7 How Do Academic Directors Influence Corporate Digital Transformation? An Explanatory Framework Integrating Motivation and Ability

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Abstract

Using the data of Chinese listed companies from 2014 to 2021, we have obtained empirical evidence to support our arguments. This paper proposes that academic directors have a significant positive effect on digital transformation through the functions of advising, monitoring, and providing resources. In addition, from the perspective of whether academic directors "want to" and "can" carry out digital transformation, we further find that academic director shareholding, CEO academic background, and CEO power enhance the positive influence of academic directors on digital transformation. This paper not only enriches the research on the influencing factors of digital transformation but also recommends enterprises wishing to create a board structure that can enhance the internal driving force of digital transformation.

Keywords: *Academic directors, Digital transformation, Academic director shareholding, CEO academic background, CEO power*

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1. Introduction

With the rapid emergence and development of artificial intelligence, big data, and other technologies, digital transformation has become a new engine for economic growth. For enterprises, digital transformation not only represents an "admission ticket" with respect to joining

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the current development trend but also a "bonus card" to confront future uncertainty (Li and Yang, 2024). Although enterprises have realized the importance of digital transformation, owing to the high cost, high risk, and long cycle of such transformation, as well as their own resource constraints, risk aversion, and inertial thinking regarding it, many enterprises "can't turn", are "not good at turning" or "dare not turn" (Chen and Yang, 2022). The *Accenture China Enterprise Digital Transformation Report of 2023* noted that, owing to the turbulent international political environment, the speed of the digital transformation of Chinese enterprises has decelerated vehemently. Further, the proportion of transformational leaders has decreased from 17% in 2022 to 9% in 2023, (among them only 1% are capable of leading a reshaping of their businesses through digitalization and achieving comprehensive performance improvement). Hence, how to drive the digital transformation of enterprises is an important theoretical question as well as a practical problem that urgently needs to be solved.

Practically, the board of directors plays a coordinating role in strategic decisions including digital transformation. In fact, prior studies have recognized the critical role of key decision-makers in the digital transformation of firms. These studies suggest that CEOs' overseas experience, overconfidence, and authority affect digital transformation (Wang and He, 2024; Xu and Hou, 2024; Zhu, Li and Ma, 2024). However, such research ignores the central role of the board of directors. Resource dependence theory (RDT) emphasizes the dependency relationship between an organization and its external environment, especially its dependence on resource acquisition. Theoretically, the board of directors is regarded as an important resource for the organization who can bring strategic advantages to the organization. The industrial experience and expertise of board members can guide the organization to acquire more resources in the market. Directors with academic backgrounds tend to have rich knowledge reserves, advanced strategic vision, high ethical standards, and stable social capital due to the rigorous professional training they have received in academia. Henceforth, the academic directors would be regarded as superior to other directors while guiding the digital transformation of enterprises (Liu, 2020). On the one hand, academic directors can deepen firms' understanding of the importance of corporate transformation by virtue of their professional knowledge and strategic vision. On the other, a more developed sense of ethics enables them to monitor executives' opportunistic behaviors splendidly. Additionally, their secure social capital enables them to provide more support for corporate transformation. Hence, it is significant to explore whether academic directors influence the digital transformation of enterprises or not?

Furthermore, it is necessary to analyze the intensity of directors with academic backgrounds while influencing the digital transformation. Therefore, the digital transformation effect of academic directors is subject to several key situational factors which have often been ignored by the extant literature. From the perspective of "want or not", whether to hold shares is an important determinant of their motivation or not? Academic directors who hold shares are more deeply connected to the firm, and their interests are more bound to its success vigorously (Kong, et al., 2024). Moreover, they are more concerned with the survival and development of the enterprise while motivating them to utilize their abilities to help the enterprise achieve digital transformation. Further, in the perspective of implementation of strategic decisions, among the corporate board, CEOs play a pivotal role. Relevantly, the CEO's willingness determines the depth of implementation of the board's digital transformation decisions. Firstly, CEOs who also have academic backgrounds are more likely to understand and agree with the transformation decisions of academic directors while enhancing the effectiveness of digital transformation (Carpenter and Fredrickson, 2001). Secondly, CEO power refers to the ability of CEOs to implement strategies according to individual wishes, and CEOs with high power who are influenced by opportunism may hinder digital transformation (Gull, et al., 2023). It may weaken the role of academic directors in promoting digital transformation.

In summary, this paper endorses Shanghai and Shenzhen A-share listed companies from 2014-2021 as the research object to investigate the moderating roles of academic director

shareholding, CEO academic background, and CEO power on the basis of the detailed and insightful revelation of the impact of academic directors on corporate digital transformation. The main contributions of this study are as follows. Firstly, this paper complements the theoretical research on the economic consequences of academic directors. We find that academic directors significantly and positively affect digital transformation, and this finding provides new insights for firms, enabling them to fully and comprehensively recognize the positive role of academic directors. Secondly, this study enriches the research on the antecedents of digital transformation. On the basis of the literature, this paper further incorporates academic directors into the study of digital transformation antecedents and reveals the internal mechanism of their influence in a detailed manner, thus providing a better understanding of enterprises' digital transformation behaviors. Finally, the boundary conditions of academic directors' influence on digital transformation are expanded. From the perspective of "want or not" and "can or cannot", three situational factors affecting the relationship between the two conditions are examined. This approach is more conducive to explaining the different digital transformation performances of enterprises in the same institutional environment and, to a certain extent, opens the "black box" of academic directors' influence on digital transformation.

2. Literature review and research hypothesis

2.1. Literature review

Academic directors are those directors who have teaching experience in universities or are engaged in research work in scientific research institutions and associations and whose business advice is characterized by rich knowledge, meticulous logic, forward-looking vision, and high morality. Research has confirmed that academic directors play a key role in corporate governance structure adjustment and strategy selection. On this basis, the literature has investigated the impact of academic directors on green innovation (Ullah, Jiang and Elamer, 2024), noncompliance (Xiang and Zhu, 2023), mergers and acquisitions (Francis, Hasan and Wu, 2015), CEO change (Francis, Hasan and Wu, 2015), social responsibility (Cho, et al., 2017) and other corporate behaviors as well as financial performance (Huang, et al., 2016). However, as a strategic choice that companies must face in the context of the digital economy, it remains unclear whether digital transformation is influenced by academic directors.

Digital transformation is a process in which enterprises use new digital technologies, such as artificial intelligence, to trigger major changes in organizational attributes and strategic changes. Because decision-makers play a coordinating role in digital transformation, their professional background, industry experience, and psychological qualities fundamentally affect the problems of "can't turn", "not good at turning", and "dare not to turn" experienced by enterprises. Therefore, their effect on digital transformation has become a focus of academic discussion. Previous research has focused on the impact of the CEO-led executive team mainly in terms of three aspects: professional backgrounds (including overseas experience, technical expertise, financial expertise, and green experience) (Xu and Hou, 2024; Zhang, et al., 2024), psychological characteristics such as overconfidence (Zhu, Li and Ma, 2024), and authority factors encompassing celebrity effect and positional power (Wang, et al., 2023; Wang and He, 2024). Admittedly, emerging studies have begun to explore the impact of directors' social capital on firms' digital transformation, but such studies have come to contradictory conclusions. The promotion view holds that the social capital directors possess can provide resource support for digital transformation (Lin and Xie, 2024); the inhibition view suggests that social capital can place directors into a "resource curse", which leads to a decline in the level of corporate governance and operational efficiency, thus hindering digital transformation (Chen and Hao, 2022).

Unfortunately, there is a lack of theoretical and empirical evidence that supports examining the promotion path of digital transformation from the internal perspective of directors' academic background.

2.2. Research hypotheses

2.2.1. Impact of academic directors on corporate digital transformation

Firstly, academic directors can solve the problem of "not good at turning" through their advising function. Knowledge level is an important factor affecting the advising function of directors (Coleman, 1988). Because academic directors have professional academic training, they often possess solid theoretical foundations, which can enhance their motivation for and ability to digitally transform enterprises. On the one hand, academic directors possess rich professional knowledge, keen observational ability, and an advanced strategic vision, which can deepen enterprises' understanding of the importance and necessity of sustainable development strategies such as digital transformation (Liu, 2020). On the other hand, their close connections with scientific research institutes enable academic directors to better understand the internal logic of digital technology and the transformation process and to have easier access to nonpublic heterogeneous information and transformation examples. Therefore, they can provide valuable suggestions different from those of practical directors regarding the direction, intensity, progress, and specific schemes of corporate digital transformation (Du, Jian and Lai, 2017). In addition, academic directors often possess a rigorous ability to think logically and a critical spirit, and they frequently pay more attention to the accuracy of the decision implementation process and results; thus, their suggestions are more likely to avoid guiding a firm's digital transformation in the wrong direction (Xiang and Zhu, 2023).

Secondly, academic directors can overcome the problem of "dare not to turn" by performing monitoring. In the supervision of executives' digital transformation opportunism, academic directors have stronger motivation and ability. In terms of motivation, academic directors tend to have higher ethical standards and a sense of social responsibility and will urge managers to strengthen digital transformation investment and reduce opportunistic behavior from the perspective of long-term corporate interests and economic and social development (Xiang and Zhu, 2023). At the same time, because academics often have good reputations and social status and opportunistic behavior is prone to causing reputation crises, academic directors are more motivated to monitor managers to avoid digital transformation "greenwashing" and other behaviors (Fisman, et al., 2018). In terms of ability, because of their rich knowledge and experience, academic directors have a greater voice in corporate digital transformation decision-making, which can reduce the probability of the executive team hindering decision-making and implementation due to risk aversion (Xiang and Zhu, 2023). In addition, academic directors have a rich knowledge base and a rigorous dialectical thinking method and are thus more capable of judging the effectiveness of project implementation and the authenticity of financial information, which can reduce duplicitous behavior by the executive team (Chen, et al., 2011).

Finally, academic directors can address the problem of "can't turn" by playing the function of providing resources. In the process of receiving professional education and academic training, academic directors establish close relationships with universities and research institutes, and these social relationships can provide resource support for the digital transformation of enterprises. On the one hand, the connection between academic directors and universities and other institutions can help enterprises obtain human resources with high levels of professionalism, and improving employee quality can reduce resistance in the process of digital transformation; for example, scientific and technological talent can adapt to new digital technology faster, and managerial talent can improve the efficiency of digital transformation (White, et al., 2014). On the other hand, the resources of academic directors in the academic community can help enterprises establish links and cooperative relationships with university research teams and research

institutions, which is conducive to helping enterprises obtain cutting-edge theoretical information and technical resources and promoting digital transformation with the help of external forces (Francis, Hasan and Wu, 2015). The preceding analysis leads to our first hypothesis:

H1. Academic directors positively affect corporate digital transformation.

2.2.2. Moderating role of academic director shareholding, CEO academic background, and CEO power

"Academic director shareholding" refers to whether academic directors hold shares in the enterprises they serve, which can increase their motivation to carry out digital transformation. According to Hauser's (2018) research, the board's energy and resources are limited, and serving in multiple companies will divert a director's commitment to a single company. In addition, the interests of directors and shareholders are incompatible. To avoid employment risk and protect their reputations, academic directors can also display opportunistic tendencies in risk decisions (Lu and Wang, 2018). Therefore, the possibility of part-time employment in many companies and the incompatibility between directors and corporate interests indicate that the digital transformation effect of certain academic directors is limited. However, holding company stock makes academic directors more closely linked to enterprises. On the one hand, this close relationship increases the attention of academic directors to the survival and development of enterprises, making them more motivated to provide valuable suggestions and scarce resources to support the digital transformation of enterprises (Hauser, 2018). On the other, holding company stock makes the interests of academic directors compatible with those of shareholders and increases their enthusiasm for their work, thus effectively promoting the implementation of risk strategies such as digital transformation (Hillman, Withers and Collins, 2009). These arguments lead to our next hypothesis:

H2a. Academic director shareholding positively moderates the impact of academic directors on corporate digital transformation.

"CEO academic background" refers to the work experience of CEOs in universities or scientific research institutions, which can enhance the ability of academic directors to promote digital transformation. In addition to the board of directors, the CEO, as the core figure of the strategic execution team, also plays an important role in digital transformation, determining the effectiveness and depth of the implementation of the board's decisions. Therefore, the influence of academic directors on digital transformation is also subject to the CEO (Yang, Shi and Wang, 2021). CEOs with academic backgrounds are similar to academic directors in terms of their thinking mode, and a greater sense of ethics makes them less duplicitous, thus increasing the influence of academic directors on digital transformation. Specifically, on the one hand, CEOs' education level and academic experience are conducive to alleviating their short-sightedness and providing them with an advanced strategic vision such that companies are more likely to implement higher-risk but more sustainable strategies, such as digital transformation (Li, Zhang and Zhang, 2015). On the other hand, the fact that both directors and CEOs have academic backgrounds enhances the tacit understanding and trust between decision-makers and executives. The CEO will be more likely to identify with the digital transformation decisions of the board of directors and will be more motivated and efficient (Wang, Zhang and Han, 2021). In addition, a good education and professional academic training will also furnish the CEO with a greater sense of ethics and social responsibility, which will make the CEO less likely to engage in fraudulent or opportunistic behaviors when executing board decisions regarding digital transformation (Ren, Zhong and Wan, 2023). Against this backdrop, an additional hypothesis is as follows:

H2b. CEO academic background amplifies the positive effect of academic directors on ***digital*** transformation.

"CEO power" refers to the influence of the CEO in the operation and strategy implementation of the enterprise. CEO power can reduce the ability of academic directors to promote digital transformation. Agency theory holds that CEOs have an opportunistic tendency to avoid high-risk projects such as digital transformation to protect their reputations and professional security, preferring to spend resources on projects that can reliably bring benefits (Lin and Guan, 2024). Therefore, CEOs use their rights to interfere with or hinder the digital transformation decisions of the board of directors. However, the extent of the CEO's power determines his or her influence ability. When CEOs have less power, their influence is limited, and they find it more difficult to have their personal preferences reflected in decision-making. Conversely, with greater power, CEO authority increases, potentially affecting the board's independent decision-making capability, thus aligning corporate strategy more closely with the CEO's personal preferences and interests (Tran and Turkiela, 2020), and their risk aversion tendency limits the effect of the digital transformation decisions of academic directors (Schepker, et al., 2018). Moreover, CEOs with authoritative power face fewer checks and balances, weakening the supervision capacity of academic directors. In CEO-dominated organizations, board appointments may also be influenced by the CEO, who may challenge the board's independence and its ability to monitor the executive team effectively with respect to digital transformation (Gull, et al., 2023). On the basis of the preceding analysis, the following hypothesis is proposed:

H2c. CEO ***power*** negatively moderates the impact of academic directors on corporate digital transformation.

3. Methods

3.1. Sample selection and data sources

This paper takes China's listed companies from 2014 to 2021 as its research object for empirical testing. To guarantee the scientific validity of the conclusions, we screened the data as follows. (1) Enterprises in the financial and insurance industries were excluded. (2) Enterprises that were ST, ST * from 2014 to 2021 were excluded. (3) Enterprises with missing relevant variables were excluded. Finally, we obtained balanced panel data for 794 companies from 2014 to 2021, with a total of 6352 sample observations. Moreover, to avoid interference from extreme values, we trimmed the pool by removing 1% of the lowest and highest values of all continuous variables. The data for all the variables were obtained from the CSMAR database and the China Research Data Services Platform (CNRDS).

3.2. Variables and measures

3.2.1. Explained variable

Corporate digital transformation is the explained variable, which is denoted by Dt. Based on many authoritative studies, CSMAR database summarizes the keywords relating to the two concepts of "underlying technology utilization" and "technology practice application" in corporate digital transformation and provides the number of occurrences of these keywords in the annual reports of listed companies. Thus, this paper uses the keyword frequencies of the annual reports provided by the CSMAR database to measure the digital transformation of enterprises (Meng, Su and Yu, 2022). Considering the large differences in keyword appearance frequency among enterprises, this study added 1 to the totals and took the logarithm of each total.

3.2.2. Explanatory variable

The explanatory variable is academic directors, which is denoted by Ad. This paper uses the ratio of the number of directors with academic backgrounds to the total number of board members to measure academic directors. Director with academic background refers to the director teaching

in a university, working in a scientific research institution, or engaged in research work in an association (Liu, 2020). The data were collected from the CSMAR database.

3.2.3. Moderating variables

Academic director shareholding is denoted by Stockh. In this paper, it is set as a dummy variable. If an academic director holds shares in listed companies, the dummy variable is 1; otherwise, it is 0. CEO academic background is denoted by Ceoa. It is set as a two-category variable. If the CEO has an academic background, the two-category variable value is 1; otherwise, it is 0. CEO power is denoted by Dual. It too is set as a dummy variable. If the CEO is concurrently the chairperson, the dummy variable is taken to be 1; otherwise, it is 0. The data were collected from the CSMAR database.

3.2.4. Control variables

We controlled enterprise growth capability (Growth), net profit margin on total assets (Roa), ownership concentration (Tophold), age of listing (Listage), cash flow (Cf), asset liability ratio (Lev), earnings per share (Eps), enterprise scale (Size), nature of property rights (Soe), the area where the firm is located (Area), industry (Industry), and year (Year) on the basis of the literature (Liu, 2020).

3.3. Research model

We performed a benchmark model selection test, and the results show that the fixed effect model should be used. Arguably, there are variables that remain unchanged over time, such as the nature of property rights. Therefore, the Reghdfe regression was executed to avoid them being omitted in the ordinary fixed effect regression.

In order to test H1, the regression Model (1) was set.

$$Dt_{it} = \alpha_1 + \beta_1 Ad_{it} + \sum \gamma_i Controls_{it} + \varepsilon \quad (1)$$

In order to test H2a, H2b, and H2c, grouped regression was performed on Model (1) to compare the size, sign, and significance level of academic directors' regression coefficients in different subgroups.

4. Empirical analysis

4.1. Descriptive statistics and correlation analysis

As shown in Table 1, the minimum, maximum, mean, median, and standard deviation of Dt are 0, 4.564, 1.247, 1.097, and 1.212, respectively, which indicates that there is a large gap between enterprises and the majority of enterprises are at a lower level. Moreover, the minimum, maximum, mean, median, and standard deviation of Ad are 0, 0.778, 0.304, 0.286, and 0.165, respectively, indicating that the percentage of academic directors in most companies is relatively low.

The results of correlation analysis show that the absolute values of correlation coefficients are generally below 0.5. Moreover, the results of VIF test demonstrate that the average, minimum, and maximum VIF values of the variables are 1.34, 1.03, and 2.37, respectively, indicating that there is no absolute multicollinearity problem.

Table 1 Descriptive statistics and correlation analysis

Variables	1	2	3	4	5	6	7
1.Dt	1						
2.Ad	0.096***	1					

3.Growth	0.021*	-0.008	1				
4.Roa	0.054***	0.066***	0.161***	1			
5.Tophold	-0.043***	0.007	0.007	0.123***	1		
6.Listage	0.045***	0.005	0.019	-0.113***	-0.157***	1	
7.Cf	-0.026**	0.001	-0.069***	0.227***	0.085***	0.057***	1
8.Lev	0.009	0.042***	0.064***	-0.334***	0.049***	0.117***	-0.078***
9.Eps	0.118***	0.070***	0.146***	0.688***	0.114***	-0.025**	0.152***
Variables	1	2	3	4	5	6	7
10.Size	0.175***	0.153***	0.071***	0.172***	0.226***	-0.013	0.018
11.Soe	-0.072***	0.049***	-0.032***	-0.098***	0.246***	0.157***	0
12.Area	0.119***	0.024*	-0.013	0.064***	0.030**	-0.048***	0.011
13.Industry	0.204***	0.010	0.005	-0.074***	-0.008	0.131***	-0.038***
14.Year	0.188***	0.056***	0.032***	0.018	-0.050***	0.319***	0.101***
Variables	8	9	10	11	12	13	14
8.Lev	1						
9.Eps	-0.096***	1					
10.Size	0.347***	0.355***	1				
11.Soe	0.166***	-0.046***	0.081***	1			
12.Area	-0.055***	0.101***	0.097***	-0.053***	1		
13.Industry	0.088***	-0.018	0.019	0.054***	0.150***	1	
14.Year	-0.024*	0.085***	0.053***	-0.007	-0.001	0.015	1
Mean	1.247	0.304	0.169	0.109	0.163	0.145	0.03
Std. Dev.	1.212	0.165	0.375	0.312	0.369	0.505	0.059
Median	1.097	0.286	0	0	0	0.071	0.028
Min	0	0	0	0	0	-0.62	-0.239
Max	4.564	0.778	1	1	1	3.724	0.184

Note: ***, **, and * represent significance at the 1%, 5%, and 10% level, respectively. Same as below.

4.2. Analysis of regression results

As shown in the regression results of Models (1) in Table 2, the regression coefficient of Ad to Dt is 0.428, which is significant at the 1% level. The regression results indicate that academic directors have a significant positive effect on corporate digital transformation, validating H1.

Table 2 Regression results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Main effect	Stockh		Ceoa		Dual	
		Yes	No	Yes	No	Yes	No
Variables	Dt	Dt	Dt	Dt	Dt	Dt	Dt
Ad	0.428***	0.502**	0.202**	1.037***	0.212**	0.622***	0.387***
	(5.25)	(2.44)	(2.00)	(3.98)	(2.27)	(3.01)	(4.33)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Constant	-2.933***	-2.295**	-2.979***	-2.480**	-2.887***	-5.438***	-2.355***
	(-8.52)	(-2.55)	(-7.88)	(-2.16)	(-7.97)	(-6.27)	(-6.24)
N	6352	1076	5276	694	5657	1035	5316
Adj. R2	0.263	0.310	0.247	0.249	0.265	0.315	0.253
P (Chow test)	.	0.014		0		0	
P (F test)	0	0	0	0	0	0	0
F	40.27	7.613	27.60	4.935	32.57	20.03	23.58

The Chow test method was used to test the difference in the intergroup coefficients, and the results indicate that the regression coefficients of Ad differ significantly among the three moderating variable subgroups. As shown in the regression results of Models (2) and (3) in Table 2, the regression coefficients of Ad to Dt in the two subgroups are significant at the 5% level, but it is larger in the academic director shareholding group (0.502>0.202). These results indicate that academic director shareholding strengthens the positive impact of academic directors on digital transformation, and H2a is verified.

As shown in the regression results of Models (4) and (5) in Table 2, the regression coefficients of Ad to Dt in the two subgroups are significant at the 1% and 5% level, respectively, but it is larger when the CEO has an academic background (1.037>0.212). These results indicate that CEO academic background positively moderates the impact of academic directors on corporate digital transformation, and H2b is verified.

As shown in the regression results of Models (6) and (7) in Table 2, the regression coefficients of Ad to Dt in the two subgroups are significant at the 1% level, but it is larger when the CEO has more power (0.622>0.387). These results indicate that CEO power enhances the positive impact of academic directors on digital transformation. Therefore, H2c has inverse support, and we will discuss this empirical result in the discussion section.

4.3. Robustness check

4.3.1. Replacing measurements

The ratio of the number of digital transformation-related words to the total number of words in the annual report (Dt2) was used to replace the corporate digital transformation measurement. As shown in Table 3, the regression results of Model (1) once again verify H1.

We used the number of directors with academic background (Ad2) to replace the academic directors measurement. As shown in Table 3, the regression results of Model (2) still support H1.

Table 3 Robustness tests

	(1)	(2)	(3)	(4)	(5)
Variables	Dt2	Dt	Dt	Dt	Dt
Ad	0.053***			0.560***	0.576***
	(3.10)			(4.72)	(5.20)
Ad2		0.043***			
		(4.80)			
L.Ad			0.478***		
			(5.39)		
Controls	Yes	Yes	Yes	Yes	Yes
Constant	-0.257***	-2.866***	-3.092***	-5.493***	-173.721***
	(-3.59)	(-8.29)	(-8.20)	(-10.69)	(-10.61)
N	6352	6352	5558	6352	5558

Adj. R2	0.374	0.262	0.246	.	0.111
P (F test)	0	0	0	0	0
F	13.74	39.75	38.83	.	.

4.3.2. Time-lag problem treatment

Lagging the independent variable was executed to solve the time-lag problem by regressing the Dt of period t through the Ad of period t-1 while addressing endogeneity to a certain extent. As shown in the regression results of Model (3) in Table 3, H1 remains verified.

4.3.3. Replacement estimation method

To avoid the influence of the presence of too many zero values for the dependent variable on the regression results, Tobit regression was used to test the main effect. As shown in Table 3, the regression results of Model (4) still validate H1.

4.3.4. Instrumental variable regression

Considering the endogeneity problem caused by omitted variables and other factors, this paper used the lagged value of the independent variable (L.Ad) as an instrumental variable and conducted an instrumental variable regression. The rationality of the instrumental variable is as follows. Firstly, the p value of the unidentifiable test is 0; secondly, the F value of the weak instrumental variable test is 1291.5; and finally, the Sargan value of the overidentification test is 0. As shown in the regression results of Model (5) in Table 3, H1 remains validated.

5. Conclusions and implications

This paper uses data for A-share listed companies from 2014-2021 to investigate the influence mechanism and boundary conditions of academic directors on corporate digital transformation on the basis of RDT, and the conclusions are as follows. Firstly, academic directors significantly and positively affect corporate digital transformation. Secondly, the moderating effect test revealed that academic director shareholding and CEO academic background enhance the positive impact of academic directors on corporate digital transformation.

Notably, we obtain opposite empirical findings for the moderating effect of CEO power. Specifically, CEO power can enhance, rather than weaken, the positive impact of academic directors on corporate digital transformation. A possible explanation for this is that the theoretical analysis in this paper ignores the positive impact of CEO power expansion on the willingness to enhance the digital transformation of enterprises and the efficiency of organizational functioning. On the one hand, granting CEOs sufficient power and trust can stimulate their competitive awareness and creativity, enabling them to better perform their “stewardship” function, thus reducing the opportunistic behavior of the top management team (Chen, 2014). In addition, the increased status and authority that come with greater power increase CEOs’ self-confidence and risk tolerance (Pucheta-Martinez and Gallego-Alvarez, 2024). On the other hand, more power means that CEOs have greater discretion, which can reduce the problems of low communication efficiency caused by disputes within management during decision-making and improve the efficiency of decision-making and implementation (Zhang, et al., 2022).

5.1. Theoretical implications

Firstly, this study provides new insights into how academic directors influence enterprises’ strategic choices, contributing to a more comprehensive and nuanced understanding of the economic consequences of academic directors. It has not been confirmed whether digital transformation, as a key strategy that firms must focus on and implement in the transition to the digital economy, is influenced by the presence of academic directors at the core of decision-making. Therefore, the findings of this paper enrich the research on the economic consequences

of academic directors from the perspective of digital transformation and provide theoretical guidance for firms desiring to comprehensively and fully understand their governance role.

Secondly, this paper contributes to the research on the influencing factors of enterprise digital transformation by identifying new antecedents. Research on the antecedents of digital transformation from an organization-driven perspective has focused more on the role of the CEO-centered executive team and internal resources in digital transformation while neglecting the impact of the board of directors, which plays a strategic coordinating role. Although emerging research has focused on the impact of directors' social capital on digital transformation, it has not further analyzed the role of academic directors. Therefore, this paper explores the impact of academic directors on digital transformation, which helps open the "black box" of the relationship between the two, while expanding the research on the antecedents of digital transformation and providing new insights into how enterprises can shape their competitive advantage in the digital economy.

Thirdly, this study examined the moderating variables affecting the relationship between academic directors and digital transformation from the perspectives of motivation and ability, which helps expand the boundaries of research on the relationship. In fact, whether or to what extent academic directors can contribute to digital transformation is influenced by their motivation and ability. Therefore, this paper investigated the moderating effects of academic director shareholding, CEO academic background, and CEO power from the perspectives of "want or not" and "can or cannot" and constructed a relatively complete theoretical framework of academic directors' influence on digital transformation, which can provide theoretical guidance for enterprises wishing to maximize the positive role of academic directors.

5.2. Management implications

On the one hand, it is important to give full play to the positive effect of academic directors in corporate digital transformation. Academic directors, as a core source of strategic decision-making, should give full play to their advantages, earnestly fulfill their responsibilities, and help enterprises achieve sustainable development. They should make full use of their rich professional knowledge, ability to think rigorously, and advanced strategic vision to make suggestions regarding the digital transformation of enterprises and fully deploy their consulting function. At the same time, they should maintain high levels of ethics and social responsibility and strengthen the supervision of any opportunistic behavior by the executive team in the process of digital transformation. In addition, academic directors should utilize their social network relationships to help enterprises acquire high-quality human resources and seek external cooperation to alleviate the shortage of such resources in the digital transformation effort. Enterprises should fully recognize and attach importance to the positive role of academic directors in their pursuit of digital transformation. Therefore, the staff structure of the board of directors should be rationally adjusted to increase the proportion of academic directors so that academic directors and practical directors can complement one another's strengths while working together to promote digital transformation.

On the other hand, enterprises should recognize the conditions necessary for academic directors to drive digital transformation. With respect to having academic directors, enterprises should also pay attention to the situational conditions that affect their role. Firstly, equity incentives should be provided to academic directors. If such directors hold company shares, their interests will be more closely linked to those of the company, which in turn can alleviate the problems of insufficient performance in the role of academic directors caused by concurrent appointments by multiple companies and the incompatibility between the interests of shareholders and directors. Secondly, companies should recognize and pay attention to the role of CEOs' academic experience in enhancing the quality of board decision implementation and alleviating agency problems and enhance the positive impact of academic directors on digital transformation through the appointment of CEOs with academic backgrounds. Finally, business owners should provide CEOs the power to maximize the positive impact of academic directors on digital transformation.

In addition, investors should use the proportion of academic directors to assess a company's digital transformation capability and potential. For investors who value digital transformation, when assessing the sustainability and certainty of a company's digital transformation, it is important to examine not only historical data but also the proportion of academic directors. Investors should increase their awareness of the positive impact of academic directors on digital transformation and judge whether enterprises have a corporate governance level and resource supply that suit the transformation goal. Such an awareness will help them objectively and comprehensively evaluate the ability and potential of enterprises to digitally transform.

5.3. Research limitations

Although this paper examines the internal mechanism and situational factors of academic directors' influence on the digital transformation of enterprises from theoretical and empirical perspectives and draws valuable conclusions, there remain several limitations to the research that are worthy of further investigation. Firstly, the research object of this paper is listed companies. Thus, whether the findings are applicable to unlisted companies must be tested and analyzed in future studies. Secondly, although this paper adopted the lagging explanatory variable method and instrumental variable regression method to address the endogeneity problem, it could not completely resolve the endogeneity caused by omitted variables. Subsequent studies could address this issue to reveal more factors affecting digital transformation. Finally, although this paper clarified the mechanism and boundary conditions of academic directors' influence on digital transformation to a certain extent, there remain other mediating variables and situational factors in the relationship, which should be explored in future research.

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