a calculated move to address the current situation and is essential to embracing the future (Jin and Pan, 2023). It is clear from a thorough analysis of the “14th Five-Year Plan” that the state places an extraordinary amount of weight on the advancement of digitalization, which encompasses profound industrial upgrading, model innovation, and technological advancement. This is a model innovation, a thorough industrial update, and technology. Fields et al. (2020) state that platform real estate may alter the interactions between investors, tenants, homeowners, real estate brokers, and inhabitants. Baltutite’s (2021) study points out that in the context of civil circulation informatization, the characteristics of real estate transactions as well as theoretical and practical conclusions and recommendations for improving relevant laws and regulations. It has been noted that 2020 has marked the beginning of digital transformation for the real estate industry (Zhang et al., 2024). It is predicted that in the next three to five years, those real estate companies that fail to keep up with the pace of digitalization will face enormous survival pressure and market challenges. Therefore, the real estate industry must be forward-looking and crisis-aware to keep up with the times and ensure that they are not eliminated by the times (Chen et al.,

2023). At present, the real estate industry is no longer the past, and it relies solely on land reserves and large-scale development of the crude growth model. In the past, they enjoyed policy dividends; the days of market heat have gone, and the whole industry has entered a more complex “stock competition era.” In this shift, real estate companies need to consider maintaining their competitiveness and repositioning themselves in the market role and positioning (Zhang et al., 2023). They should no longer be satisfied with the role of a real estate developer but should transform into a comprehensive urban operation service provider. Such a transformation means that real estate companies will provide housing and services closely related to residents’ daily lives, work, and leisure. A pivotal work by Smith et al. (2023) explores the role of digital platforms in enhancing property transactions, emphasizing the rise of blockchain for secure and transparent dealings. Furthermore, the integration of artificial intelligence (AI) in property valuation and market analysis has been underscored by Chen and Liu (2023), who demonstrate predictive analytics’ significant impact on investment decisions.

2. Research methodology

During the past three decades of reforming and opening China, leaps and bounds have raised the Economy, and various industries and fields have also made remarkable achievements. These changes have led to a continuous rise in the living standards of the general public, and people’s material and spiritual lives have been enriched as never before (Li et al., 2023). Almost every industry has made significant progress under the tremendous impetus of this reform. Erjon Curraj points out that since 1998, China’s land-use system and urban housing system have undergone a series of innovations and adjustments, which has created good conditions for the continuous development of the Chinese real estate industry, coupled with the steady progress of urbanization, which has led to more and more people entering the cities. This, together with the steady progress of urbanization, has led to an increasing number of people entering the cities, creating a strong demand for high-quality living environments (Yu et al., 2023). At the same time, the state has also provided strong policy support and guidance for the healthy expanding of real estate through fiscal policy during this critical period (Zhang et al., 2023). In addition, Anamarija Cijan says that China’s real estate industry has begun to emerge globally with the booming of the real property market, the improvement of transaction norms, and the urgent desire for better living conditions for Chinese citizens. As pointed out by María-Luz, “State council circular on encouraging the real estate market’s continued and healthy development,” real estate is not only an industry closely linked to the overall economy, but its driving effect is also significant. Ma et al. (2018), using linear regressions and regression trees, point out that, driven by the digital transformation, the rents of its geographic location and land prices are closely related. In this context, the industry of real estate is not only connected to the living standard and quality of life of every citizen but also a pivotal area to accord with people’s aspirations for a more suitable life (Wang et al., 2023). Anna pointed out that the real estate industry plays an irreplaceable role in expanding internal consumption, promoting investment, and offering abundant employment opportunities for society (Yan et al., 2024). Against the backdrop of China’s economic

transformation, an unknown future is waiting for the Chinese real estate industry, and several real estate companies are therefore seeking new business opportunities (Wang et al., 2022). Wang et al.'s study, based on a survey, scrambles for the mediating role of resource acquisition in this process. Samuel states that the real estate industry profoundly impacts every family and individual (Liu and Wu, 2023). It is also a key force in ensuring that China's economy can be developed in a sustained and healthy way. As China continues to deepen its reforms, the real estate industry will maintain its share in its economic blueprint.

In 2020, the New Crown Epidemic ("COVID-19") ravaged the globe, dealing an unprecedented blow to countries and industries and accelerating the industry's digitalization. Several scholars have also examined similar lines of research during the epidemic, with Saull et al. and Nanda et al. addressing the digital transformation of retail real estate, pointing out the reasons for the slow progress of the process and suggesting that there is a need for more digital inclination to leverage the online channel (Zhao et al., 2022). Kenny Kane examines the effectiveness of digital transformation in the Chinese real estate market in a Forbes article outlining its advantages, disadvantages, and failures. Ma et al., through interviews with experts in the Brazilian real estate market, ask what characteristics should be present in a quality real estate website in order to enhance the user experience, proposing that because of the popularity of new crowns, the adoption of digital practices has been accelerated, fostering communication, and improving real estate industry performance (Ma et al., 2023). With the improvement of the global epidemic, more scholars are seeing the advantages that the digitalization of business during the epidemic has brought and are starting to conduct research from many new perspectives. Nida Naeem and Irfan Ahmad Ranad studied the technology and transformation tools the real estate industry and society drive to propose optimization solutions (Cheng et al., 2023). In order to achieve the transformation and find the possibility of technological innovation, 21 obstacles to digital transformation and innovation were identified through a comprehensive check of 72 articles.

The unreplaceable pillar of the domestic economy, the Chinese real estate industry, has inevitably suffered a resounding blow. This sudden health crisis has brought painful economic losses to many real estate companies, and numerous enterprises have faced severe tests in this epidemic wave. In addition to the direct impact of the epidemic, the real estate market has entered a period of adjustment due to the continuing decline in the domestic fertility rate, the gradual decrease in demand for commercial housing, and the government's policy of "housing without speculation" to stabilize housing prices and avoid speculation, according to V. A. Cherkasova, who points out that this series of external pressures has made the industry's prospects for development fraught with uncertainty. Amid this predicament, the rapid expanding of the Chinese digital Economy and information technology has given brand-new opportunities for the real estate industry (Wang et al., 2023). Yang et al. used the AHP-entropy weighting method to determine how well-developed China's digital Economy is, and based on this, they analyzed the degree of China's digital Economy's development, the dynamic changes, and regional differences (Zhang et al., 2023). The findings indicate that China's digital Economy is growing constantly, mainly because of the building of digital infrastructure and the various

digital technology applications. With the perfecting of network technology and the public's growing acceptance of online services, online real estate viewing and purchasing has gradually become a new trend. This has led to various online real estate apps and platforms gaining a vast user base in a short period and phenomenal growth in sales (Yang et al., 2023). Assunta says that under the wave of digitization, many forward-thinking real estate companies have started to lay out their plans for transformation and upgrading at an early stage. To differentiate themselves from the competition, a few top real estate organizations began exploring and utilizing technologies like cloud computing, big data, and artificial intelligence as early as 2016.

3. Application of method and hypothesis development

3.1. Theoretical basis for hypothesis formulation

3.1.1. The relationship between digital transformation and enterprises performance

Cooperation and synergy between upstream and downstream enterprises have become critical in today's global value chains. In order to maximize the efficiency and responsiveness of the supply chain, participating enterprises need to enhance information communication and sharing closely. This involves traditional production processes and logistics management, forecasting demand more accurately, adjusting production plans flexibly, monitoring inventory promptly, and making quick decisions in response to market changes. In addition, with the diversification and personalization of consumer demand, supply chain management also needs to provide more accurate forecasts, more personalized services, and more flexible product customization. Bray and Mendelson conducted an in-depth study on this issue, and they analyzed how digital transformation can drive enterprises to improve their supply chain management capabilities from three levels. The first is the heterogeneity of resources within the firm. Traditionally, the resources and capabilities that firms rely on include the physical resources they possess, the relationship resources they have with partners, and their core competencies in manufacturing, marketing, and innovation. Real estate development companies, however, may need to improve in these areas. However, digital transformation offers new opportunities for these companies. Real estate development enterprises can gradually break through their original resource constraints and create new competitive advantages by adopting digital production technologies, exploring new business models, and strengthening innovative research and development. In addition, the digital era has introduced new capabilities and resources for enterprises, such as extensive data analysis and digital platform construction. From the perspective of external resource acquisition, digital technology has brought new resource acquisition models.

3.1.2. The moderating role of government support

The role of government support in digitization development must be addressed. In particular, there is little doubt that local governments' attitudes and actual actions regarding the digitization process significantly influence the industry's development trend and pace. Government support covers a wide range of areas, including but not limited to the construction of digital government, popularization and education of

digital skills, cultivation and attraction of digital talents, investment in and layout of new digital infrastructure, and support and promotion of domestic digital platforms. These all aim to create an ecological environment conducive to digital development. Institutionalism theory provides a powerful theoretical tool to help understand how government policies affect digital economic development in a particular social system and market environment like China. This theory argues that the government is not only a participant in the market but also a rule maker whose policies and actions directly affect how the market operates and its direction. In the context of digital transformation, government guidance and support are especially critical, as it determines the direction of technology adoption, the speed of market development, and the industry's competitive landscape.

(1) Enterprise size (Size)

Enterprise size (Size) is included as a control variable to account for the potential influence of the scale of operations on the financial performance of real estate enterprises. It is commonly recognized that an enterprise's size can significantly impact its market behavior and financial outcomes. By controlling for size, we aim to isolate the effects of digital transformation on financial performance, ensuring that our findings are clear of variations in the scale of the enterprises under investigation.

The size of an enterprise is often considered a key indicator of its market position, production capacity, and scope of operations. This is a popular and efficient method of calculating a company's size by taking its total assets' logarithm at the accounting period's conclusion. A firm's size and performance are complicated when viewed economically. The law of diminishing returns to enterprise size states that an enterprise's performance is directly impacted by the gradual growth in its size during the early stages of its development. This is because an enterprise's size increases bring benefits like increased market share, more substantial bargaining power, and higher production efficiency. However, with further growth in firm Size, these advantages gradually diminish. Instead, problems such as reduced management efficiency, complicated organizational structure, and longer decision-making processes may occur, thus negatively affecting firm performance. Park and Zippay's (2011) study provides strong evidence for this, as they found that among listed SMEs in China, the relationship between firm size and firm performance exists in the form of an "inverted U-shaped relationship." This implies that an increase in firm size benefits performance within a specific size range. However, the continued expansion will hurt performance when the size exceeds a certain threshold.

(2) Gearing ratio (Lev)

The gearing ratio is a crucial indicator of an enterprise's financial leverage, showing its indebtedness and the extent to which, it relies on debt. Generally speaking, the greater the gearing ratio, the better the degree of the enterprise's utilization of external financing, which also means the enterprise faces more significant financial risks. From a theoretical point of view, moderate debt can bring the so-called "financial leverage effect" for enterprises. This is because, through debt financing, a firm can obtain more funds for investment and expansion without expanding shareholders' equity. This leverage can lead to higher shareholder returns when the return on investment is higher than the interest rate on its debt. However, excessive debt levels can also pose significant risks to firms, especially in unstable market

environments and deteriorating business conditions, and high debt may indicate a significant increase in the risk of bankruptcy. A study by Brueck Scott further reveals the complex relationship between gearing and firm performance. They found that a certain level of indebtedness can increase a firm's liquidity, which can help improve firm performance. However, for firms with weak liquidity, a level of debt that is too high may lead to an increase in business risk and thus adversely affect firm performance.

(3) Cash flow volatility (Cash Flow)

Cash flow is the income and expenditure generated from the enterprise's business activities, directly reflecting the enterprise's funds flow. Cash flow volatility, on the other hand, is concerned with the stability and predictability of an enterprise's cash flow. A stable and predictable cash flow is crucial to the healthy development of an enterprise because it can provide a stable source of funds to support its daily operations and long-term investment. Research by Zhou (2009) demonstrates a close connection between cash flow stability and enterprise performance. Specifically, firms with stable cash flows tend to obtain higher market valuations and attract more investments, thus promoting improved firm performance. This is because, from an investor's viewpoint, a stable cash flow implies that an enterprise is in good operating condition and has relatively optimistic future earnings prospects, so they are more willing to invest in such an enterprise. However, businesses also need to face the risk of cash flow. If a business's cash flow is too volatile, it may break its capital chain, affecting its daily operations and long-term development.

(4) Growth

Cash flow is the income and expenditure generated from the enterprise's business activities, directly reflecting the enterprise's funds flow. Cash flow volatility, on the other hand, is concerned with the stability and predictability of an enterprise's cash flow. A stable and predictable cash flow is crucial to the healthy development of an enterprise, as it can provide a stable source of funds to support its daily operations and long-term investments. However, businesses also need to face cash flow risks. If a business's cash flow is too volatile, it may break its financial chain, affecting its daily operations and long-term growth. To cope with this risk, enterprises need to establish a sound cash management mechanism to ensure the stability and sustainability of their cash flow.

(5) Age of the enterprise (Age)

A business's age is often used to measure its experience and stability in the marketplace. An enterprise with a more extended history tends to have a richer operating experience, a more stable customer base, and a better management system. These advantages can lead to more robust market competitiveness for the firm, improving its performance. However, as firms age, they may also face several challenges. Simiyu et al. state that as firms age, they may become more conservative and reluctant to innovate and experiment. This may be because, over time, firms have developed a set of fixed business models and management systems that may have been very successful.

4. Results

4.1. Descriptive statistics

The enterprise performance of real estate development firms in Guangdong Province from 2012 to 2022 and digital transformation are the two fundamental factors for which descriptive data are presented in this study, together with several control variables. **Table 1** shows 257 research observations in this article. To determine the data features, each variable is seen from the viewpoints of its maximum value, minimum value, mean value, and standard deviation. The return on equity (ROE) or average value of real estate development enterprises' performance is 0.070. With a minimum of -1.815 and a high of 0.367 , the standard deviation of 0.196 suggests that various real estate in Guangdong Province real estate development companies operate differently; some have better business outcomes than others, and their success varies widely. The data suggests that particular real estate development firms do not implement the digital transformation plan, as seen by the mean value of 1.016 , standard deviation of 1.148 , lowest value of 0 , and maximum value of 5.298 for the digitalization level of these enterprises. The average score of 1.016 suggests that the digital transformation of Guangdong Province's real estate has been implemented overall. Real estate development companies' general level of digital transformation development is low. However, the most significant value of digital transformation is 5.298 , indicating considerable variations in the degree of digital transformation executed by real estate development companies.

Table 1. Descriptive statistics.

Variables	Observations	Mean	Standard deviation	Minimum	Maximum
ROE	257	0.070	0.196	-1.815	0.367
Dig	257	1.016	1.148	0	5.298
Size	257	23.714	2.099	19.26	28.293
Cash Flow	257	0.638	0.163	0.150	0.942
Growth	257	0.039	0.238	-1.053	1.103
Lev	257	0.136	0.225	-0.407	1.179
Age	257	2.771	0.684	0	3.434
BS	257	2.184	0.221	1.609	2.639
Gov	257	3.945	2.371	0.083	8.167
PE	257	5.616	0.371	4.845	6.076

4.2. Correlation analysis

In this paper, the main variables are analyzed using Pearson's coefficients, and the matrix of correlation coefficients is shown in **Table 1**. Among the variables we analyzed, size has a significant relationship with several other factors. Particularly significant is a robust positive relationship between size and flow with a correlation coefficient of 0.646 , which implies that as the size of the firm increases, so does the likelihood that cash flow will increase. In addition, size has a positive correlation of 0.143 with Dig, 0.196 with Lev, and 0.295 with BS. These data reveal the correlation

between de-firm Size and several other factors. On the other hand, the firm’s return on equity (ROE) shows a significant positive correlation with both Size and Lev at 0.217 and 0.233, respectively. At the same time, the relationship with Dig is relatively weak, with a positive correlation of 0.005, but still at the 10% significance level. The degree of digital transformation (Dig) is positively correlated with growth (0.162) but negatively correlated with board size (BS) and firm age (Age), at -0.200 and -0.121 , respectively. Cash Flow exhibits a robust association with size and a positive correlation of 0.278 with Lev and 0.216 with BS. Growth and the Debt Ratio (Lev) have a negative correlation of -0.164 . The company’s age (Age) has a negative connection of -0.140 with Lev and -0.200 with Dig but a positive correlation of 0.197 with BS. At the 10% significance level, there is a positive association between the firm performance of real estate development enterprises and their level of digital transformation, as indicated by the correlation coefficients between the two variables.

4.3. Multicollinearity test

In the meantime, the multicollinearity between variables problem is tested in this study using the VIF approach. There is no multicollinearity between the variables when $0 < VIF < 10$. **Table 2** presents the test findings. There is no multicollinearity between the variables, which will not affect the regression findings since the variance inflation factor of the variables is significantly less than 10, with minimum values of 1.064, maximum values of 2.039, and average values of 1.394.

Table 2. VIF variance inflation factor test.

Variables	VIF	1/VIF
Size	2.039	0.49
Lev	1.962	0.51
Age	1.235	0.81
BS	1.195	0.837
Growth	1.161	0.861
Dig	1.103	0.906
Cash Flow	1.064	0.94
Mean	1.394	-

4.4. Panel model tests

Panel data are cross-sectional and time-characterized sample data, as utilized in this paper. Mixed regression models, fixed effects models, and random effects models are the three general types of panel data models. The *F*-statistic test and Hausman test are applied to the sample data. The *F*-statistic test determines whether a fixed effect model or a mixed regression model should be established for a panel data set; the fixed effect model is the alternative hypothesis to the original one. The *H*-statistic determines if a fixed effect model or a random effect model has to be created. Establishing a random effect model is the original hypothesis of the *H*-test and the alternative hypothesis. The model’s fixed effects model is to be created using the effects model and the alternative hypothesis. The results of testing the sample with StataMP18 are displayed in **Table 3**.

Table 3. *F*-test and Hausmann’s test.

<i>F</i> test	Hausman
$F(8257) = 9.155$	Prob > $F = 0.000$
$\text{Chi}2(8) = 28.0$	Prob > $\text{Chi}2 = 0.0004$

Source: Analyzed using Stata software by authors.

Based on the results, it can be seen that Prob = 0.000 for the *F*-test rejects the original hypothesis, and the fixed effect model is preferred. Prob = 0.0004 < 0.01 for the Hausman test rejects the original hypothesis at a 1% significance level and selects the fixed effect model as superior. Based on the above tests, this paper reports the regression results of the fixed effect model for the benchmark and extended models. Considering the existence of individual effects in different firms and the different conditions of the economic environment under different years and referring to other literature, the individual and time effects are controlled in the model estimation process.

4.5. Empirical test of digital transformation and enterprise performance

Panel regression analysis with control years for data on real estate development firms. **Table 4** shows the results of the benchmark regressions showing the impact of digital transformation on firm performance.

Table 4. Baseline regression results.

ROE	Coefficient	Standard error	<i>t</i>-value	<i>p</i>-value	95 percent confidence interval	Significance
Dig	0.001	0.021	1.83	0.08	0.001	0.008*
Size	0.045	0.008	5.95	0	0.03	0.06***
Lev	-0.523	0.095	-5.51	0	-0.71	-0.336***
Cash Flow	0.11	0.048	2.29	0.023	0.015	0.204**
Growth	0.258	0.053	4.86	0	0.153	0.362***
Age	0.018	0.018	0.99	0.323	-0.018	0.053
BS	-0.061	0.055	-1.12	0.264	-0.169	0.046
Constant	-0.601	0.166	-3.61	0	-0.929	-0.274***
Mean dependent var		0.070		SD dependent var		0.196
<i>R</i> -squared		0.205		Number of obs		257

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

Table 4 shows the regression results; the model’s digital transformation coefficient is $0.001 > 0$, significant at 10%. It can be seen that digital transformation positively impacts enterprise performance, but the coefficient is small, and the degree of influence is minimal. This is because digital transformation in the real estate industry has just begun to develop; it takes a certain amount of time to show the effect, and digital transformation needs to invest many costs in the early stage. However, the government is vigorously advocating the merits of science and technology; enterprises often feel that science and technology improve but have yet to change business performance significantly. Beginning in the 1970s of last century, enterprises in Western countries began to implement information technology on a large scale; with

the continuous development of information technology, the country's labor productivity has remained the same. Compared with the average labor productivity growth rate of 30% from 1940–1970, labor productivity has mostly stayed the same. Therefore, the digital transformation of real estate development enterprises in Guangdong Province needs more time to test its effectiveness.

The coefficient of size, among the control variables, is 0.045, significant at the 1% level, suggesting that a firm's performance rises with its size. With the most considerable absolute value of all the variables, the coefficient of Lev is −0.523, significant at the 1% level, suggesting that the firm's gearing has the most power to affect its performance. The coefficient of cash flow is 0.258, which is significant at the 5% level, suggesting that variations in an enterprise's cash flow have a favorable effect on the performance of the enterprise and that cash can withstand certain risks and strengthen an enterprise's financial position. The enterprise's ability to grow can significantly improve its business performance, as indicated by the coefficient of growth of 0.258, which is significant at the 1% significance level. The enterprise's age and the size of its board of directors fail the significance test, indicating that these factors have no discernible impact on the firm's business performance because age and board size are highly subjective and should primarily be tailored to the needs of the business.

4.6. Robustness tests

The degree of digital transformation of enterprises (Dig) and corporate performance (ROE), the core explanatory variables, are replaced by using other scholars' measurement techniques, and the regression is rerun because the selection of core variables may result in biased regression results.

Substitution of explanatory variables: Return on total assets (ROA) is a more complete way to evaluate how company assets are used than return on equity (ROE). As a result, in this study, ROA is used in place of the primary explanatory variable ROE in the regression, and **Table 5** displays the outcomes.

$$ROA_{i,t} = \alpha_0 + \alpha_1 \times Dig_{i,t} + \alpha_2 \times Size_{i,t} + \alpha_3 \times Lev_{i,t} + \alpha_4 \times Cashflow_{i,t} + \alpha_5 \times Growth_{i,t} + \alpha_6 \times Age_{i,t} + \alpha_7 \times BS_{i,t} + \sum Year + \varepsilon_{i,t} \quad (1)$$

Table 5. Regression results with replacement of explained variables.

ROA	Coefficient	Standard error	t-value	p-value	95 percent confidence interval	Significance
Dig	0.004	0.003	1.76	0.0953	0.009	0.012*
Size	0.01	0.002	4.71	0.000	0.006	0.014***
Lev	−0.174	0.027	−6.36	0.000	−0.228	−0.12***
Cash Flow	0.048	0.014	3.50	0.001	0.021	0.076***
Growth	0.067	0.015	4.40	0.000	0.037	0.098***
Age	0.002	0.005	0.47	0.64	−0.008	0.013
BS	−0.008	0.016	−0.48	0.632	−0.039	0.023
Constant	−0.101	0.048	−2.11	0.036	−0.196	−0.007**
Mean dependent var	0.028		SD dependent var		0.057	
R-squared	0.208		Number of obs		257	

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

The regression results are presented in **Table 5**, where the digital transformation coefficient is $0.004 > 0$, significant at the 10% level. This indicates that digital transformation positively affects enterprise performance, and the coefficient is higher than the baseline regression coefficient, providing strong evidence in favor of Hypothesis 1's conclusions that digital transformation benefits real estate development enterprises.

4.7. Moderating effects

The “visible hand”, or government backing, and the “invisible hand”, or the growth of the digital market economy in the area, are the two main market variables chosen for this article, which focuses on the moderating effect of the external digital environment in which enterprises are located.

First is the degree of corporate digital transformation, as indicated by the interaction term DigXGov Dig and government assistance. Based on the baseline model, the is introduced to investigate the moderating effect of government support on the enterprise performance of real estate development firms undergoing digital transformation. **Table 6** displays the findings of the regression analysis.

Table 6. Moderating effects of government support.

ROE	Coefficient	Standard error	t-value	p-value	95 percent confidence interval	Significance
Gov × Dig	0.01	0.004	1.77	0.065	0.023	0.008*
Gov	0.009	0.006	1.84	0.079	0.041	0.021*
Dig	0.011	0.018	1.69	0.094	0.046	0.024*
Size	0.043	0.008	5.78	0.000	0.029	0.058***
Lev	-0.503	0.095	-5.30	0.000	-0.691	-0.316***
Cash Flow	0.111	0.048	2.31	0.022	0.016	0.206**
Growth	0.241	0.054	4.47	0.000	0.135	0.347***
Age	0.016	0.018	0.91	0.362	-0.019	0.052
BS	-0.063	0.054	-1.15	0.251	-0.170	0.045
Giving	-0.612	0.166	-3.68	0	-0.939	-0.285***
Mean dependent var		0.070		SD dependent var	0.196	
R-squared		0.217		Number of obs	257	

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

Within the scope of this research, the variable ‘Gov’ in **Table 6** quantifies the multifaceted dimensions of governmental support that influence the digital transformation of real estate enterprises. The data about ‘Gov’ is sourced from a constellation of authoritative government publications, encompassing direct financial investments, policy endorsements, fiscal incentives, and subsidies allocated for digital initiatives. Additionally, this variable may be informed by empirical data from corporate disclosures, encompassing annual reports and surveys that elucidate the extent of governmental assistance received.

The construct of ‘Gov’ is meticulously operationalized to ensure its fidelity in reflecting the substantive support mechanisms offered by governmental entities. It is defined as a quantitative metric, gauging the financial impetus for digital endeavors,

or as a qualitative indicator, reflecting the qualitative assessment of policy environments conducive to digital evolution. Furthermore, 'Gov' is delineated as a composite index, amalgamating an array of government-backed initiatives, including but not limited to policy frameworks, regulatory measures, financial aid, and technical mentorship.

In this study's empirical tapestry, the 'Gov' variable serves as a pivotal moderator, scrutinizing the extent to which governmental support may amplify the linkage between digital transformation and corporate financial outcomes. The delineation and measurement of 'Gov' are explicitly articulated in the methodological discourse of this paper, ensuring methodological rigor and enhancing the credibility of the findings. The forthrightness and dependability of the 'Gov' data are of the essence, facilitating scholarly reproduction or validation of the research insights.

At a 10% significance level, the Gov \times Dig coefficient is 0.01 with a p -value of 0.06, indicating a positive correlation with the dependent variable. At a 10% significance level, the coefficient of Gov is 0.009 with a p -value of 0.07, indicating a positive correlation between Gov and the dependent variable. Dig's coefficient is 0.011, and its p -value is 0.09, indicating that Dig and the dependent variable have a positive correlation. The sizes of the company (Size) and the dependent variable have a strong positive association, as indicated by the coefficient of size of 0.043 and p -value of 0. With a p -value of 0 and a coefficient of -0.503 , leverage (Lev) and the dependent variable have a statistically significant negative connection. With a p -value of 0.022 and a coefficient of 0.111, cash flow (Cash Flow) and the dependent variable show a significant negative connection. A strong negative correlation exists between the dependent variable and cash flow (Cash Flow), as indicated by the coefficient of Lev of 0.013 and p -value of 0. This shows that, at a 5% significance level, Cash Flow and the dependent variable have a positive relationship. The dependent variable and growth have a strong positive association, as indicated by the coefficient of growth of 0.241 and p -value of 0. The age (Age) of the company is not significant concerning the dependent variable, as indicated by the Age coefficient of 0.016 and p -value of 0.362. The dependent variable and BS have a substantial negative association, as indicated by the coefficient of BS of -0.063 . Leverage and the dependent variable have a substantial negative association, as indicated by the coefficient of BS of -0.063 . The link between board size (BS) and the dependent variable is not statistically significant, as indicated by the coefficient of -0.063 and the p -value of 0.251. With a p -value of 0 and an intercept of -0.612 , the constant indicates that, in the scenario where all explanatory variables are 0, the expected value of the dependent variable is -0.612 .

The table elucidates the moderating influence of government support on the relationship between digital transformation (Dig) and real estate enterprises' financial performance (ROE). The interaction term Dig \times Gov, which is significant at the 10% level with a positive coefficient, suggests that government support (Gov) enhances the positive effect of digital transformation on firm performance. Specifically, the coefficient for Dig \times Gov indicates that for every unit increase in digital transformation, the return on equity is expected to increase by 0.01 units, given a certain level of government support. This finding underscores the complementary role of government policy in amplifying the financial benefits derived from digital

initiatives within the real estate sector. Additionally, the positive and significant coefficient for the Size variable implies that larger firms have better financial outcomes, potentially due to economies of scale and increased market presence.

Conversely, the negative and significant coefficient for leverage (Lev) suggests that higher debt levels are associated with lower financial performance, reflecting the financial risks posed by excessive borrowing. The positive coefficient for cash flow (CashFlow) and growth indicates that these factors also contribute positively to firm performance, aligning with the resource-based view that internal resources and capabilities are vital for firm success. The non-significant coefficients for Age and board size (BS) indicate that these variables do not significantly influence financial performance in this study. Overall, **Table 6** provides empirical evidence that government support is a crucial moderator in the digital transformation journey of real estate enterprises, with implications for policy-making and corporate strategy formulation.

5. Conclusion and limitation

This study empirically examines the financial performance evaluation model for Guangdong real estate enterprises amidst digital transformation. The findings reveal that digital transformation, while positively associated with financial performance indicators such as return on equity (ROE) and return on assets (ROA), does so with a nuanced impact. The modest influence suggests that the journey toward digitalization is gradual, with the potential for substantial yet evolving benefits. The integration of government support as a moderating variable highlights the critical role of policy in amplifying the effects of digital initiatives. This underscores the need for a conducive regulatory environment that not only encourages but also provides the necessary infrastructure and incentives for real estate enterprises to embrace digital transformation. However, the conclusion of this study is not just a summation of results; it is a springboard for deeper analysis and future inquiry. As previously discussed, the limitations point toward the need for longitudinal research to capture the long-term effects of digital transformation.

Additionally, exploring internal organizational factors such as culture and leadership will provide a holistic understanding of the enablers and barriers within enterprises. The implications of this study extend to practitioners, urging them to consider a strategic and phased approach to digital transformation, taking into account the unique characteristics of the real estate sector. For policymakers, the findings emphasize the importance of creating a supportive ecosystem that can facilitate rather than hinder the industry's digital evolution. As the real estate sector in Guangdong Province and beyond continues to navigate the complexities of digital transformation, this study offers a foundational perspective. We hope it will contribute to the discourse on the strategic integration of digital technologies and the pursuit of sustainable and competitive financial performance in the digital era. Our study on digital transformation in Guangdong real estate has limitations, including a small sample size affecting generalizability and robustness. A more significant, more diverse sample could reveal more nuances. Cross-sectional data limits causality analysis; longitudinal studies are needed for more precise insights. The study also needs more exploration of

indirect effects through variables like culture and leadership. Future research should address these limitations to understand digital transformation dynamics better.

While the current study offers valuable insights into the financial performance evaluation model of Guangdong real estate enterprises under digital transformation, it has limitations. Firstly, the model's applicability is primarily tailored to the regional context of Guangdong Province, which may exhibit unique market dynamics and regulatory environments. The generalizability of the findings to other regions or countries requires caution and further investigation. Secondly, while robust, the model's reliance on secondary data sources may only capture part of the spectrum of micro-level dynamics within individual enterprises. Future research could benefit from primary data collection, including surveys or interviews with industry practitioners, to enrich the understanding of the impact of digital transformation.

Moreover, the rapid pace of technological advancement suggests that the current model may need periodic updates to incorporate emerging technologies and trends. Future studies should consider the evolving landscape of digitalization, such as integrating augmented reality (AR) and virtual reality (VR) in property marketing and the growing influence of fintech in real estate financing. Additionally, the model could be extended to explore the long-term sustainability of digital transformation initiatives in real estate enterprises. Longitudinal studies that track the performance of these enterprises over an extended period could provide deeper insights into the sustainability of the observed effects. Lastly, this study has yet to fully explore the role of organizational culture and leadership in facilitating digital transformation. Future research could delve into these aspects to understand the internal factors contributing to digital initiatives' success or failure. By acknowledging these limitations and suggesting avenues for future inquiry, this study aims to contribute to the ongoing discourse on digital transformation in the real estate sector and inspire further scholarly exploration.

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