

Research Article

Executive Stock Ownership and Enterprise Digital Transformation: Interest Convergence or Trench Defense

Na Chen ^{1,2} and Shuili Yang ¹

¹School of Economics and Management, Xi'an University of Technology, Xi'an, China

²Business School, Gansu University of Political Science and Law, Lanzhou, China

Correspondence should be addressed to Na Chen; 1200511012@stu.xaut.edu.cn

Received 4 August 2022; Revised 29 September 2022; Accepted 6 October 2022; Published 21 October 2022

Academic Editor: Emilio Jiménez Macías

Copyright © 2022 Na Chen and Shuili Yang. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Digital transformation gives enterprises new development momentum and vitality. The existing research studies mainly focused on the economic consequences of the digital transformation of enterprises, and few literatures pay close attention to the driving factors of digital transformation. In particular, they ignored the important role played by the core element of executives. To fill this gap, this study empirically examines the influence mechanism of executive ownership on enterprise digital transformation based on Chinese A-share manufacturing listed companies from 2008 to 2021. The results show that there is an inverted U-shaped relationship between executive ownership and enterprise digital transformation. When the shareholding ratio is low, “interest convergence” is dominant; when the shareholding ratio is high, “trench defense” is more obvious. Heterogeneity analysis shows that the nature of property rights and the degree of industry competition can alleviate the threshold effect of executive ownership on digital transformation, while ownership concentration will aggravate the threshold effect of executive ownership on digital transformation. This study not only enriches the research on the influencing factors of digital transformation but also provides practical guidance for enterprises to improve the design of incentive mechanism and promote the digital transformation of enterprises.

1. Introduction

In recent years, China's economy has a trend of “shifting from real to virtual” [1]. Data may be identified as the seventh production factor after labor, capital, land, knowledge, technology, and management, reflecting that the current economic factors supporting economic and social development have begun to undergo epoch-making changes [2]. Under the background of the new era, digital transformation is not only a key force driving macroeconomic growth and preventing the economy from becoming unrealistic but also an important means to promote strategic change and transformation of momentum for micro-enterprises. However, at the same time, as a systematic project, digital transformation is inseparable from the large amount of investment and long-term support of enterprise resources. Its complexity and long periodicity make it

regarded as a part of corporate strategy, and its risks and uncertainties also make many enterprises confused about whether to make digital investment or not. Research has found that many enterprises are “unwilling to turn” due to weak transformation ability and high transformation cost, “not good at turning” due to unclear transformation strategy, and “dare not to turn” due to the long “pain period” of transformation [3]. The latest survey data show that at present, only 11% of Chinese enterprises have successfully carried out digital transformation and most enterprises are still facing difficulties in digital transformation [4]. Therefore, how to promote the digital transformation of enterprises has become a hot issue of common concern in academia and industry. Executives are strategic decision-makers who usually decide the direction and intensity of long-term resource investment. According to the principal-agent theory, executive shareholding can motivate

executives to formulate valuable long-term strategies for the company, share profits and risks with the company, effectively reduce the short-term behavior of executives, and thus contribute to the long-term development of the company [5]. The digital transformation of enterprises reflects the long-term behavior of enterprises and their risk preferences in the selection of investment projects. Therefore, from the characteristics of digital transformation and the original intention of equity incentive, it will be of great practical significance to investigate the impact of long-term executive incentives on digital transformation. Unfortunately, at present, domestic and foreign research mainly focused on the economic consequences of the digital transformation of enterprises, and the only literature on the drivers of digital transformation concentrates on qualitative research and batch search [6, 7]. Few literatures focused on the role of corporate internal governance factors in the process of enterprise digital transformation, especially on whether executive equity incentive will have an impact on enterprise digital transformation. The existing research on the theoretical analysis and empirical test of the operation law between executive equity incentive and enterprise digital transformation is not sufficient. In view of the above-mentioned research gaps, based on the data of China's A-share manufacturing listed companies from 2008 to 2021, this study investigates the impact mechanism of executive ownership on enterprise digital transformation and conducts heterogeneity analysis from the perspectives of property rights, industry, and equity.

This study makes several principal contributions as follows: (1) This study enriches the theoretical research on the driving factors of enterprise digital transformation. The exploration of the antecedents of enterprise digital transformation is a hot issue of common concern to all sectors of society. The existing research on the driving factors of enterprise digital transformation is still in its infancy, and there are still many theoretical problems to be solved. In this study, we found that executive stock ownership is an important factor affecting enterprise digital transformation, and moderate executive equity incentive can have a positive impact on enterprise digital transformation, which further makes up for the shortcomings of existing research and strengthens our understanding of the enterprise's implementation of digital investment decision-making process. (2) This study extends the research on the economic consequences of executive shareholding, and examines the economic impact of executive ownership from the perspective of enterprise digital transformation, which is helpful to deepen our understanding of the importance of executive motivation and decision-making. (3) Our research provides practical guidance for classified implementation of digital transformation strategy. The study revealed the applicable scenarios of the impact of executive shareholding on the digital transformation of enterprises, providing an important reference for enterprises to implement the digital transformation strategy in combination with property rights, industry, equity, and other characteristics while using executive incentives.

The study is organized as follows: first, Section 2 summarizes the existing literature; then, Section 3 includes theoretical analysis and research hypothesis; Section 4 is the research design; the empirical results and analysis are presented in Section 5; Section 6 and 7 draws some conclusions about the study and presents some implications and limitations as well.

2. Literature Review

At present, the academia has not reached a consensus on the concept of "digital transformation of enterprises". By summarizing the existing literature, scholars generally agree that digital transformation is a process of promoting the deep integration of digital technology and traditional production factors of enterprises through integration, reconstruction, upgrading, and other ways, based on digital technology and digital platform, taking data as an important resource for enterprises to realize value creation [8, 9]. The literature review is mainly carried out from two aspects, namely, the economic consequences and driving factors of the digital transformation.

2.1. Research on the Economic Consequences of Digital Transformation. At present, the economic consequences of digital transformation mainly include "promotion view" and "challenge view." (1) The positive effects of digital transformation. A large number of studies have shown that through the deep integration of digital technology and enterprise strategy, digital transformation will lead to systematic changes in enterprise strategic logic, management mode, competition mode, business ecology, etc. [10, 11], and eventually bring a series of positive impacts to enterprises, such as supporting enterprise business model, product, and service innovation [12, 13], reshaping enterprise business processes [14], improving the level of enterprise specialization [15], optimizing supply chain management [16–18], significantly improving the performance of enterprise capital market [2], and ultimately promoting customer value [19], competitive advantage [20], enterprise performance [21], and total factor productivity [22]. (2) The negative effects of digital transformation. Another document focuses on the potential threats and challenges brought by the digital transformation of enterprises. Some scholars believe that the implementation of digital transformation by enterprises is long-term and uncertain. The application of digital technology makes the organizational structure and business processes of enterprises more complex, leading to an increase in enterprise management costs and a decrease in the concentration of innovative resources and elements [23]. Because the management organization system and capabilities of enterprises lag behind the changes of digital technology, the original resources and business flow of enterprises are difficult to effectively match digital technology [24], which makes the driving effect of digitalization on enterprise value very limited [25] and even induces "the paradox of IT efficiency."

2.2. Research on Driving Factors of Digital Transformation. At present, research on the drivers of enterprise digital transformation mainly focuses on technology, environment, and organization. (1) From the perspective of technology drivers, the superposition of different digital technologies represented by the Internet of things, big data, and artificial intelligence [26, 27] has promoted the phased transformation of enterprise business processes, organizational structures, business models, etc. [28], and the digital resources, organizational structures, growth strategies, and measurement indicators of enterprises at each stage are quite different [29, 30]. Finally, through industrial digitalization, service digitalization and other ways promote enterprise digitalization transformation. (2) From the perspective of environmental drivers, government support (regulation), digital economy policy implementation, industrial digital development level, financial science and technology points, intellectual property protection, and other factors will have a significant impact on the digital transformation of enterprises [31–33]. (3) From the perspective of organizational drivers, the top management of the organization finally decides whether the enterprise needs to carry out digital transformation or not. Therefore, the support attitude of the top managers is a prerequisite [34]. At the same time, organizational mindfulness regards digital transformation as a prerequisite of information processing capability to achieve market agility [35]. In addition, enterprise strategic consistency [36], organizational practices [37], dynamic capabilities [7, 38], open organizational culture [39], employee attitudes [40], leadership [41], etc., are also important factors driving the success of enterprise digital transformation.

Existing literature has achieved fruitful results, which has important reference significance. However, there are still some problems not involved, which is also the direction of our research. Therefore, we will proceed from the following aspects: (1) The existing literature has studied the economic consequences of digital transformation from both positive and negative aspects, while quantitative research on the driving factors of digital transformation is relatively scarce, and more importantly, empirical analysis based on large samples is lacking, and the relevant conclusions are not universally recognized. It is rare to use the data of listed companies to empirically test this problem. (2) The role of internal governance factors in the process of enterprise digital transformation has not received the attention that the academia should have paid, especially ignoring the role played by key factors such as executive equity incentive in the digital transformation. Few literatures have included executive equity incentive and enterprise digital transformation into a unified analysis framework, lacking theoretical explanation of how executive equity incentive affects enterprise digital transformation.

3. Theoretical Analysis and Research Hypothesis

3.1. The Impact of Executive Ownership on Digital Transformation. According to agency theory, the separation of ownership and management rights will lead to

agency problems [42]. Owing to the huge investment, high-risk and long recovery cycle of digital transformation, senior executives may lack motivation to make digital investment. On the one hand, corporate executives tend to give up investing in long-term projects in order to make more secure use of control rights for personal gain, and also avoid investing in high-risk and high-return projects because of the time-consuming and laborious learning and management of new technologies. On the other hand, since investment projects with high-risk are also likely to fail, managers tend to choose investment projects with low risk based on the consideration of career and reputation establishment. According to the optimal contract theory, equity incentive as a long-term incentive mechanism, which is conducive to the organic combination of senior executives' personal interests and the long-term value of the company, urges senior executives to consider long-term interests in the process of enterprise investment decision [43]. Enterprise digital transformation is a long-term strategy of the company. When the proportion of senior executives' shareholding increases gradually, the personal interests of senior executives are closely combined with the interests of the enterprise, so senior executives have the motivation to choose digital investment projects that are conducive to the long-term development of the company and improve the enthusiasm of the enterprise to implement digital transformation. At the same time, the residual claim theory holds that executive shareholding gives managers the right to share the residual claim of the company, which urges executives to attach importance to the long-term development of the company and encourages them to actively carry out digital transformation activities. First of all, when senior executives hold certain shares, they can enjoy the value added by digital transformation. Therefore, senior executives are more motivated to enhance the core competitiveness of enterprises and improve their future performance through the implementation of digital transformation. In addition, as equity incentive deeply binds the personal interests of senior executives with the long-term value of the company through "golden handcuffs," the equity held by senior executives has a long ownership period, but the tenure of senior executives is characterized by phases and liquidity. Therefore, senior executives are more likely to choose investment projects that can maintain the sustainable development of the company when making investment decisions. That is, more stable long-term labor contracts can be obtained by promoting the digital transformation of enterprises. At this time, the interests of executives and shareholders are consistent, resulting in interest convergence effect, that is, executive shareholding can actively promote enterprises to implement digital transformation.

With the increasing proportion of executives' shareholding, the control of executives over the company increases correspondingly, the internal and external supervision mechanism weakens the constraints on executives, the rent-seeking motivation of executives' increases, and the opportunistic behavior also increases. According to the theory of managerial power, when executive ownership

reaches a certain proportion, equity incentive will instead facilitate rent-seeking by company executives. The increase of executive shareholding will improve the job security of executives, enhance the voting rights and bargaining power of company executives, and pursue individual benefits at the expense of the interests of the company and shareholders. Under the premise of pursuing the maximization of their own interests, managers may make decisions that harm the interests of owners [44]. As digital transformation projects are long-term and multistage, compared with the long-term benefits that digital transformation may bring in the future, executives are more inclined to use the existing power to quickly satisfy their own interests in the short term. On the one hand, enterprises invest a large amount of money in the implementation of digital transformation. In the process of resource investment, senior executives may use their power to seek personal interests through on-the-job consumption, benefit transmission, and related transactions, so as to seize the company's resources and influence the actual operation decisions and investment of enterprises. On the other hand, digital transformation has a large investment and a long return period, and the performance appraisal of senior executives focuses more on current performance. Digital transformation will increase the current cost of enterprises and reduce current profits. Therefore, senior executives may tend to avoid the high investment brought by digital transformation during their tenure and reduce their digital investment in enterprises. In addition, the high stakes of digital transformation can also make executives suffer failure and be ousted. Based on the consideration of reputation, executives with a high shareholding ratio will carefully choose digital investment projects. It can be seen that when the shareholding ratio of executives exceeds a certain critical value, further increasing the equity incentive will inhibit the digital transformation of enterprises. At this time, executive ownership mainly shows the entrenchment defense effect, that is, executive ownership will have a negative impact on the digital transformation of enterprises. Based on the abovementioned analysis, this study puts forward the following hypotheses:

Hypothesis 1. Executive ownership has an inverted U-shaped effect on enterprise digital transformation, that is, with the increase of executive ownership level, digital transformation will rise first and then decline, and only appropriate proportion of equity incentives can effectively promote enterprise digital transformation.

3.2. Heterogeneity Analysis. The relationship between executive ownership and digital transformation of enterprises may be affected by the nature of property rights, industry competition, ownership structure, and other important strategic circumstances. The nature of property rights determines the basis of resources needed for enterprise digital transformation. The degree of industry competition can stimulate or inhibit the motivation and vitality of enterprises to implement digital transformation, and ownership concentration affects digital investment decisions of enterprises.

3.2.1. The Moderating Effect of Property Right Nature. Due to the differences in resource endowment and governance mechanism, state-owned enterprises and private enterprises have different performances in digital transformation. Compared with private enterprises, for the strong political nature of the executive appointment mechanism in state-owned enterprises, the senior management of state-owned enterprises is subject to less supervision and incentive from the enterprise and the market but more government intervention. First, state-owned enterprises have natural resource advantages, which can facilitate the implementation of digital transformation by themselves. Backed by powerful resources, state-owned enterprises can partly eliminate the risk concerns caused by the implementation of digital transformation and break the dilemma that enterprises are "afraid to turn" due to resource constraints, instead of requiring incentives such as executive shareholding to promote enterprises to implement digital transformation. Second, the executives of state-owned enterprises are mainly through administrative appointment rather than through the market selection and the status of senior executives in state-owned enterprises is between officials and corporate managers. Resulting in the interests of the state executive pursuit of alienation, in addition to the pursuit of economic interests, which are more likely to focus on contact such as perk consumption and political promotion incentives, at this point, the equity incentive role is very limited and difficult to really motivate them to make digital investments for the long-term benefit of the company. Finally, in addition to the economic goal of making profits, state-owned enterprises also bear multiple political and social goals of the government and senior executives' business decisions are more susceptible to the intervention of local governments and the mandatory constraints of various policies. Therefore, compared with private enterprises, the effect of equity incentive on the change of senior executives' business decisions is more limited. In this regard, we propose the following hypotheses:

Hypothesis 2. Property rights play a moderating role in the impact of executive ownership on digital transformation. Compared with private enterprises, state-owned enterprises will alleviate the threshold effect of executive ownership on digital transformation.

3.2.2. The Moderating Effect of the Degree of Industry Competition. Industry competition can effectively alleviate the agency problem between shareholders and managers. As an alternative mechanism for the supervision of executives, it will reduce the rent-seeking behavior of executives and reduce the equity incentive effect of executives to a certain extent. On the one hand, the degree of information asymmetry of enterprises decreases with the higher degree of industry competition. Shareholders can effectively obtain relevant information of senior executives, supervise the behavior of managers, and make the risk of rent-seeking of senior executives higher, so as to reduce the opportunistic behavior of managers, make the interests of senior

executives and shareholders tend to be consistent, and thus stimulate the vitality of digital transformation of enterprises. On the other hand, market competition forces enterprises to respond to market demands quickly. In order to maintain market share and avoid being eliminated by the market, senior executives will adopt alternative strategies or take new measures to gain competitive advantages, maintain the sustainable development of enterprises, and thus promote the digital transformation of enterprises. At the same time, based on their own compensation and reputation, senior executives will take the initiative to reduce the damage to the interests of shareholders and increase the digital investment of enterprises. Owing to the fact that industry competition can reduce agency costs and encourage executives to take the initiative to consider the long-term interests of the enterprise, the space for equity incentive to play its role will be smaller. Only when the degree of industry competition is lower, can equity incentive really play its role. Kim and Lu (2011) also found that when the industry competition is at a low level, the inverted U-shaped relationship between executive equity incentive and R&D expenditure is more significant [45]. In this regard, we propose the following hypotheses.

Hypothesis 3. The degree of industry competition plays a moderating role in the impact of executive ownership on digital transformation. The higher the degree of industry competition, the more the threshold effect of executive ownership on digital transformation can be alleviated.

3.2.3. The Moderating Effect of Ownership Concentration. According to the principal-agent theory, when the ownership is dispersed, the executives of the company tend to make decisions that deviate from the interests of the company due to the lack of shareholder supervision. When the ownership is concentrated, the problem of “free riding” of minority shareholders can be prevented, and the senior executives can be effectively supervised, so as to restrain the short-sighted behavior of senior executives and improve the decision-making efficiency of the company. As the digital transformation of an enterprise is a complex systematic project facing great uncertainties, the active participation of major shareholders can help enterprises better identify opportunities and risks [43]. Meanwhile, large holdings of major shareholders can strongly support the company to break resource bottlenecks, so that the company dares to invest in high-risk projects, which are helpful to stimulate the potential of enterprise digital transformation. On the one hand, the higher the concentration of equity, the greater the control and voting rights of the major shareholders. The more capable and motivated the controlling shareholders are to participate in the company’s daily business activities, the stronger the senior executives’ behavior will be subject to the supervision and restraint of the controlling shareholders. At this time, increasing equity incentive will produce a synergistic effect of supervision and incentive, thus effectively reducing senior executives’ speculative behavior and making senior executives’ business decisions more scientific.

On the other hand, when the equity is more concentrated, the interests of the controlling shareholders will be organically combined with the enterprise value, which makes them motivated to optimize the company’s resource allocation, intervene in senior executives’ strategic decisions, and promote senior executives to choose investment projects that meet the long-term interests of the company by increasing their equity incentives, thus effectively promoting the implementation of digital transformation of enterprises. Therefore, equity concentration will have a positive impact on the relationship between executive shareholding and digital transformation. In this regard, we propose the following hypotheses:

Hypothesis 4. Ownership concentration plays a moderating role in the impact of executive ownership on digital transformation. The higher the ownership concentration, the more aggravating the threshold effect of executive ownership on digital transformation.

4. Research Design

4.1. Sample Selection and Data Sources. Considering the continuity and availability of digital transformation data, China’s A-share manufacturing listed companies from 2008 to 2021 are selected as the initial research samples of this study. The data preprocessing process in this study is as follows: (1) Companies involved in digital industries such as computer, communications, and other electronic equipment manufacturing were excluded from the sample, because digital technology and Internet listed companies have natural digital characteristics and do not belong to the category of physical enterprises. (2) Businesses missing data, delisted, abnormal financial data, ST, and *ST were excluded. With that, the final sampling pool contained a total of 23594 corporate values for analysis. Meanwhile, to avoid the interference of extreme values, we then trimmed the pool by removing 1% of the lowest and highest values of all continuous variables. The data about the adoption of digital transformation were provided by sorting out the annual reports of listed companies with Python language, and other relevant data were obtained from CSMAR database.

4.2. Variable Definition

- (1) Explained variable: digital transformation (DITL). Following the way Wu et al. [2] and Yuan et al. [15] used to measure the digital transformation level of enterprises. First, we refer to the 2020 Digital Transformation Trend Report and other policy documents to obtain the basic etymology of enterprise digital transformation. At the same time, we enlarge the digital feature lexicon in combination with the annual report text of listed companies, mainly classify them according to the digital underlying technology (artificial intelligence, big data, cloud computing, and blockchain) and technical practice, and finally, acquire 84 words related to enterprise digital transformation. Second, based on Python language, we search, match, and count keywords from the data pool formed by the

text extraction of the annual reports of China's A-share manufacturing listed companies, and the data was cleaned by combining manual reading. Finally, the disclosure times of cleaned keywords were counted, and the logarithm value of the total number of keywords plus 1 was used to measure the degree of enterprise digital transformation.

- (2) Explanatory variable: executive ownership ratio (MS). Inspired by Zhu and Zhou [43], the ratio between the total number of shares held by senior executives and the total number of shares is selected to measure the degree of senior executives' shareholding. The senior executives referred to in this study refer to the general manager, president, CEO, deputy general manager, vice president, secretary to the board of directors, and other management personnel (including concurrent senior executives among directors) published in the annual report of the company, which is consistent with the statistics of senior management members of CSMAR Database.
- (3) Moderating variables: property right (SOE), industry competition (HHI), and ownership concentration (TOP1). According to the property right nature, the value of state-owned enterprises is 1, and the value of private enterprises is 0. The degree of industry competition is expressed by the Herfindahl-Hirschman index HHI. Specifically, $HHI = \sum_{i=1}^N (X_i/X)^2$, where X represents the total operating revenue of the industry,

X_i is the operating income of the company in the current year. The higher the HHI index, the lower the degree of competition in the industry; ownership concentration is measured by the proportion of shares held by the largest shareholder.

- (4) Control variables: based on existing research, relevant variables at firm level and corporate governance level are controlled. At the enterprise level, the variables include company size (SIZE), asset-liability ratio (LEV), enterprise profitability (ROA), net cash flow divided by total assets (CASH), shareholding ratio of the largest shareholder (TOP1), property right nature (SOE), and listing years (LISTAGE). The variables regarding corporate governance level involved the size of the board of directors (BOARD), the proportion of independent directors (INDEP), CEO duality (DUAL), and whether the auditor is from the Big Four international firms (BIG4). At the same time, year (YEAR) and industry (IND) fixed effects are controlled in the model.

4.3. Model Setting. Based on the above theories and assumptions, the benchmark model (1) is designed to test the relationship between executive ownership and enterprise digital transformation. Model (2) was constructed to test the moderating effects of property rights, industry competition, and ownership concentration on the relationship between executive ownership and digital transformation.

$$DITL_{i,t} = \alpha_0 + \alpha_1 MS_{i,t} + \alpha_2 MSQ_{i,t} + \alpha_3 \text{Controls} + \sum \text{YEAR} + \sum \text{IND} + \varepsilon_{i,t}, \quad (1)$$

$$DITL_{i,t} = \beta_0 + \beta_1 MS_{i,t} + \beta_2 MSQ_{i,t} + \beta_3 Z_{i,t} + \beta_4 MS_{i,t} \times Z_{i,t} + \beta_5 MSQ_{i,t} \times Z_{i,t} + \beta_6 \text{Controls} + \sum \text{YEAR} + \sum \text{IND} + \varepsilon_{i,t}. \quad (2)$$

Among them, DITL represents the digital transformation of enterprises and MS and MSQ represent the proportion of executive ownership and the square term of executive ownership, respectively, to verify whether there is an inverted *U*-shaped relationship between executive ownership and digital transformation. Controls represent all control variables; ε as random perturbation terms; Z is the moderating variable, which represents the property right (SOE), the degree of industry competition (HHI), and the degree of ownership concentration (TOP1), respectively.

5. Empirical Results and Analysis

5.1. Descriptive Statistical Analysis. Table 1 reports the results of descriptive statistical analysis of the main variables. From the perspective of the digital transformation (DITL) index, the mean and standard deviation are 1.124 and 1.270, respectively, indicating that there are certain differences in the implementation of digital transformation among enterprises. The average value of executive ownership (MS) is

8.8%, the minimum value and maximum value are 0 and 58.7%, respectively, signaling that there is a big gap in executive equity incentive among enterprises.

5.2. Benchmark Regression Results and Analysis. The VIF test was performed on the variables, and the mean value of VIF was 2.95, which was less than the empirical value of 10, indicating that the model was not disturbed by the multicollinearity problem. Table 2 reflects the benchmark regression results of executive ownership and digital transformation. Only control variables are added in column (1) of Table 2. By adding the executive ownership ratio (MS) into column (2), it can be seen that executive ownership (MS) and digital transformation (DITL) have a significant positive correlation. On the basis of column (2), MSQ is further added into column (3). The correlation coefficient between executive ownership (MS) and digital transformation (DITL) is 0.953, which is significantly positive at 1% level. MSQ is significantly negative with

TABLE 1: Results of descriptive statistical analysis.

Variables	N	Mean	p50	SD	Min	Max
DITL	23594	1.124	0.693	1.270	0.000	6.148
MS	23594	0.088	0.004	0.150	0.000	0.587
SIZE	23594	21.904	21.744	1.175	17.641	27.547
LEV	23594	0.390	0.379	0.199	0.007	1.957
ROA	23594	0.047	0.045	0.076	-1.125	0.969
CASH	23594	0.049	0.047	0.074	-1.938	0.726
BOARD	23594	2.118	2.197	0.194	0.693	2.890
INDEP	23594	0.375	0.333	0.055	0.000	0.800
DUAL	23594	0.319	0.000	0.466	0.000	1.000
LISTAGE	23594	1.880	2.079	0.942	0.000	3.466
SOE	23594	0.272	0.000	0.445	0.000	1.000
TOP1	23594	0.339	0.318	0.143	0.024	0.900
BIG4	23594	0.044	0.000	0.205	0.000	1.000

TABLE 2: Benchmark regression results of executive ownership and digital transformation.

	(1) DITL	(2) DITL	(3) DITL
MS		0.315*** (5.11)	0.953*** (5.55)
MSQ			-1.252*** (-4.08)
SIZE	0.149*** (17.87)	0.150*** (17.53)	0.150*** (17.47)
LEV	-0.269*** (-5.70)	-0.250*** (-5.18)	-0.248*** (-5.15)
ROA	0.001 (0.01)	-0.073 (-0.55)	-0.080 (-0.61)
CASH	-0.506*** (-4.47)	-0.530*** (-4.57)	-0.534*** (-4.61)
BOARD	-0.065 (-1.36)	-0.053 (-1.08)	-0.045 (-0.93)
INDEP	0.902*** (5.83)	0.855*** (5.44)	0.878*** (5.58)
DUAL	0.116*** (6.89)	0.076*** (4.10)	0.071*** (3.85)
LISTAGE	0.027*** (2.69)	0.039*** (3.69)	0.048*** (4.43)
SOE	-0.245*** (-13.21)	-0.242*** (-12.76)	-0.236*** (-12.40)
TOP1	-0.243*** (-4.71)	-0.235*** (-4.43)	-0.161*** (-2.91)
BIG4	-0.077** (-2.20)	-0.059 (-1.62)	-0.058 (-1.58)
Constants	-2.842*** (-15.26)	-2.905*** (-15.22)	-2.973*** (-15.51)
YEAR	Yes	Yes	Yes
IND	Yes	Yes	Yes
N	23594	23594	23594
A-R ²	0.232	0.230	0.230

Note: *T* values calculated according to robust standard errors are in parentheses; ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

digital transformation. There is a nonlinear relationship between executive ownership and digital transformation. Referring to the research method of Haans et al. [46], to determine whether there is an inverted U-shaped relationship between the explained variables and explanatory

variables, three conditions need to be met simultaneously. First, the regression coefficient of the square term of the explanatory variable should be significantly negative. The regression coefficient of MSQ is -1.252 , which is significantly negative at 1% level, which satisfies the condition. Second, the critical point of inverted U-shaped curve $-\alpha_1/2\alpha_2$ is within the range of explanatory variables. In column (3), the inflection point of the inverted U-shaped curve is 0.333 , located in the value range of executive's shareholding $(0,0.587)$, which meets the condition. Third, the linear slope is greater than 0 where the explanatory variable is minimum, and the linear slope is less than 0 where the explanatory variable is at its maximum. In column (3), when executives' shareholding takes minimum value of 0, the linear slope here $\alpha_1 + 2\alpha_2 MS_{\min} = 0.953$ is greater than zero. When executives' shareholding takes a maximum of 0.587 , the linear slope here $\alpha_1 + 2\alpha_2 MS_{\max} = -0.517$ is less than zero, which accords with the condition. Therefore, there is a significant inverted U-shaped relationship between executive ownership and digital transformation, and Hypothesis 1 is verified. It shows that with the increase of the proportion of senior executives' shareholding, the interests of senior executives are organically combined with the long-term value of the enterprise, and the convergence effect of interests appears, and the enterprise will more actively promote the digital transformation. However, when the shareholding ratio of executives exceeds the critical point of 0.333 , the entrenchment effect will appear, which will inhibit enterprises from implementing digital transformation.

5.3. Endogeneity Treatment. In order to ensure the reliability of the research results, this study tries to use the following methods to solve the endogeneity problem caused by sample self-selection and omitted variables:

- (1) Fixed effects model: considering the possible omission of variables in the model, this study further controls the individual firm effect. In column (1) of Table 3, the estimated coefficient of MS is 0.595 , and the coefficient of MSQ is -1.255 , both of which pass the 1% significance level test, further supporting the previous conclusion.
- (2) Explanatory variables lag by one period: considering the dynamic changes, the results of executive ownership (MS) and the square term of executive ownership (MSQ) are put into the model with a lag of one period, as shown in column (2) of Table 3. It can be found that the regression results have not changed substantially.
- (3) Excluding the impact of annual events in the industry: on the basis of industry and year, the fixed effects of industry annual intersection are further controlled. The results in column (3) of Table 3 show that the estimated coefficient of MS is 0.986 , and the regression coefficient of MSQ is -1.320 , which are both significant at 1% level, demonstrating that the research conclusion in this study is reliable.

TABLE 3: Endogeneity treatment and robustness test.

	(1) FE DITL	(2) OLS DITL	(3) OLS DITL	(4) OLS DITL	(5) OLS DITL	(6) OLS DITL
MS	0.595*** (3.29)		0.986*** (5.75)	1.389*** (3.78)	1.004*** (5.50)	1.237*** (3.70)
MSQ	-1.255*** (-3.87)		-1.320*** (-4.31)	-1.902*** (-2.69)	-1.349*** (-4.16)	-1.310** (-2.16)
L.MS		0.861*** (4.73)				
L.MSQ		-1.058*** (-3.28)				
SIZE	0.220*** (16.69)	0.152*** (17.22)	0.152*** (17.80)	0.133*** (9.86)	0.163*** (17.28)	0.233*** (12.93)
LEV	-0.057 (-1.10)	-0.253*** (-5.06)	-0.271*** (-5.63)	-0.184** (-2.46)	-0.252*** (-4.73)	-0.260*** (-2.62)
ROA	-0.037 (-0.42)	-0.069 (-0.51)	-0.074 (-0.57)	-0.113 (-0.58)	-0.069 (-0.48)	0.596** (2.45)
CASH	-0.198** (-2.42)	-0.551*** (-4.56)	-0.546*** (-4.72)	-0.432** (-2.48)	-0.582*** (-4.40)	-0.838*** (-3.62)
BOARD	0.245*** (4.65)	-0.050 (-1.00)	-0.049 (-1.01)	-0.007 (-0.09)	-0.049 (-0.87)	0.065 (0.65)
INDEP	0.017 (0.11)	0.923*** (5.63)	0.864*** (5.52)	0.724*** (3.12)	0.909*** (5.08)	2.000*** (6.06)
DUAL	0.017 (1.00)	0.090*** (4.66)	0.071*** (3.84)	0.061** (1.98)	0.071*** (3.55)	0.077** (2.06)
LISTAGE	0.106*** (6.51)	0.017 (1.25)	0.051*** (4.72)	-0.023 (-1.38)	0.053*** (4.51)	0.082*** (3.72)
SOE	-0.050 (-1.41)	-0.218*** (-11.09)	-0.240*** (-12.70)	-0.152*** (-5.47)	-0.279*** (-12.85)	-0.405*** (-9.94)
TOP1	-0.410*** (-4.86)	-0.177*** (-3.06)	-0.132** (-2.41)	-0.116 (-1.34)	-0.169*** (-2.75)	0.057 (0.49)
BIG4	-0.041 (-0.79)	-0.072* (-1.93)	-0.058 (-1.62)	-0.102** (-1.96)	-0.062 (-1.55)	-0.049 (-0.62)
Constants	-4.804*** (-15.81)	-2.963*** (-14.88)	-3.050*** (-15.58)	-2.615*** (-9.09)	-3.081*** (-13.99)	-7.670*** (-17.53)
YEAR	Yes	Yes	Yes	Yes	Yes	Yes
IND	Yes	Yes	Yes	Yes	Yes	Yes
YEAR × IND	No	No	Yes	No	No	No
N	23594	21612	23594	8275	20936	23594
A-R ²	0.247	0.232	0.237	0.236	0.187	

Note: *T* values calculated according to robust standard errors are in parentheses; ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

(4) Propensity score matching method: to solve the problem of sample selective bias, the propensity score matching method is adopted, and the control variable in model (1) is used as the matching variable to conduct 1:1 nearest neighbor matching for enterprises that implement and do not implement executive equity incentive. The ATT value after matching is 0.229, which passes the test at the 1% significance level. On this basis, the matched and screened samples were used to conduct the regression again. The results are shown in Table 3 columns (4). It can be found that the MS and MSQ coefficients are 1.389 and -1.902, respectively, which both pass the 1% significance level test. Therefore, the results further consolidated the robustness of our conclusions.

5.4. *Robustness Test.* To make our conclusions more reliable, we took the following steps to test robustness:

- (1) Changing the estimated time period: data for the first three years were deleted and re-estimated using data from 2011 to 2021. There is no substantial difference between the regression results in column (5) of Table 3 and the abovementioned conclusions.
- (2) Replacing the explained variable: the virtual variable “whether to implement digital transformation (DITL1)” is introduced to represent the degree of enterprise digital transformation. If $DITL > 0$, the value is 1; otherwise, the value is 0. The regression coefficients of MS and MSQ in column (6) of Table 3 passed the test at least at 5% significance level, which is consistent with the abovementioned analysis.

5.5. Analysis of the Moderation Effect. The effect of executive ownership on enterprise digital transformation may be influenced by multiple internal and external factors. This study discusses the differences in the impact of executive ownership on the digital transformation of enterprises from three aspects, namely, property right nature, industry competition degree, and ownership concentration degree, and the specific results are shown in Table 4. According to the research results of Haans et al. [46], the inverted U-shaped regulation effect can be reflected in the following two aspects: First, the flatness of the inverted U-shaped curve changes. When the regression coefficient β_5 of the square term of the explanatory variable and the interaction term of the moderating variable is significantly positive, the moderating effect will make the inverted U-shaped curve flatter. When β_5 is significantly negative, the regulatory effect makes the inverted U-shaped curve steeper. The other is that the inflection point of the inverted U-shaped curve moves around. When the regression coefficient $\beta_1\beta_5 - \beta_2\beta_4 > 0$, it means that the inflection point of the curve will move to the right. When the regression coefficients $\beta_1\beta_5 - \beta_2\beta_4 < 0$, the inflection point will move to the left.

- (1) The regulating effect of property right nature: column (1) shows the regulating effect of property right nature. It can be found that the regression coefficient of the interaction term between MSQ and SOE is -39.823 , which is significant at 1% level, indicating that the property right will make the relationship curve between MS and DITL become steeper. At the same time, $\beta_1\beta_5 - \beta_2\beta_4 = -26.970$, which is less than 0, so the inflection point will move to the left, that is, to the direction of lower executive ownership ratio, indicating that state-owned enterprises can more easily implement digital transformation strategy in enterprises with the lower executive ownership ratio. State-owned enterprises can give full play to their “resource advantages” and alleviate the threshold effect of executive equity incentive on digital transformation. Therefore, Hypothesis 2 is verified.
- (2) The moderating effect of the degree of industry competition: column (2) shows the moderating effect of the degree of industry competition. From the column (2), the executives shareholding squared (MSQ) and industry competition degree (HHI) interaction of regression coefficient is 3.967, significant at 5% level, because the values of HHI; the greater the industry, the lower the competition degree; that degree of industry competition makes the executives’ shareholding (MS) and the relation curve of digital transformation (DITL) become more steep. At the same time, $\beta_1\beta_5 - \beta_2\beta_4 = 0.914$, the value is greater than 0, so the inflection point will move to the right, that is, to the direction of higher proportion of executive ownership, indicating that the smaller the degree of industry competition, the easier it is to choose enterprises with higher proportion of executive ownership to promote digital transformation. Hypothesis 3 is verified.

- (3) The regulating effect of ownership concentration. Column (3) shows the regulating effect of ownership concentration. The coefficient of the square interaction term of executive ownership is 3.187 and passes 10% significance level, which indicates that ownership concentration will make the relationship curve between executive ownership (MS) and digital transformation (DITL) flatter. At the same time, $\beta_1\beta_5 - \beta_2\beta_4 = 0.595$, the value is greater than 0, so the inflection point will move to the right, that is, to the direction of higher proportion of executive ownership, indicating that when the ownership concentration is higher, enterprises with higher proportion of executive ownership are more likely to implement digital transformation. Ownership concentration will aggravate the threshold effect of executive ownership on digital transformation. Hypothesis 4 is verified.

6. Discussion

How to promote the digital transformation of enterprises becomes the main focus of corporate strategy. Previous research ignored the role of executives as a core element in the digital transformation strategy. In this study, we draw on the corporate governance perspective and empirical study on the influence mechanism of executive shareholding on digital transformation based on China’s A-share manufacturing listed companies from 2008 to 2021. Specifically, we find that the significant inverted U-shaped relationship between executive shareholding and enterprise digital transformation and this conclusion is still valid after a series of robustness tests, implying that with the increase of executive ownership level, digital transformation will rise first and then decline, and only appropriate proportion of equity incentives can effectively promote enterprise digital transformation. Accordingly, our study provides a new understanding of the role of executive ownership, especially in the context of digital transformation.

In addition, we have provided new evidence for the specific context in which executive ownership affects digital transformation. Specifically, we find that the nature of property rights and the degree of industry competition can alleviate the threshold effect of executive ownership on digital transformation, while ownership concentration will aggravate the threshold effect of executive ownership on digital transformation. Generally speaking, the nature of property rights determines the basis of resources needed for enterprise digital transformation. The degree of industry competition can stimulate or inhibit the motivation and vitality of enterprises to implement digital transformation, and ownership concentration affects digital investment decisions of enterprises. Past studies have investigated the moderating role of property rights, industry, and equity in different contexts; however, to the best of our knowledge, limited efforts have been made to investigate the role of these factors in influencing the relationship between executive ownership and digital transformation. In this study, we confirm that the above factors have a significant regulatory effect on the relationship between the

TABLE 4: Test results of moderating effect.

	(1) Differences in property rights DITL	(2) Industry competition degree difference DITL	(3) Ownership concentration difference DITL
MS	0.943*** (5.47)	1.235*** (5.57)	1.555*** (4.05)
MSQ	-1.215*** (-3.95)	-1.814*** (-4.51)	-2.283*** (-3.02)
MS × SOE	8.710*** (4.67)		
MSQ × SOE	-39.823*** (-4.85)		
MS × HHI		-2.197** (-2.11)	
MSQ × HHI		3.967** (1.97)	
MS × TOP1			-1.910* (-1.76)
MSQ × TOP1			3.187* (1.74)
SOE	-0.262*** (-13.49)	-0.243*** (-12.88)	-0.237*** (-12.41)
HHI		-0.722*** (-11.11)	
TOP1	-0.133** (-2.41)	-0.126** (-2.28)	-0.115* (-1.89)
SIZE	0.149*** (17.38)	0.153*** (17.91)	0.149*** (17.28)
LEV	-0.241*** (-5.01)	-0.225*** (-4.67)	-0.248*** (-5.15)
ROA	-0.089 (-0.68)	-0.135 (-1.03)	-0.077 (-0.59)
CASH	-0.533*** (-4.61)	-0.489*** (-4.25)	-0.533*** (-4.61)
BOARD	-0.046 (-0.94)	-0.041 (-0.85)	-0.046 (-0.94)
INDEP	0.894*** (5.68)	0.851*** (5.40)	0.879*** (5.58)
DUAL	0.071*** (3.87)	0.067*** (3.62)	0.071*** (3.86)
LISTAGE	0.055*** (5.09)	0.045*** (4.16)	0.049*** (4.52)
BIG4	-0.053 (-1.47)	-0.049 (-1.35)	-0.058 (-1.58)
Constants	-2.976*** (-15.52)	-2.856*** (-14.95)	-2.966*** (-15.47)
YEAR	YES	YES	YES
IND	YES	YES	YES
N	23594	23594	23594
A-R ²	0.231	0.237	0.230

Note: *T* values calculated according to robust standard errors are in parentheses; ***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

two. Our findings refined the theoretical research framework between executive shareholding and digital transformation and also provided a reference for enterprises to implement digital transformation strategies differently.

7. Conclusions, Implications, and Limitations

7.1. Conclusions. Digital transformation of enterprises is not only the core force driving macroeconomic growth but also the key factor for enterprises to reshape their competitive

advantages in the market. Based on the data of China's A-share manufacturing listed companies from 2008 to 2021, this study investigates the impact mechanism of executive ownership on enterprise digital transformation and conducts heterogeneity analysis from the perspectives of property rights, industry, and equity. The main research conclusions of this study are as follows:

- (1) There is a significant inverted U-shaped relationship between executive shareholding and enterprise digital transformation; "the convergence of interests"

and “moat defensive” are the two effects that exist at the same time; when executives shareholding is 33.3% below the critical value, the interests of dominant convergence effect, executives’ shareholding can promote enterprise to implement digital transformation. When the value is higher than the critical value, the entrenchment effect is dominant, and the executive ownership will have a negative impact on the digital transformation of enterprises.

- (2) The nature of property rights and the degree of industry competition can alleviate the threshold effect of executive ownership on digital transformation, while ownership concentration will aggravate the threshold effect of executive ownership on digital transformation.

In general, our findings provide a novel theoretical explanation for the impact factors of digital transformation. We also hope that our research can provide some implications for companies on how to promote digital transformation in the digital age.

7.2. Implications. Based on the abovementioned conclusions, we offer several key implications for practitioners:

- (1) We need to Reasonably strengthen equity incentives for senior executives to solve the dilemma of enterprise digital transformation. Senior executives are important strategic decision makers of enterprises. Reasonable executive shareholding is the key to promote the implementation of digital transformation decisions of microenterprises and the high-quality development of manufacturing enterprises. When designing executive incentive contracts, enterprises should not only pay attention to short-term incentives such as compensation incentives but also strengthen long-term incentives such as equity, so as to promote the convergence of the interests of executives and the long-term value of the enterprise, so as to avoid the short-sighted behavior of executives. However, at the same time, it is necessary to reasonably control the proportion of executive ownership, because excessive proportion of executive ownership will lead to the entrenchment effect, which will have a negative impact on the implementation of digital transformation of enterprises.
- (2) We need to implement digital transformation by category. Combined with the nature of enterprise property rights, the degree of competition in the industry, and the concentration of enterprise equity, the company can accurately solve various difficulties that enterprises may face in the pain period of digital transformation, resolve potential risks, and promote the digital transformation of enterprises in a differentiated way. Specifically, in state-owned enterprises, the market-oriented selection mechanism of senior executives should be further improved. In enterprises with low industry competition and high ownership concentration, equity incentives for

senior executives should be further increased to better promote the implementation of digital transformation.

7.3. Limitations. Despite the major contributions, several limitations of the present work can be strengthened as follows:

- (1) This study verified the direct impact of executive stock ownership on the digital transformation of enterprises but did not discuss its channel mechanism in depth, which will become a breakthrough for refining this study in the future;
- (2) The research samples can be further specified. This study is based on the sample of A-share manufacturing listed companies in China. Considering that there are significant differences in different fields and different subsectors of the manufacturing industry, it may have a certain impact on the research results. In the future, we can take a typical industry as an example to explore the impact of digital transformation in a single industry.

Data Availability

The data used to support the findings of this research are available from the corresponding authors upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The research was funded by the National Social Science Fund of China Project (21AJY020).

References

- [1] L. Miao, Y. Zhuo, H. Wang, and B. Lyu, “Non-financial enterprise financialization, product market competition, and total factor productivity of enterprises,” *Sage Open*, vol. 12, no. 2, pp. 1–15, 2022.
- [2] F. Wu, H. Hu, H. Lin, and X. Ren, “Enterprise digital transformation and capital market performance-empirical evidence from stock liquidity,” *Journal of Management World*, vol. 37, no. 07, pp. 130–144+10, 2021.
- [3] S. Liu, J. Yan, S. Zhang, and H. Lin, “Can digital change in enterprise management improve input-output efficiency?” *Journal of Management World*, vol. 37, no. 05, pp. 170–190+13, 2021.
- [4] R. Accenture, “Digital transformation index of Chinese enterprises,” *Software and Integrated Circuit*, vol. 38, no. 01, pp. 68–78, 2021.
- [5] H. Shen, F. Pan, and X. Gao, “Institutional environment and the incentive effect of managerial ownership,” *Chinese industrial economy*, vol. 08, pp. 96–108, 2012.
- [6] X. Zhang, Y. Xu, and L. Ma, “Research on the configuration effect of factors affecting the digital transformation of SMEs,” *Economic and Management Review*, vol. 38, no. 01, pp. 92–102, 2022.

- [7] K. S. Warner and M. Wäger, "Building dynamic capabilities for digital transformation: an ongoing process of strategic renewal," *Long Range Planning*, vol. 52, no. 3, pp. 326–349, 2019.
- [8] L. Wu, B. Lou, and L. Hitt, "Data analytics supports decentralized innovation," *Management Science*, vol. 65, no. 10, pp. 4863–4877, 2019.
- [9] A. Goldfarb and C. Tucker, "Digital economics," *Journal of Economic Literature*, vol. 57, no. 01, pp. 3–43, 2019.
- [10] S. Nambisan, M. Wright, and M. Feldman, "The digital transformation of innovation and entrepreneurship: progress, challenges and key themes," *Research Policy*, vol. 48, no. 8, pp. 1–9, 2019.
- [11] F. Li, "Leading digital transformation: three emerging approaches for managing the transition," *International Journal of Operations & Production Management*, vol. 40, no. 6, pp. 809–817, 2020.
- [12] R. Thomas and L. P. Carsten, "Digitization capability and the digitalization of business models in business-to-business firms: past, present, and future," *Industrial Marketing Management*, vol. 86, pp. 180–190, 2020.
- [13] L. Li, W. Zhou, L. Weig, and S. Yang, "How can digital collaboration capability boost service innovation? Evidence from the information technology industry," *Technological Forecasting and Social Change*, vol. 182, Article ID 121830, 2022.
- [14] K. Dery, I. M. Sebastian, and V. D. M. Nick, "The digital workplace is key to digital innovation," *MIS Quarterly Executive*, vol. 16, no. 2, pp. 135–152, 2017.
- [15] C. Yuan, T. Xiao, and C. Geng, "Digital transformation and division of labor: specialization or vertical integration," *Chinese industrial economy*, vol. 09, pp. 137–155, 2021.
- [16] H. Mak and Z. M. Shen, "When triple-A supply chains meet digitalization: the case of JD.com's C2M model," *Production and Operations Management*, vol. 30, no. 3, pp. 656–665, 2021.
- [17] Z. Seyedghorban, H. Tahernejad, R. Meriton, and G. Graham, "Supply chain digitalization: Past, present and future," *Production Planning & Control*, vol. 31, no. 2-3, pp. 96–114, 2020.
- [18] F. Ye, K. Liu, L. Li, K. Lai, Y. Zhan, and A. Kumar, "Digital supply chain management in the COVID-19 crisis: an asset orchestration perspective," *International Journal of Production Economics*, vol. 234, Article ID 108396, 2022.
- [19] M. Matarazzo, L. Penco, G. Profumo, and R. Quaglia, "Digital transformation and customer value creation in made in Italy SMEs: a dynamic capabilities perspective," *Journal of Business Research*, vol. 123, pp. 642–656, 2021.
- [20] A. Hanelt, R. Bohnsack, D. Marz, and C. A. Marante, "A systematic review of the literature on digital transformation: insights and implications for strategy and organizational change," *Journal of Management Studies*, vol. 58, no. 5, pp. 1159–1197, 2021.
- [21] M. Abou-foul, J. L. Ruiz-Alba, and A. Soares, "The impact of digitalization and servitization on the financial performance of a firm: an empirical analysis," *Production Planning & Control*, vol. 32, no. 12, pp. 975–989, 2021.
- [22] W. Pan, T. Xie, Z. Wang, and L. Ma, "Digital economy: an innovation driver for total factor productivity," *Journal of Business Research*, vol. 139, pp. 303–311, 2022.
- [23] F. Zeng, X. Zheng, and X. Li, "Research on the relationship between IT capability and enterprise sustainable development performance," *Scientific research management*, vol. 39, no. 04, pp. 92–101, 2018.
- [24] S. Liu, J. Yan, S. Zhang, and H. Lin, "Can digital transformation of enterprise management improve input output efficiency," *Management World*, vol. 37, no. 05, pp. 170–190+13, 2021.
- [25] C. Forman and K. McElheran, "Firm organization in the digital age: IT use and vertical transactions in U.S. manufacturing," *SSRN Working Paper Series*, 2019.
- [26] S. Chaniyas, M. D. Myers, and T. Hess, "Digital transformation strategy making in pre-digital organizations: the case of a financial services provider," *The Journal of Strategic Information Systems*, vol. 28, no. 1, pp. 17–33, 2019.
- [27] P. Y. Nie, C. Wang, and H. X. Wen, "Effects of Artificial Intelligence on Duopoly Competition," *Applied Economic Letters*, 2022.
- [28] S. Bresciani, K. H. Huarng, A. Malhotra, and A. Ferraris, "Digital transformation as a springboard for product, process and business model innovation," *Journal of Business Research*, vol. 128, pp. 204–210, 2021.
- [29] P. C. Verhoef, T. Broekhuizen, Y. Bart et al., "Digital transformation: a multidisciplinary reflection and research agenda," *Journal of Business Research*, vol. 122, pp. 889–901, 2021.
- [30] Y. C. Yang and P. Y. Nie, "Subsidy for clean innovation considered technological spillover," *Technological Forecasting and Social Change*, vol. 184, Article ID 121941, 2022.
- [31] C. L. Chen, Y. C. Lin, W. H. Chen, C. F. Chao, and H. Pandia, "Role of government to enhance digital transformation in small service business," *Sustainability*, vol. 13, no. 3, pp. 1–24, 2021.
- [32] F. Wu, X. Chang, and X. Ren, "Government-driven innovation: fiscal expenditure on science and technology and Enterprise digital transformation," *Public Finance Research*, vol. 01, pp. 102–115, 2021.
- [33] Z. Zhou and X. Wu, "The impact of intellectual property protection on the digital transformation of enterprises-The empirical evidence from the reform of "three trials in one," *Science of Science and Management of S.&T.* vol. 43, no. 06, pp. 89–109, 2022.
- [34] S. Sun, D. J. Hall, and C. G. Cegielski, "Organizational intention to adopt big data in the B2B context: an integrated view," *Industrial Marketing Management*, vol. 86, pp. 109–121, 2020.
- [35] H. Li, Y. Wu, D. Cao, and Y. Wang, "Organizational mindfulness towards digital transformation as a prerequisite of information processing capability to achieve market agility," *Journal of Business Research*, vol. 122, pp. 700–712, 2021.
- [36] M. Cichosz, C. M. Wallenburg, and A. M. Knemeyer, "Digital transformation at logistics service providers: barriers, success factors and leading practices," *International Journal of Logistics Management*, vol. 31, no. 2, pp. 209–238, 2020.
- [37] A. Steiber, S. Alange, S. Ghosh, and D. Goncalves, "Digital transformation of industrial firms: an innovation diffusion perspective," *European Journal of Innovation Management*, vol. 24, no. 3, pp. 799–819, 2020.
- [38] J. Soluk and N. Kammerlande, "Digital transformation in family-owned mittelstand firms: a dynamic capabilities perspective," *European Journal Of Information Systems*, vol. 30, no. 6, pp. 676–711, 2021.
- [39] P. Maroufkhani, M. L. Tseng, M. Iranmanesh, W. K. W. Ismail, and H. Khalid, "Big data analytics adoption: determinants and performances among small to medium-sized enterprises," *International Journal of Information Management*, vol. 54, Article ID 102190, 2020.
- [40] D. Horvath and R. Z. Szabo, "Driving forces and barriers of industry 4.0: do multinational and small and medium-sized companies have equal opportunities?" *Technological Forecasting and Social Change*, vol. 146, pp. 119–132, 2019.

- [41] B. K. AlNuaimi, S. K. Singh, S. Ren, P. Budhwar, and D. Vorobyev, "Mastering digital transformation: the nexus between leadership, agility, and digital strategy," *Journal of Business Research*, vol. 145, pp. 636–648, 2022.
- [42] M. C. Jensen and W. H. Meckling, "Theory of the firm: managerial behavior, agency costs and ownership structure," *Journal of Financial Economics*, vol. 3, no. 4, pp. 305–360, 1976.
- [43] D. Zhu and X. Zhou, "Wnership checks and balances, executive ownership and enterprise innovation efficiency," *Nankai Business Review*, vol. 19, no. 03, pp. 136–144, 2016.
- [44] B. Lyu and H. Chen, "Effect of founder control on equity financing and corporate performance based on moderation of radical strategy," *Sage Open*, vol. 12, no. 2, pp. 1–16, 2022.
- [45] E. H. Kim and Y. Lu, "CEO ownership, external governance, and risk-takin," *Journal of Finance and Ecomics*, vol. 102, no. 2, pp. 272–292, 2011.
- [46] R. F. J. Haans, C. Pieters, and Z. L. He, "Thinking about U: theorizing and testing U-and inverted U-shaped relationships in strategy research," *Strategic Management Journal*, vol. 37, no. 7, pp. 1177–1195, 2016.