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The Impact of Digital Transformation on Risk-Taking: An Empirical Study of Japanese Companies

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ABSTRACT

Goal: This paper examines the effect of digital transformation on corporate risk-taking in Japanese firms and, more importantly, identifies links between digital technology integration and risk appetite. This study inspects how digital transformation impacts internal control quality, investment efficiency, and general financial soundness, with special emphasis on the differences between state-owned versus non-state-owned enterprises. **Methods:** The empirical analysis uses the data of Nikkei Index firms from 2010 through 2023. Out of the total, excluding the financial and insurance sectors as well as aberrant statuses in trading, 225 firms resulted in 14,567 observations. The regression models controlled for a number of different factors, such as enterprise size, profitability, and industry type of firm. **Results:** The empirical evidence based on the pooled sample implies that enhanced digital transformation significantly boosts the capability of corporate risk-taking. Specifically, a comparison of the estimated coefficients obtained across the state-owned enterprises versus their non-state-owned counterparts shows a large difference in the magnitude for the latter. The increasing adoption of digital technologies heightens the propensity of those firms to invest in high-risk investments, hence improving their value at large. **Conclusions:** The study contributes to an understanding of how digital transformation affects corporate behavior in terms of risk-taking. It underlines the need to develop digital initiatives that contribute to investment efficiency and financial stability. The findings imply that policymakers and business leaders should encourage strategies of digital transformation, especially for non-state-owned enterprises, to achieve economic growth through increased risk-taking ability.

Keywords: enterprise risk-taking; digital transformation; property rights; investment efficiency; corporate governance; technological integration; economic growth

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ОРИГИНАЛЬНАЯ СТАТЬЯ

Влияние цифровой трансформации на принятие рисков: эмпирическое исследование японских компаний

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АННОТАЦИЯ

Цель: в данной статье рассматривается влияние цифровой трансформации на корпоративное принятие рисков в японских фирмах и, что еще более важно, выявляются связи между интеграцией цифровых технологий и склонностью компаний к риску. В исследовании рассматривается влияние цифровой трансформации на качество внутреннего контроля, эффективность инвестиций и общую финансовую устойчивость, с особым акцентом на различия между государственными и негосударственными предприятиями. **Методы:** в эмпирическом анализе используются данные компаний, входящих в индекс Nikkei с 2010 по 2023 г. Из общего числа, за исключением финансового и страхового секторов, а также предприятий с аберран-

тными статусами в торговле, по 225 фирмах было проведено 14 567 наблюдений. Регрессионные модели включали различные факторы, такие как размер предприятия, прибыльность и отраслевой тип фирмы. **Результаты:** эмпирические данные, основанные на объединенной выборке, свидетельствуют о том, что расширенная цифровая трансформация значительно повышает способность корпоративного принятия риска. В частности, сравнение оценочных коэффициентов, полученных по государственным предприятиям и их негосударственным аналогам, показывает большую разницу в величине для последних. Широкое внедрение цифровых технологий повышает склонность этих фирм к инвестициям с высоким уровнем риска, что в целом увеличивает их стоимость. **Выводы:** исследование способствует пониманию того, как цифровая трансформация влияет на корпоративное поведение с точки зрения принятия риска. Оно подчеркивает необходимость разработки цифровых инициатив, которые способствуют эффективности инвестиций и финансовой стабильности. Результаты свидетельствуют, что политики и руководители бизнеса должны поощрять стратегии цифровой трансформации, особенно для негосударственных предприятий, для достижения экономического роста за счет повышения способности принимать риски.
Ключевые слова: принятие риска предприятием; цифровая трансформация; права собственности; эффективность инвестиций; корпоративное управление; технологическая интеграция; экономический рост

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Introduction

The fourth plenary session of the 19th government of Japan in October 2019 incorporated "data" into the distribution of production factors. It explicitly advocated for the use of digital transformation as the primary catalyst to advance the modernization of government governance and enhance the efficiency of enterprises in the capital market. In Japan's present economic development, digital transformation has emerged as a crucial strategic approach for firms to attain high-quality growth and gain essential competitive advantage. This transformation is a result of the integration of digital technology with the real economy. The ability of firms to effectively accomplish digital transformation and upgrading is crucial for economic development [1]. Digital transformation is a significant catalyst for stabilizing Japan's economic growth since it has a profound influence on all aspects of business operations and development [2]. It contributes to better economic growth by enhancing corporate growth. Furthermore, for smaller financial institutions, the tendency to take higher risks tends to increase investment in research and development (R&D) programs. This also has a significant impact on the value of the firm as it leads to socio-technical development and ultimately to economic growth [3]. By combining the aforementioned factors, the convergence of digital transformation and business risk management can significantly facilitate economic expansion. Digital transformation refers to the integration of digital technologies in the operations of a firm, leading to significant changes in its internal processes [4]. These changes have a significant impact on the company's ability to acquire resources. Organizational risk taking, which is considered a type of resource management behavior [5], can be affected by digital transformation, and the two are linked to some extent [6]. It is important to understand the the relationship between two. It provides valuable input and policy guidance to the government to guide economic growth [7].

Digital transformation significantly affects firms' risk appetite by increasing their investment efficiency, information processing capabilities, and internal process efficiency. Using big data analytics, firms can gain insights into customer demand, which can increase knowledge of capital markets and increase their risk tolerance [8, 9]. Digital transformation also improves information processing capabilities, allows direct access to business functions and processes, makes it easier to identify inefficiencies, and optimizes internal processes [10, 11]. This reduces inadequate information, enables companies to assess their growth status and improves financial stability. Digital transformation definition is a well-planned integration of digital technologies into all organization processes, which completely changes how it performs and delivers value for its customers [12]. It is more than just the adoption of big data, artificial intelligence, or the Internet of Things but represents the cultural shift that enables innova-

tion and agility within the enterprise [13]. Risk tolerance definition is the degree of uncertainty that an investor is willing and able to withstand in the value of their investment portfolio [14]. The amount of risk that an investor is willing and able to take to meet their financial goals or objectives.

This study aims to investigate the relationship between digital transformation and business risk-taking in property opportunities, with the hypothesis that digital transformation can improve firm value through a higher willingness to risk by encouraging the development [15]. The research seeks the impact of digital transformation on investment in particular, total factor productivity and corporate performance [16]. The paper contributes to existing research on the economic consequences of digital transformation and introduces contextual variables related to the nature of property rights to enhance understanding of these relationships.

Literature review

Digital transformation refers to the strategic use of digital technology by organizations to gain a competitive advantage in the market [17]. Japan's digital economy is rapidly advancing, leading to an increasing number of enterprises adopting digital technologies such as big data, the Internet of Things, and artificial intelligence to revolutionize their business processes and models [18]. Factors that impact digital transformation include the macroeconomic environment and microenterprises peculiarities [19]. At the macroeconomic level, companies have a higher likelihood of acquiring financial resources due to interest rate marketization. The advancement of digital finance offers technological assistance for the process of digital transformation [20]. Existing research primarily examines microenterprise features through the lens of political linkages and institutional investors. Political ties may be a powerful catalyst for the digital transformation of small and medium-sized firms, while diverse institutional investors have varying impacts on digital transformation [21].

Financial repercussions of digital transformation include enhanced productivity and efficiency, bolstered internal control capabilities, innovation drive, reduced audit expenses, decreased information asymmetry, conveyed favorable messages to external stakeholders, enhanced corporate social responsibility, raised market expectations, and improved performance in the capital market [22]. Both the theoretical and practical communities have shown a great deal of interest in the factors that influence risk-taking, which is essential to the establishment and operation of businesses [23]. Differences in equity ratios have a significant impact on risk-taking within a company's internal governance. State-owned shares have a significant inhibiting effect on risk-taking, while foreign shares have a significant increasing effect [24]. Executives' aversion to risk can decrease their willingness to take risks when dealing with agency problems. Offering incentives to executives can effectively decrease agency problems in companies, thus enhancing the level of risk-taking [25].

External governance levels and industrial policy can enhance government subsidies and loan support for enterprises, increasing their risk appetite [26]. Regional economic policy uncertainty can significantly impact business decision-making and create development opportunities for enterprises, leading to increased risk-taking [27]. Tax increases have a fantastic effect in decreasing danger-taking conduct, at the same time as tax reductions do not have a considerable effect on the danger urge for food. Institutional fragility amplifies the uncertainty surrounding managers' destiny projections and heightens the chance of danger aversion, diminishing the propensity of companies to take dangers [28]. This paper conducts an empirical evaluation to observe the effect of virtual transformation on corporate risk-taking, exploring contextual traits and action mechanisms involved [29].

While setting up the causality between digital transformation and corporate risk-taking, other ways of analysis have to be taken into consideration in order to show the possible complicating variables. This can be done with the non-causal method of the two-step approach: establishing the relationship of digital transformation to the risk appetite, one examines how other variables affect this relationship. The proposed methodology enables researchers to account for a number of alternative confounding variables, organizational size, industry type, and external economic conditions that might also affect a firm's risk appetite. Indeed, factors other than digital transformation, such as managerial risk preferences, market competition, and regulatory environments,

could separately influence a company's attitude toward taking risks. In a nutshell, although digital transformation has an essential role in shaping corporate risk appetite through improvement in information processing and efficiency of investment, the relationship is also crucially affected by other factors such as managerial preferences and market dynamics.

Theoretical analysis and research hypothesis

Risk-taking is a key driver of collaboration, and digital transformation is the process of integrating digital technology into various parts of an organization [30]. This transformation can improve resource management, reduce information duplication and increased economic stability. Digital transformation has increased distribution, improve internal control quality, and increase risk-taking [31]. By integrating real-time market data, businesses can make informed investment decisions based on market demand, leading to increased investment efficiency and risk-taking. Moreover, digital transformation can strengthen information management and internal controls, leading to increased risk-taking [32]. Furthermore, digital transformation has increased financial efficiency, enhanced financial stability, and increased risk-taking [33]. In situations of limited financial stability, favorable economic conditions can improve profitability and encourage managers to invest in equity, thereby increasing risk-taking [34]. Overall, digital transformation can increas corporate risk-taking through increased financial leverage, improved internal controls and financial stability. Therefore, this paper proposes hypothesis 1:

H1: Digital transformation can increase the level of corporate risk-taking.

Digital transformation can improve investment efficiency and increase risk-taking in organizations. However, property rights play a significant role in this process. State-owned firms, with limited market competition, may not be motivated to adopt digital transformation [35]. Private firms, on the other hand, face intense competition and digital transformation, which has enhanced their investment effectiveness and financial resilience. State-owned firms may prioritize stable projects over risk-taking, while privately-owned companies may allocate resources toward high-risk projects. Therefore, digital transformation's impact on risk-taking capacity is less significant in state-owned enterprises. State-owned enterprises (SOEs) in Japan are those businesses where the government has a significant share that enables it to direct operations, decisions, and strategies of the company. These companies, in general, serve public interests or play a very important economic, infrastructural, or strategic role. The Japanese government controls the company's stock through direct investments or designated entities. Most Japanese SOEs aim to stabilize vital services (such as electricity, transportation), and others contribute to promoting innovation or maintaining national security. Some of the privatized Japanese SOEs include Japan Post, Japan Railways, and Nippon Telegraph and Telephone. In certain strategic sectors, partial governmental ownership is maintained either for purposes of governance or public benefit. Because of their quasi-governmental character, SOEs may receive subsidies or special rules. This may lower the pressure to innovate or take risks via market forces. The study found that SOEs are less risk-taking and slower to implement digital transformation compared to non-state-owned firms because of their emphasis on stability and lesser competitive pressure. Based on this, this paper proposes hypothesis 2:

H2: Compared with state-owned enterprises, the digital transformation of non-state-owned enterprises has a stronger effect on improving the level of corporate risk-taking.

Research design

Sample selection and data sources

This study utilizes data from the Nikkei Index businesses in Japan's capital market between 2010 and 2023 as the research sample. The data is organized as follows: (1) Exclude data from the financial and insurance sectors; (2) Exclude data from aberrant trading statuses; (3) Exclude data with missing values, resulting in a final sample size of 14,567 observations of 225 companies listed on Japan's Nikkei Index. The internal control quality index is derived from the Internal Control Quality Index (ICQI) database, while additional data is sourced from the Bloomberg database. This work applies Winsorize shrinkage processing to all continuous variables, namely at the 1% and 99% quantiles, in order to mitigate the negative impact of extreme sample values on the data.

Variable definition

Explained variable. RISK denotes the degree of risk that a corporation is willing to undertake. This research examines the methodology used by [6] and utilizes the earnings volatility indicator as a measure of business risk-taking. More precisely, the industry-adjusted total asset return rate is analyzed over a three-year period to determine its standard deviation and range. These values are then referred to as RISK1 and RISK2, respectively.

Explanatory variables. DDT is a metric that quantifies the extent to which an organization has undergone digital transformation. This article discusses the study conducted by [36] and provides a definition of digital transformation as the fundamental concept used in the process of digitalization. The logarithm of word frequency in the deployment of digital technology inside a business is utilized to provide a precise measure of digital transformation. The indicator is derived using a dataset obtained from the textual content of the annual reports of publicly traded corporations, using the programming language Python.

Situational variables. NONSOE symbolizes the essence of possession. If the firm is controlled by a non-state entity, the value is 1; otherwise, it is 0.

Control variables. This article discusses the methodology used by Wu Fei et al. (2021) [36] and identifies the specific variables that were chosen for control. These variables include enterprise size (SIZE), cash holding level (CASH), debt-to-asset ratio (LEV), profitability (ROA), growth ability (GROWTH), equity concentration (FIRST), enterprise age (AGE), board size (BOARD), proportion of independent directors (RATIO), dual-position director combination (DUAL), loss status (LOSS), annual dummy variable (YEAR), and industry dummy variable (INDUS). *Table 1* displays the variables and their corresponding meanings in this study.

Model Setting

To examine the influence of digital transformation on corporate risk-taking as stated in Hypothesis 1, this study adopts the methodology proposed by Wu Fei [36] and develops model (1) to assess the extent to which digital transformation enhances corporate risk-taking.

$$RISK = \beta_0 + \beta_1 ADT + \beta_2 SIZE + \beta_3 CASH + \beta_4 LEV + \beta_5 ROA + \beta_6 GROWTH + \beta_7 FIRST + \\ + \beta_8 AGE + \beta_9 BOARD + \beta_{10} RATIO + \beta_{11} DUAL + \beta_{12} LOSS + YEAR + INDUS + \in . \quad (1)$$

Based on the theoretical study presented in the previous article, the coefficient of the DDT item of anticipated digital transformation, β_1, is shown to be much bigger than 0. This suggests that digital transformation has a strong positive impact on the risk-taking capacity of organizations.

Table 1
Variable definition and description

Variable type	Variable name	Variable symbol	Variable definition
Interpreted variable	Corporate risk-taking level	RISK1	Rolling calculation of the standard deviation of the three-year industry-adjusted total return on assets
		RISK2	Rolling calculation of the extremely poor three-year industry-adjusted total return on assets
Explanatory variables	Degree of digital transformation	DDT	See the previous article for the specific calculation method
Situational variables	Nature of property rights	NONE	When the nature of the enterprise is non-state-owned, the value is assigned to 1, otherwise, it is 0

Control variable	Enterprise scale	SIZE	Natural logarithmic value of total assets
	Cash holding level	CASH	The ratio of cash flow to total assets at the end of the year
	Asset-liability ratio	LEV	The ratio of total liabilities to total assets
	Profitability	ROA	The ratio of net profit to average total assets
	Growth ability	GROWTH	(Current year's operating income-previous year's operating income)/Previous year's operating income
	Equity concentration	FIRST	The proportion of shares held by the largest shareholder
	Business age	AGE	LN (Research year-listing year +1)
	Size of the board of directors	BOARD	The natural logarithm of the number of directors
	Proportion of independent directors	RATIO	The ratio of the number of independent directors to the number of directors
	Two jobs in one	DUAL	If the chairman is also the CEO, the value is assigned to 1, otherwise it is 0
	Loss status	LOSS	Take 1 when the net profit is negative, otherwise take 0
	Year	YEAR	Covers 11 years and sets 10 virtual variables
	Industry	INDUS	Set industry virtual variables according to the 2012 SFC industry classification standards
RISK	Risk-taking level measured by earnings volatility	Standard Deviation (%)	Bloomberg
DDT	Degree of digital transformation	Logarithm of Word Frequency	Annual Reports Dataset

Source: Developed by the authors.

This study aims to analyze the function of property rights in different situations. To do this, the paper presents the cross-product DDT×NONSOE and property rights NONSOE of digital transformation, based on model (1), to develop a model (2).

$$RISK = \beta_0 + \beta_1 ADT + \beta_2 DDT \times NONSOE + \beta_3 NONSOE + \beta_4 SIZE + \beta_5 CASH + \beta_6 LEV + \beta_7 ROA + \\ + \beta_8 GROWTH + \beta_7 FIRST + \beta_{10} AGE + \beta_{11} BOARD + \beta_{12} RATIO + \beta_{13} DUAL + \\ + \beta_{14} LOSS + YEAR + INDUS + \in . \quad (2)$$

Empirical results and analysis

Descriptive statistics and analysis

Table 2 presents the statistical summary of the primary variables. The average values for RISK1 and RISK2 are 0.0456 and 0.0598, with standard deviations of 0.0612 and 0.0875, and 3/4 quantiles of 0.0480 and 0.0628, respectively. This suggests that the majority of organizations have similar degrees of risk-taking. The average value of DDT is 1.3981, with a maximum value of 4.4438 and a minimum value of zero. This suggests significant variations in the extent of digital transformation

Table 2
Descriptive statistics of the main variables

variable	Observed value	Mean	Standard deviation	Minimum value	1/4 quantile	median	3/4 quantile	Maximum value
RISK1	14567	0.0456	0.0612	0.0016	0.0123	0.0185	0.048	0.3457
RISK2	14567	0.0598	0.0875	0	0.0177	0.0468	0.0628	0.4785
DDT	14567	1.3981	1.0657	0	0.6842	1.3843	2.1672	4.4438
NONSOE	14567	0.7532	0.5327	0	0	1	1	1
SIZE	14567	21.8721	1.3658	19.8622	20.4305	22.1832	22.8727	25.2325
CASH	14567	0.0487	0.0678	−0.3421	0.0085	0.0573	0.095	0.3313
LEV	14567	0.5054	0.2113	0.0485	0.1797	0.5136	0.5547	0.7862
ROA	14567	0.0487	0.0713	−0.413	0.0195	0.0426	0.0934	0.2359
GROWTH	14567	0.2075	0.4386	−0.4579	−0.0273	0.1282	0.3596	2.7573
FIRST	14567	0.2889	0.236	0.0317	0.2113	0.3108	0.4294	0.7465
AGE	14567	1.8957	0.8326	0	1.3843	2.0794	2.7726	3.2581
BOARD	14567	2.0246	0.1796	1.6183	1.7348	2.1672	2.1672	2.6391
RATI	14567	0.4093	0.0635	0.2537	0.2537	0.3545	0.4286	0.5714
DUAL	14567	0.4024	0.4347	0	0	0	1	1
LOSs	14567	0.0892	0.2847	0	0	0	0	1

Source: Developed by the authors.

among Japanese companies. This presents an opportunity for this paper to examine the correlation between digital transformation and levels of corporate risk-taking. The average value of NONSOE is 0.7532, suggesting that 68.41% of the firms in the study sample own property rights that are not controlled by the state. Therefore, it is very significant to include property rights as a contextual variable in further research. The average value of SIZE is 21.8721, with a high of 25.2325 and a low of 19.8622, suggesting a significant variation in the size of the sample firms. The average value of CASH is 0.0487, and the 3/4 quantile is 0.0950, suggesting that the majority of the sampled enterprises exhibit favorable cash flow. The average value of Return on Assets (ROA) is 0.0487, with a standard deviation of 0.0713. This suggests that the profitability of the enterprises in the sample is generally consistent. The average value of GROWTH is 0.2075, with a maximum value of 2.7573 and a lowest value of −0.4579. This suggests significant variations in the growth potential across the firms in the sample. The average value of DUAL is 0.4024, which signifies that 38.15% of the organizations in the survey had both the chairman and general manager positions held by the same person.

Correlation analysis

Table 3 reports the results of the correlation analysis of the main variables. The coefficients of RISK1, RISK2, and DDT are all significantly positive at the 10% level, and the Spearman correlation coefficients are similar, so they will not be repeated. This preliminary shows that the higher the degree of digital transformation, the higher the level of corporate risk-taking, and Hypothesis 1 is verified. However, the relationship between digital transformation and corporate risk-taking needs to be further tested in the following multivariate regression analysis.

Analysis of multiple regression results

Table 4 lists the results of the multivariate regression analysis of the relationship between digital transformation and corporate risk-taking. From the regression results, it can be found that

Table 3
Correlation analysis of main variables

Variable	RISK1	RISK2	DDT	NONSOE
RISKI	1	0.9841*	0.0468*	0.0378*
RISK2	0.9861*	1	0.0526*	0.0736*
DDT	0.0531*	0.0538*	1	0.0883*
NONSOE	0.0651*	0.0657*	0.0876*	1

Source: Developed by the authors.

Note: * — indicate that they are significant at the levels of 10%.

DDT is significantly positively correlated with RISK1 and RISK2 at the 1% level. This result shows that digital transformation can significantly improve the level of corporate risk-taking; that is, the higher the degree of digital transformation, the higher the level of corporate risk-taking, and hypothesis 1 is verified. The possible reason is that the higher the degree of digital transformation, the wider the scope of application of digital technology in the enterprise, the higher the information transparency of the enterprise, the lower the degree of information asymmetry, and it can improve the internal governance level and resource allocation efficiency of the enterprise, enhance financial stability, lay a stable development foundation for the enterprise, and enhance the confidence of the enterprise in venture capital, thereby improving the level of corporate risk-taking.

In terms of control variables: the coefficient of the SIZE item is significantly negative, indicating that the expansion of enterprise scale may reduce the enterprise's risk-taking level; the coefficient of the CASH item is significantly positive, indicating that the enterprise's cash holdings can improve the enterprise's risk-taking level to a certain extent; the coefficient of the AGE item is significantly positive, indicating that the longer the enterprise operates, the stronger its risk resistance ability and the higher its risk-taking level; the coefficient of the GROWTH item is significantly positive, indicating that the stronger the enterprise's growth ability, the higher its risk-taking level.

Digital transformation affects corporate risk-taking greatly because it improves the efficiency of investments, enhances internal controls, and contributes to better financial stability. When organizations become more digital, their capacity to process information about the market is heightened; therefore, decisions become better. The enhanced capability would then enable firms to spot more opportunities for growth and thereby optimally allocate their resources, culminating in the desire and will to undertake more ventures with a high level of risk. Research shows that those companies that are at high levels or have undergone digital transformation have significantly higher risk appetites, exemplified by investments in innovative projects and ventures that would have been viewed as too risky in the past. The digital transformation effects on risk-taking are noticeably different between SOEs and non-SOEs. Normally, SOEs focus on stability and public service but not on aggressive growth strategy, and thus the propensity of risk is relatively low compared with that of non-SOEs. Non-SOEs are, however, under the whip of competitive power and innovative impulse and are thus more likely to adopt digital transformation so as to enhance their operational efficiency and financial resilience. Therefore, the effect of digital transformation on risk appetite is more salient in the case of non-SOEs, where the integration of advanced digital technologies can lead to drastic improvements in investment effectiveness and an overall rise in corporate risk appetite.

The study reveals that digital transformation has a stronger effect on improving the risk-taking level of non-state-owned enterprises compared to state-owned enterprises. This is due to two reasons: first, state-owned enterprises have special policy attributes and natural advantages in resource acquisition and market recognition, while non-state-owned enterprises face fierce market competition and weaker competitive pressure. They lack motivation to carry out digital transformation, making it difficult to form positive feedback of resources. Second, state-owned en-

Table 4
Digital transformation and corporate risk-taking level

Variable	(1) RISK1	(2) RISK2
DDT	0.0031***(5.3276)	0.0048***(5.3236)
SIZE	−0.0054***(−11.7536)	−0.0120***(−12.1216)
CASH	0.0538***(6.1625)	0.0976***(5.7648)
LEV	0.0092**(2.2152)	0.0246**(2.1764)
N	−0.1743***(−11.2234)	−0.3321***(−11.1477)
ROA	0.0123***(5.4235)	0.0182***(6.5573)
GROWTH	−0.0127***(−4.5533)	−0.0176***(−4.5377)
FIRST	0.0064***(10.7438)	0.0114***(12.4367)
AGE	−0.0065**(−2.3833)	−0.0105**(−2.3456)
BOARD	0.0074(1.1324)	0.0183(1.1555)
RATI	0.0001(0.1148)	0.0004(0.2157)
DUAL	0.0347***(13.8915)	0.0546***(15.5374)
LOSS	0.1873***(16.3854)	0.2835***(14.1283)
Constant	Yes	Yes
YEAR/INDUS	15 258	14 659
Adj-R 2	0.3517	0.3535

Source: Developed by the authors.

Note: ***, ** — indicate that they are significant at the levels of 1% and 5%, respectively, and the t value is in parentheses. Same below.

terprises' managers are more inclined to invest in low-risk projects, limiting the room for digital transformation to improve risk-taking levels. However, non-state-owned enterprises are more concerned about their own profit-making goals, and investment returns are often closely related to performance evaluation. Therefore, compared to state-owned enterprises, the digital transformation of non-state-owned enterprises has a stronger effect on improving their own risk-taking level. This supports Hypothesis 2.

Sensitivity test

Instrumental variable method

This paper uses the regional mean of the degree of digital transformation as an instrumental variable. The rationality of this instrumental variable is as follows: first, the degree of digital transformation is closely related to the level of digital transformation in each region, which meets the correlation of the instrumental variable; second, the regional level of digital transformation is less correlated with the risk-taking level of individual enterprises, which meets the exogeneity requirement of the instrumental variable. The specific regression results are shown in *Table 6:* DDT and RISK1 and RISK2 are all significantly positive at the 5% level, indicating that after controlling for endogeneity, digital transformation can significantly improve the risk-taking level of enterprises, and the research conclusions are still robust.

Propensity score matching

This paper uses the 1:1 nearest neighbor matching method to address potential endogeneity issues in a model. The median of digital transformation is used as the dividing line, with values greater than the median set to 1 and values less than the median set to 0. The experimental group and control group showed significant differences before and after propensity score matching. The regression results show that DDT in Panel A is significantly positively correlated

Table 5
Digital transformation and enterprise risk-taking level: Situational analysis of the nature of property rights

Variable	_(1) RISK1	(2) RISK2
DDT	−0.0010***(−2.6353)	−0.0020***(−2.7496)
DDT×NONSOE	0.0030***(5.4754)	0.0055***(5.6017)
NONSOE	0.0036***(2.7581)	0.0068***(2.9144)
Constant	0.1770***(14.7478)	0.2574***(12.3306)
Control variable	Yes	Yes
YEAR/INDUS	Yes	Yes
N	14 567	14 567
Adj-R2	0.2644	0.2751

Source: Developed by the authors.

Note: *** — indicate that they are significant at the levels of 1%.

Table 6
Digital Transformation and Enterprise risk-taking level: Tool Variable Method

Variable	(1) RISK1	(2) RISK2
DDT	0.0063**(2.4144)	0.0058**(2.3419)
Constant	0.2085***(20.3713)	0.2965***(15.6935)
Control variable	Yes	Yes
YEAR/INDUS	Yes	Yes
N	14 567	14 567
Adj-R2	0.2540	0.2655

Source: Developed by the authors.

Note: ***, ** — indicate that they are significant at the levels of 1% and 5%, respectively.

with RISK1 and RISK2 at the 1% level, and the coefficients of the DDT×NONSOE items in Panel B are also positively correlated at the 1% level. The research concludes that after propensity score matching, the research conclusions remain robust.

Replace the explanatory variables
This paper focuses on the robustness of digital transformation research by dividing it into five aspects: artificial intelligence, big data, computing, blockchain, and digital technology applications. The indicators are derived from annual reports of listed companies using Python and classified into specific technical directions. The total indicators of digital transformation are obtained by summing up the five classified indicators, resulting in the Digital Transformation Group (DCG). The data is then re-substituted into regression models, and the results are shown in *Table 8*. The DCG is found to be significantly positively correlated with RISK1 and RISK2 at the 10% level, and the coefficients of the DCG×NONSOE items in Panel B are also positive at the 1% level. In conclusion, the research conclusions remain robust even after changing the measurement method of digital transformation.

Replace the explained variable
This paper refers to the practice of [7] and respectively calculates the standard deviation of the ratio of operating profit to total assets and the ratio of EBIT to total assets adjusted by the industry average for three years as alternative variables for corporate risk-taking level, denoted

Table 7
Digital transformation and enterprise risk-taking level: Tendency score matching method

Variable	Panel A: Digital Transformation and Risk-taking level		Panel B: Situational analysis of the nature of property rights	
	(1) RISK1	(2) RISK2	(3) RISK1	(4) RISK2
DDT	0.0025***(5.0286)	0.0024***(4.9724)	-0.0012**(−2.2362)	-0.0009*(−1.8735)
DDT×NONSOE			0.0033***(3.6634)	0.0028***(4.3245)
NONSOE			0.0038(1.5684)	0.0035(1.5467)
Constant	0.1532***(10.6452)	0.1604***(11.0435)	0.1664***(9.4514)	0.1457***(9.7655)
Control variable	Yes	Yes	Yes	Yes
YEAR/INDUS	Yes	Yes	Yes	Yes
N	7119	7119	7119	7119
Adj-R2	0.2629	0.2858	0.3768	0.2975

Source: Developed by the authors.

Note: ***, ** and * indicate that they are significant at the levels of 1%, 5% and 10%, respectively.

as RISK3 and RISK4. The re-measured corporate risk-taking level indicators are substituted into Model (1) and Model (2) for regression, and the results are shown in *Table 9*. It can be seen that DDT in Panel A of *Table 9* is significantly positively correlated with RISK3 and RISK4 at the 1% level, and the coefficients of the DDT×NONSOE items in Panel B are significantly positive at the 1% level. The above results show that after changing the measurement method of corporate risk-taking level, the research conclusions remain robust.

Path Analysis

In the theoretical analysis and research hypothesis part, this paper believes that digital transformation can improve investment efficiency, optimize internal control quality, and improve financial stability, thereby increasing the level of corporate risk-taking. Therefore, this paper adopts a mediation effect model to test the mediating role of investment efficiency, internal control quality, and financial stability in the relationship between digital transformation and corporate risk-taking, as follows:

Test of mediating effect based on investment efficiency

In order to test whether investment efficiency plays a mediating role in the relationship between digital transformation and corporate risk-taking, this paper constructs Model (3) and Model (4), as follows:

$$INVEFF = \beta_0 + \beta_1 DDT + \beta_2 SIZE + \beta_3 CASH + \beta_4 LEV + \beta_5 ROA + \beta_6 GROWTH + \beta_7 FIRST + \beta_8 AGE + \\ + \beta_9 BOARD + \beta_{10} RATIO + \beta_{11} DUAL + \beta_{12} LOSS + YEAR + INDUS + \in . \quad (3)$$

$$RISK = \beta_0 + \beta_1 DDT + \beta_2 INVEFF + \beta_3 SIZE + \beta_4 CASH + \beta_5 LEV + \beta_6 ROA + \beta_7 GROWTH + \\ + \beta_8 FIRST + \beta_9 AGE + \beta_{10} BOARD + \beta_{11} RATIO + \beta_{12} DUAL + \beta_{13} LOSS + YEAR + INDUS + \in . \quad (4)$$

Among them, INVEFF represents the investment efficiency of enterprises. This article refers to the practices of [8–12] and uses the absolute value of the residual in the investment efficiency model as a proxy variable for enterprise investment efficiency. The higher the absolute value, the lower the enterprise investment efficiency.

Table 10 reports the results of the mediation effect test based on investment efficiency. In Panel A, DDT and INVEFF are significantly negative at the 1% level, indicating that digital transformation can

Table 8
Digital transformation and enterprise risk-taking level: Changing the measurement method of digital transformation

Variable	Panel A: Digital Transformation and Risk-taking level		Panel B: Situational analysis of the nature of property rights	
	(1) RISK1	(2) RISK2	(3) RISK1	(4) RISK2
DCG	0.0005*(1.6325)	0.0011*(1.5872)	−0.0011***(−2.5454)	−0.0021***(−2.6587)
DCG×NONSOE			0.0031***(5.3646)	0.0054***(4.7236)
NONSOE			0.0035***(2.6472)	0.0057***(2.8132)
Constant	0.1944***(16.3335)	0.2812***(13.9548)	0.1762***(13.6569)	0.2463***(11.4515)
Control variable	Yes	Yes	Yes	Yes
YEAR/INDUS	Yes	Yes	Yes	Yes
N	13202	13202	13202	13202
Adj-R2	0.2484	0.2588	0.2755	0.2662

Source: Developed by the authors.

Note: *** and * indicate that they are significant at the levels of 1%, and 10%, respectively.

Table 9
Digital transformation and enterprise risk-taking level: Change the measurement method of enterprise risk-taking level

Variable	Panel A: Digital Transformation and Risk-taking level		Panel B: Situational analysis of the nature of property rights	
	(1) RISK3	(2) RISK4	_(3) RISK3	(4) RISK4
DDT	0.0022***(5.4513)	0.0022***(5.4956)	−0.0008**(−3.1784)	−0.0007*(−1.7258)
DDT×NONSOE			0.0035***(4.7257)	0.0019***(4.5472)
NONSOE			0.0024***(3.5114)	0.0026***(1.8539)
Constant	0.1725***(16.3372)	0.1627***(15.6125)	0.1541***(14.5924)	0.1547***(14.1713)
Control variable	Yes	Yes	Yes	Yes
YEAR/INDUS	Yes	Yes	Yes	Yes
N	13 202	13 202	13 202	13 202
Adj-R2	0.3746	0.1937	0.3765	0.2742

Source: Developed by the authors.

Note: ***, ** and * indicate that they are significant at the levels of 1%, 5% and 10%, respectively.

significantly improve the investment efficiency of enterprises. On the basis of model (1), the investment efficiency is further controlled, and the results are shown in column (3): DDT and RISK1 are significantly positive at the 1% level, and INVEFF and RISK1 are significantly negative at the 5% level; the results in Panel B are similar and will not be repeated. The above data show that investment efficiency plays a mediating role in the impact of digital transformation on the level of corporate risk-taking; that is, there is a mediation effect transmission path of "digital transformation-investment efficiency-enterprise risk-taking level". Therefore, digital transformation can improve the investment efficiency of enterprises, enhance the confidence of enterprises in venture capital, and thus improve the level of corporate risk-taking.

Test of the mediating effect based on internal control quality

In order to test whether internal control quality plays a mediating role in the relationship be-

tween digital transformation and corporate risk-taking level, this paper constructs Model (5) and Model (6), as follows:

$$IC = \beta_0 + \beta_1 DDT + \beta_2 SIZE + \beta_3 CASH + \beta_4 LEV + \beta_5 ROA + \beta_6 GROWTH + \beta_7 FIRST + \beta_8 AGE + \\ + \beta_9 BOARD + \beta_{10} RATIO + \beta_{11} DUAL + \beta_{12} LOSS + YEAR + INDUS + \in . \quad (5)$$

$$RISK = \beta_0 + \beta_1 DDT + \beta_2 IC + \beta_3 SIZE + \beta_4 CASH + \beta_5 LEV + \beta_6 ROA + \beta_7 GROWTH + \beta_8 FIRST + \\ + \beta_9 AGE + \beta_{10} BOARD + \beta_{11} RATIO + \beta_{12} DUAL + \beta_{13} LOSS + YEAR + INDUS + \in . \quad (6)$$

The article uses the Internal Control Quality Index (ICQI) to measure internal control quality, which is a key factor in determining an enterprise's internal governance level. The results of a mediation effect test show that digital transformation can significantly improve internal control quality, with DDT and IC showing significant positive results at the 1% level. This indicates that digital transformation can also enhance risk-taking levels in enterprises. The mediation effect transmission path is "digital transformation-internal control quality-enterprise risk-taking level". This suggests that digital transformation can enhance risk warning, prevention, and control capabilities, ultimately improving the risk-taking level of enterprises. The data suggests that digital transformation can play a mediating role in the impact of digital transformation on enterprise risk-taking levels.

Table 10

Digital transformation and enterprise risk-taking level: Intermediary effect test based on investment efficiency

Variable	**Panel A: RISK1**			**Panel B: RISK2**		
	(1) RISK1	(2) INVEFF	(3) RISK1	(4) RISK2	(5) INVEFF	(6) RISK2
DDT	0.0022*** (5.5634)	−0.0023* (−5.5367)	0.0021*** (5.5682)	0.0046*** (4.9558)	−0.0022* (−5.5684)	0.0028*** (4.4487)
INVEFF			−0.0265** (−2.3717)			−0.0578** (−3.3563)
Constant	0.1723*** (14.7244)	−0.0233*** (−5.1486)	0.1825*** (14.9348)	0.3824*** (14.8693)	−0.034* (−5.1255)	0.2765*** (12.7653)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
YEAR/ INDUS	Yes	Yes	Yes	Yes	Yes	Yes
N	13 191	13 191	13 191	13 191	13 191	13 191
Adj−R2	0.2674	0.3551	0.2677	0.2583	0.3552	0.2746

Source: Developed by the authors.

Note: ***, ** and * indicate that they are significant at the levels of 1%, 5% and 10%, respectively.

Table 11

Digital transformation and enterprise risk-taking level: Intermediary effect Inspection based on Internal control quality

Variable	Panel A: RISK1		Panel B: RISK2			
	(1) RISK1	(2) IC	(3) RISK1	(4) RISK2	(5) IC	(6) RISK2
DDT	0.0021***	0.0064***	0.0027***	0.0027***	0.0076***	0.0044***
	(4.6951)	(6.1154)	(5.3651)	(5.7311)	(6.1174)	(3.2214)
IC				0.0333*** 6.8426)		0.0312***
						(7.6553)
Constant	0.14782***	0.4259***	0.2417***	0.2174***	0.2456***	0.1874***
	(13.3127)	(6.2352)	(13.4475)	(12.1556)	(7.2142)	(10.6755)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
YEAR/ INDUS	Yes	Yes	Yes	Yes	Yes	Yes
N	11 960	11 960	11 960	11 960	11 960	11 960
Adj-R2	0.2785	0.1357	0.2733	0.3752	0.2136	0.1817

Source: Developed by the authors.

Note: *** — indicate that they are significant at the levels of 1%.

Test of the mediating effect based on financial stability

In order to test whether financial stability plays a mediating role in the relationship between digital transformation and corporate risk-taking, this paper constructs Model (7) and Model (8), as follows:

$$Z-score=\beta_0+\beta_1 DDT+\beta_2 SIZE+\beta_3 CASH+\beta_4 LEV+\beta_5 ROA+\beta_6 GROWTH+\beta_7 FIRST+\beta_8 AGE+ \\ +\beta_9 BOARD+\beta_{10} RATIO+\beta_{11} DUAL+\beta_{12} LOSS+YEAR+INDUS+\in. \quad (7)$$

$$RISK=\beta_0+\beta_1 DDT+\beta_2 Zscore+\beta_3 SIZE+\beta_4 CASH+\beta_5 LEV+\beta_6 ROA+\beta_7 GROWTH+\beta_8 FIRST+ \\ +\beta_9 AGE+\beta_{10} BOARD+\beta_{11} RATIO+\beta_{12} DUAL+\beta_{13} LOSS+YEAR+INDUS+\in. \quad (8)$$

Among them, Z-score represents the financial stability of the enterprise. This article refers to the approach of [13] and uses Z-score to measure the financial stability of the enterprise. The higher the Z-score value, the lower the financial risk and the higher the financial stability.

Table 12 reports the results of the mediation effect test based on financial stability. The coefficients of DDT and Zscore in column (2) of Panel A are significantly positive at the 1% level, indicating that digital transformation can significantly improve the financial stability of enterprises. On the basis of model (1), the financial stability of enterprises is further controlled, and the results are shown in column (3): DDT and RISK1 are significantly positive at the 1% level, and Z-score and RISK1 are significantly positive at the 1% level; the results in Panel B are similar and will not be repeated. The above data show that financial stability plays a mediating role in the impact of digital transformation on the level of corporate risk-taking, that is, there is a mediation effect transmission path of «digital transformation-financial stability-enterprise risk-taking level». Therefore, digital transformation can improve financial stability and capital utilization efficiency, thereby improving the level of corporate risk-taking.

Expansion analysis

Digital transformation improves the internal environment such as internal control quality and financial stability, and enhances the willingness of enterprises to take risks by improving investment efficiency, thereby improving the level of corporate risk-taking. The economic consequences related to it deserve in-depth study. Risk, as the essence of business, is crucial to the operation and development of enterprises. Existing studies have found that the risk-taking activities undertaken by managers in pursuit of profit maximization are conducive to enhancing corporate value [15–16].

Table 12

Digital transformation and enterprise risk-taking level: An intermediary effect test based on financial stability

Variable	Panel A: RISK1			Panel B: RISK2		
	(1) RISK1	(2) Z_score	(3) RISK1	(4) RISK2	(5) Z_score	(6) RISK2
DDT	0.0034*** (5.7241)	0.2354*** (3.4566)	0.0034*** (5.7526)	0.0032*** (5.9736)	0.1242*** (3.1477)	0.0041*** (6.7962)
Z_score			0.0004*** (2.1358)			0.0003*** (1.8844)
Constant	0.1483*** (13.396)	25.4764*** (26.5138)	0.1224*** (14.6763)	0.2164*** (13.114)	25.2564*** (24.7258)	0.1877*** (12.5637)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
YEAR/ INDUS	Yes	Yes	Yes	Yes	Yes	Yes
N	12 848	12 848	12 848	12 848	12 848	12 848
Adj-R2	2816	0.5332	0.3624	0.471	0.3442	0.3734

Source: Developed by the authors.

Note: *** — indicate that they are significant at the levels of 1%.

The main reason is that a high level of risk-taking can increase managers' willingness to invest in projects with positive net present value but higher risks, fully tap and utilize favorable investment opportunities, promote the long-term development of enterprises, and promote corporate value creation. Therefore, this paper proposes the following hypothesis: Digital transformation enhances corporate value by increasing the level of corporate risk-taking.

In order to verify the above hypothesis, this paper uses TobinQ value to measure enterprise value and examines the mediating effect of digital transformation on improving enterprise value by increasing enterprise risk-taking level. The specific regression results are shown in *Table 13*. In the first column of Panel A, DDT and TobinQ are significantly positive at the 1% level, and in the second column, DDT and RISK1 are significantly positive at the 1% level, indicating that digital transformation can significantly improve the level of enterprise risk-taking. On the basis of model (1), digital transformation is further controlled, and the results are shown in column (3): RISK1 and TobinQ are significantly positive at the 1% level; the results in Panel B are similar and will not be repeated. The above data show that the level of enterprise risk-taking plays a mediating role in the impact of digital transformation on enterprise value, and digital transformation improves enterprise value by increasing the level of enterprise risk-taking.

Discussion

Considering the effect of digitization on risk-taking propensity among Japanese companies, this research has not given substantial discussion to the results; conclusions drawn here require further specification. This paper presents an empirical investigation of the impact of digital transformation on corporate risk-taking behavior by taking a sample of firms listed in Nikkei Index firms from 2010 to 2023. Digital Transformation Increases Risk-Taking: It was indicated that with an increased level of digital transformation, the corporations would engage in more and more risk-taking. Firms' ability to increase their willingness for riskier ventures rises with their enhanced digital capabilities. State-owned enterprises are less influenced in digital transformation for risk-taking, whereas the non-state-owned ones are impacted to a significant extent. This may be attributed to the fact that the latter focuses more on stability with low competitive pressure and thus has lower motivation to pursue the adoption of transformative technologies aggressively.

Mechanisms of digital transformation increase investment efficiency, improve the quality of internal control, and promote financial stability — the critical factors influencing risk-taking behavior within firms. Big data and advanced analytics can give a company a better notion of market demands and a better optimization of investment strategy, leading to its increased risk tolerance. Yet, while

Table 13
Digital transformation and enterprise value: Intermediary effect test based on risk-taking level

Variable	Panel A: RISK1		Panel B: RISK2			
	(1) Tobin	(2) RISK1	(3) TobinQ	(4) Tobin	(5) RISK2	(6) Tobin
DDT	0.0432*** (2.4355)	0.0020*** (5.1552)	0.0175*** (2.5743)	0.0462*** (3.4354)	0.0042*** (4.1122)	0.0379*** (2.9930)
RISK			2.7425*** (7.9925)			1.4426*** (8.6342)
Constant	10.3276*** (34.924)	0.1966*** (15.3873)	9.7663*** (30.6692)	10.4561*** (34.7841)	0.2716*** (14.8464)	11.5146*** (34.1516)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
YEAR/ INDUS	Yes	Yes	Yes	Yes	Yes	Yes
N	13 107	13 107	13 107	13 107	13 107	13 107
Adj-R2	0.2515	0.1545	0.2558	0.4513	0.3647	0.2564

Source: Developed by the authors.

Note: ***, ** and* indicate that they are significant at the levels of 1%, 5% and 10%, respectively.

the study gives good insights into the relationship between digital transformation and corporate risk-taking, it cautions that further discussion should be made on implications and recommendations at specific levels for businesses to leverage digital technologies for enhanced performances and risk management.

Conclusions and policy recommendations

Implementing digital transformation is a vital strategy for organizations to modernize and enhance their operations, and it plays a critical role in ensuring the long-term growth and success of these enterprises. Conceptually, the process of digital transformation will have an impact on the extent to which enterprises engage in risk-taking. This study utilizes the pertinent data of Japan's Nikkei Index businesses from 2010 to 2023 as the research sample to empirically examine the influence of digital transformation on the extent of enterprise risk-taking. The study findings indicate that digital transformation may significantly enhance the extent to which firms are willing to take risks.

Furthermore, digital transformation has a more pronounced impact on the risk-taking behavior of non-state-owned enterprises compared to state-owned enterprises. Despite conducting a number of sensitivity tests, including the instrumental variable approach, the propensity score matching method, and altering the measuring methods for digital transformation and corporate risk-taking, the study findings of this work remain consistent. Additional mechanism tests indicate that digital transformation mostly enhances company risk-taking by boosting investment efficiency, raising the quality of internal control, and bolstering financial stability. Furthermore, this study explores the economic implications of digital transformation on organizational risk-taking and concludes that digital transformation enhances company value by elevating the degree of risk-taking inside the organization. The objective of the study was to identify the consequences of digital transformation on risk-taking behavior at a firm level for Japanese firms. Increased digital transformation leads to a greater propensity of taking risks. Moreover, state-owned enterprises have less inclination towards digital transformation than the non-state-owned ones, which in turn are being significantly affected. Digital transformation improves internal control quality and investment efficiency, besides financial stability, which factors into risk-taking behavior. However, the implications and recommendations for businesses to utilize digital technologies to perform better and minimize risk require further discussion.

The study findings of this article are valuable for conducting a thorough analysis of the influence of digital transformation on the extent of corporate risk-taking. Additionally, they provide guidance to the government in promoting digital transformation and enhancing the degree of enterprise risk-taking. Based on the aforementioned study findings, this report proposes the following two recommendations. Firstly, it is crucial for organizations to prioritize digital transformation. Implementing digital transformation may promote resource allocation efficiency, optimize internal governance, improve financial stability, and ultimately increase the risk-taking capacity of organizations. Hence, it is imperative for organizations to capitalize on this growth prospect and use digital technologies such as big data, cloud computing, and the Internet of Things across all facets of their corporate operations. To enhance the enterprise's business development, it is necessary to establish a digital platform that creates a distinct digital ecosystem. This will enhance the enterprise's ability to integrate resources, minimize the costs associated with gathering information and acquiring resources, and improve the efficiency of resource allocation. Additionally, it will enhance the enterprise's ability to anticipate and prevent risks, thereby elevating its risk-taking capacity. Ultimately, this will establish a strong technological foundation for the enterprise's high-quality development. Furthermore, the government should provide diverse policy assistance for digital transformation based on the distinct characteristics of firms. Firstly, the government should actively encourage the adoption of digital transformation in state-owned enterprises. This can be achieved by raising awareness and setting an example for other enterprises to follow. Secondly, the government should provide stronger policy support for digital transformation in non-state-owned enterprises. This includes increasing subsidies and fostering confidence and determination among these enterprises. The ultimate goal is to facilitate the seamless integration of digital technology into enterprise development, enabling them to upgrade and achieve high-quality growth.

The study finds that with the increase in digital transformation efforts of the firms, the propensity of firms to risk-taking increases. This indicates that the organizations should strategically implement the digital technologies in order to enhance their risk appetite, particularly in highly competitive sectors. The management of risk should include developing frameworks that encourage innovation yet ensure oversight to mitigate any downsides. Non-SOEs have a better correlation between digital transformation and risk-taking compared to SOEs. Risk management for SOEs should aim to strike a balance in creating an environment that will support reasoned risk-taking but without threatening stability. It also shows the need to identify the inherent risks related to the digital transformation process, which include system failure or cybersecurity risks. Furthermore, investments in internal controls and efficiency lead to an enabling environment where resources are well utilized to make informed decisions. The findings provide valuable insights for policymakers in their pursuit of promoting digital transformation while managing the associated risks.

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