

CEOs' Academic Experience and Innovation Performance: Moderating Effect of CEO Duality

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Abstract

Innovation is not only an important source of enterprise core competitiveness, but also a key element to drive Chinese economic growth and enhance international competitiveness. This study aims to analyze the impact of CEOs' academic experience on innovation performance, moderated by CEO duality in China. This study takes Chinese A-share listed firms in Shanghai and Shenzhen Stock Exchanges from 2009 to 2022 as research samples, which contain 28,565 firm-year observations and are analyzed by fixed effect regression. The results indicate that CEOs' academic experience positively impacts innovation performance supported by resource-based theory. In addition, this study also reveals that CEO duality enhances the positive effect of CEOs' academic experience on innovation performance supported by stewardship theory. This finding suggests that CEOs' academic experience provides an internal and external driving resource for enhancing innovation performance. The combination of CEO and board chair will give more power to conducting innovation. Policymakers should prioritize academic recruitment, and grant decision-making power to academic CEOs to drive innovation in enterprises and research institutes.

Keywords: CEOs' Academic Experience, CEO Duality, Innovation Performance, Resource-Based Theory, Stewardship Theory

Introduction

Innovation is an essential source of core enterprise competitiveness (Porter, 1992) and is vital in driving Chinese economic growth and enhancing international competitiveness (Lucas, 1988; Solow, 1957). China has long been known as a "manufacturing power," but the independent innovation ability of Chinese firms has long lagged behind the actual needs of economic development. According to the "National Innovation-Driven Development Strategy Outline" State Council and CPC Central Committee (2016), "the dynamic force of enterprise innovation is not enough, and the overall efficiency of the innovation system is not high." This issue still exists in China. The R&D investment of Chinese enterprises was only 2.6% of GDP in

2022 (Yao et al., 2024). According to the internationally recognized standard, only when the R&D investment level exceeds 5% can an enterprise occupy a favorable position in the fierce market (Yang & Xiang, 2023). Total patents have greatly increased, but patent quality has not achieved synchronous growth Hu et al (2017), which shows that Chinese firms still need to step up efforts to improve innovation. Meanwhile, enhancing original innovative capacity through a national high-level innovative platform and enterprise dominated and market oriented innovation is also stressed by Prime Minister Keqiang Li (Chen & Lyu, 2017). It is likely that Chinese firms need to play a major role in the process of innovation-driven development (Chen & Lyu, 2017). China's economic growth is significantly influenced by innovation, necessitating policymakers to recognize it as a crucial issue with a positive economic impact (McCann & Oxley, 2012; Yu et al., 2013).

In recent years, due to the support of national policies, especially since the Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements, which was revised by the Standing Committee of the National People's Congress (2015), strongly encourages scientific and technological personnel to take part-time jobs in enterprises; more and more scientific researchers with academic experience have entered enterprises, become members of senior management teams, and served in key positions such as CEOs. CEOs play a critical role in shaping corporate strategies and manipulating organizational behaviors in China (Chen et al., 2015).

CEOs' academic experience can help a company perform well by serving in advisory and monitoring capacities Francis et al (2015); encouraging entrepreneurial access to and assimilation of outside knowledge and experience (Audretsch & Lehmann, 2006); providing access to academic networks (Fabrizio, 2006); demonstrating intrinsic motivation for knowledge advancement Lam (2011); and having an understanding of the innovation process (Jiang & Murphy, 2007; Manso, 2011). Firms can effectively utilize resources and competencies to produce measurable performance results (Barney, 1990). Therefore, studying the impact of CEOs' academic experience on innovation performance is significant. Scholars gradually pay attention to the impact of the enterprise leadership structure on enterprise innovation and development, especially the impact of the CEO duality on enterprises (Boyd, 1995; Wijethilake & Ekanayake, 2019). China's executive team currently exists in two organizational forms: the merger of the chairman and CEO and the separation of the two (Peng & Fang, 2010). According to previous research (Gul & Leung, 2004), the combination of CEO and board chair provokes a strong power base. CEO duality can influence the selection of members of the board of directors and senior management team and make full use of the CEO power as chairman to nominate new board members or replace existing board members, thus influencing the decision-making process and results of the board of directors (Reed et al., 2009). The combination of CEO and board chair will give more power to conducting innovation. Therefore, it is significant to study the role of CEO duality in moderating the relationship between CEOs' academic experience and innovation performance.

The paper is motivated to investigate this specific research relationship. Most of the studies on the relationship between CEOs' academic experience and innovation performance are based on upper echelons theory (Bennat & Sternberg, 2022; Dorcas et al., 2021; Zhu et al., 2023). It is also important to study the ability of the firm to utilize knowledge and resources from CEOs' academic experience to enhance internal and external capability, leading to an increase in innovation performance (Wei & Ling, 2015; Audretsch & Lehmann, 2006). This study, based on resource-based theory, studies the relationship between CEOs' academic

experience and innovation performance. Based on stewardship theory, further investigations reveal that CEO duality affects innovation performance. Despite much research examining the preference for innovation performance based on agency theory, little of the existing research is grounded in stewardship theory (Zhang et al., 2018). The current study aims to close this research gap by focusing on stewardship theory and examining the influence of CEO duality on the relationship between CEOs' academic experience and innovation performance. With the above issues in mind, the objectives of this study are:

- To examine the impact of CEOs' academic experience on the innovation performance of Chinese listed firms.
- To examine the role of CEO duality in moderating the relationship between CEOs' academic experience and the innovation performance of Chinese listed firms.

Literature Review and Hypotheses Development

Resource-Based Theory

The resource-based theory is based on a study by Penrose (1959), which describes a firm as a "bundle of resources" (Rivard et al., 2006). Wernerfelt (1984) made a fundamental contribution to the study of resource-based theory and proposed the resource-based theory of enterprises by inheriting and developing the research results of (Penrose, 1959). Barney (1991) expanded on the resource-based theory by identifying the VRIN criteria, which stand for valuable, rare, inimitable, and non-substitutable.

Resource-based theory emphasizes the effective use of internal resources, including tangible and intangible assets, by firms to achieve competitive and profitable activities (Wernerfelt, 1984). The resource-based theory suggests that the manipulation of human, physical, and intangible resources is dynamic and will generate value over time (Conner, 1991). This study utilizes resource-based theory to explore how competitive strategy influences internal and external resources, thereby enhancing an organization's innovation performance (Galbreath, 2005). Competitive advantages and business success are built upon resources (Barney, 1990; Wernerfelt, 1984). Studies on enabling factors of innovation suggest that firms' innovation performance is largely influenced by internal assets and external resources, including R&D, technology investment, knowledge management, and cross-functional teams (Brown & Eisenhardt, 1995; Gumusluoglu & Ilsev, 2009). Based on resource-based theory, Laosirihongthong et al (2013) revealed that internal capital had a positive effect on innovation performance. Akram and Haq (2022) argue that enterprises can use embedded resources from innovation to achieve better innovation performance.

CEOs' Academic Experience and Innovation Performance

According to Amit and Schoemaker (1993); Barney (1991), the resource-based perspective of the company emphasizes the value of corporate resources and the situations in which they can provide a source of long-term competitive advantage. There are reasons why CEOs' academic experience affects innovation performance.

Wernerfelt (1984) argue that organizations operate differently depending on the combination of resources and competencies. CEOs' academic experience has a good theoretical accomplishment and scientific exploration spirit, and the essence of academic research is to innovate (Sunder et al., 2017), which can grasp the core of innovation decisions (Jiang & Murphy, 2007; Yuan & Wen, 2018). When senior executives have academic experience, excellent academic training and an academic atmosphere will improve theoretical accomplishment (Jiang & Murphy, 2007). Executives with a strong sensitivity to scientific and

cultural knowledge, technology research, and development are more likely to pursue innovation in business strategy and improve success rates (Sunder et al., 2017).

Resource-based theorists (Peteraf, 1993; Wernerfelt, 1984) argue that valued resources and capabilities are the cornerstones of long-term organizational success and competitive advantages. CEOs' academic experience has an exploratory cognitive model that enables them to identify and spot opportunities presented by advanced technologies faster and more accurately than their peers (Jiang & Murphy, 2007). CEOs' academic experience includes scientific decision-making that can guide firms in identifying, analyzing, and solving problems, while inhibiting personal subjective tendencies (Shao et al., 2020), so that firms can have more human, material, and financial resources to implement innovation activities, and further improve the innovation efficiency and innovation ability of firms (Datta & Guthrie, 1994).

Therefore, the study examines the academic experience of CEOs who possess strong responsibility, knowledge-sharing Fokuo et al (2023), and resources for effective integration and resource utilization, fostering innovation (Chemmanur et al., 2018; Protogerou et al., 2017). He et al (2021) revealed that senior executives with academic experience tend to invest more substantially in enterprise innovation. Therefore, this paper proposes the following hypothesis:

H1: CEOs' academic experience has a positive impact on innovation performance.

Stewardship Theory

The stewardship theory first appeared in the study of Donaldson and Davis (1991), who point out the inadequacy of the assumption of human nature in the agency theory, and hold that the agency theory is unsuitable for the assumption that managers are opportunistic "shirkers." Eddleston et al (2011) found that stewardship theory, unlike agency theory, emphasizes benevolence and a strong organizational identity, motivating trustees to contribute to corporate success. Managers will do their best for the company, for dignity and the pursuit of job satisfaction, and become the "stewards" of the company. Managers who are seen as stewards are more likely to voluntarily fulfill organizational goals aimed at maximizing shareholders' long-term wealth Eddleston & Kellermanns (2007) because it may provide opportunities for personal growth and achievement (Tosi et al., 2003). Hernandez (2007) suggests that stewardship-based managers prioritize corporate long-term growth over self-interest, enabling firms to invest in R&D to explore new product development and markets.

Based on stewardship theory, Huo and Li (2022) show that managerial power has a positive impact on enterprise innovation performance. Xu and Bai (2019) indicate that a centralized leadership structure involving CEO duality positively impacts the sustainable innovation capability of Chinese-listed companies. Ashwin et al (2015) suggests that family control over CEO and chairperson positions positively impacts innovation performance.

CEO Duality and Innovation Performance

Potential advantages of CEO duality leadership have been suggested by empirical research Boyd (1995); Donaldson & Davis (1991); Mutlu et al (2018) and more recent reviews (Krause et al., 2013; Yu, 2022). There are reasons for CEO duality improve innovation performance.

Based on stewardship theory, due to factors like reputation, dignity, professional growth, and the desire to realize their own value, managers are more inclined to provide excellent

"stewardship" for shareholders (Ashwin et al., 2015; Keay, 2017). Managers, driven by achievement and mission, take initiative, maintain innovation motivation, and implement active decisions to improve sustainable innovation capability in Chinese listed companies (Faleye, 2007; Zhang et al., 2018).

Based on stewardship theory, CEO duality may help lower the information costs associated with information flow between the CEO and chair (Brickley et al., 1997). CEO duality means more autonomy for the CEO, and this approach could hasten the shift from radical innovation to entrepreneurial orientation, particularly in a fast-paced commercial setting (Yang et al., 2018). CEO duality can be advantageous in accordance with stewardship theory (Boyd, 1995; Donaldson & Davis, 1991; Peng et al., 2007). CEO duality can improve communication between the management team and the board (Krause et al., 2013), prevent potential conflicts between the CEO and chair Brickley et al (1997); Lewellyn & Fainshmidt (2017), facilitate internal efficiencies, and improve the ability to act on innovative decisions.

As discussed earlier, a salient characteristic of CEO duality was the increased power enjoyed by a CEO Firth et al (2012), which improved innovation performance. Brickley et al (1997) found that CEO duality is indeed efficient and generally consistent with shareholders' interests for the typical large U.S. company. This demonstrates that family businesses spend more on capital projects and R&D when CEO duality is used as a moderator variable (Briano-Turrent et al., 2023). Based on the arguments above, the following hypotheses are proposed:

H2: CEO duality enhances the positive effect of CEOs' academic experience on innovation performance.

Data and Methodology of Research

The research sample for this study consisted of companies listed between 2009 and 2022 on China's A-share stock market, which is traded on the Shanghai Stock Exchange and Shenzhen Stock Exchange. The reason for selecting China's listed companies from 2009 to 2022 as samples in this study is that, following the 2008 financial crisis, China's economic and trade market policies have gradually stabilized. Consequently, Chinese listed companies have entered a new phase of vitality, thereby providing availability, representativeness, and comparable data for previous studies on Chinese listed companies (Liu et al., 2023). The sample data about the dependent variable, independent variable, and control variables comes from the China Stock Market and Accounting Research Database (CSMAR). To verify the research's validity, the insurance and financial industries, all special treatment (ST) and star special treatment (*ST), and incomplete variables data were excluded from this study. All continuous variables are winterized at 1% (top and bottom) to mitigate the effects of outliers. Data analysis is conducted using Stata 18 statistical software.

Dependent Variable

Innovation performance is "the transformation of knowledge into new products, processes, and services involving more than just science and technology (Porter et al., 1999)." Information on patents is widely used to construct measures for innovation output (Acharya & Subramanian, 2009; Balsmeier et al., 2017; Chang et al., 2015). Chen et al (2015) used two metrics, both based on patents, to measure innovation. One is the number of patent grants (PG) Argyres & Silverman (2004); Li & Shi (2010), and the other is the number of patent applications (PA) as a proxy index to measure innovation performance Dosi et al (2006) as a

surrogate variable. This study measures innovation performance using patent grants (PG) as a proxy index.

Independent Variable

According to the connotation of academic experience Shao et al (2020); Wang et al (2021), this research divides academic experience into three categories: (1) having taught in universities and engaged in academic research; (2) having worked in scientific research institutions and engaged in research work; (3) having engaged in research work in academic associations or teams. CEOs' academic experience is measured by setting a dummy variable of 1 if a CEO has academic experience, and 0 otherwise (Zhang & Liu, 2021; Shao et al., 2020).

Moderating Variable

The CEO-Chair duality is a structural dimension of CEO power (Finkelstein, 1992). In line with previous research, a CEO duality dummy variable is 1 if the CEO is the chairman of the board of directors and 0 otherwise (Peng & Fang, 2010; Ruigrok et al., 2006; Loukil et al., 2020).

Control Variables

Several control variables that affect innovation performance are covered in this study. Firm size (FSIZE), calculated as the natural logarithm of total assets (Ju et al., 2023; Shao et al., 2020). Firm age (FAGE) is measured as the number of years since the firm was founded. Male executives ratio (MER) is measured as the number of male executives divided by the total number of executives (Shen et al., 2020). CEO age (CEOAGE) is measured as CEO age (Li & Shi, 2010). Tobin's Quotient (TOBIN's Q) is measured as the market value of a firm divided by the replacement cost of its assets (Tobin, 1969).

Empirical Methodology

This study begins the investigation by examining whether CEOs' academic experience significantly affects innovation performance. In general, there are three regression methods: Ordinary Least Squares (OLS), Fixed Effects Model (FEM) and Random Effects Model (REM). In this study, the LM test and Hausman test results indicate that the Fixed Effects Model (FEM) yields the best outcomes among the three estimation methods. The Breusch-Pagan test is used to identify potential heteroskedasticity issues in a linear regression model, rejecting the null hypothesis of homoscedasticity and ensuring robust standard errors (Ling & Wahab, 2019).

Model 1 examines the impact of CEOs' academic experience on innovation performance. The baseline model is as follows:

$$PG_{it} = \alpha_{it} + \beta_1 ACA_{it} + \beta_2 FSIZE_{it} + \beta_3 FAGE_{it} + \beta_4 MER_{it} + \beta_5 CEOAGE_{it} + \beta_6 TOBINQ_{it} \quad (1)$$

Model 2 investigates how the relationship between CEOs' academic experience and innovation performance is moderated by CEO duality. The same control variables are applied to both models. The model is as follows:

$$PG_{it} = \alpha_{it} + \beta_1 ACA_{it} + \beta_2 DUA_{it} + \beta_3 ACA_{it}XDUA_{it} + \beta_4 FSIZE_{it} + \beta_5 FAGE_{it} + \beta_6 MER_{it} + \beta_7 CEOAGE_{it} + \beta_8 TOBINQ_{it} \quad (2)$$

Where

PG: Patent grant, measured as the total number of patents grants

ACA: Dummy variable for CEOs' academic experience, measured as CEO has academic experience as 1, otherwise 0.

DUA: Dummy variable for CEO duality, measured as a combination of CEO and board chair as 1, otherwise 0.

FSIZE: Firm size, measured as the natural logarithm of total assets.

FAGE: Firm age, measured as the number of years since the firm was founded

CEOAGE: CEO age, measured as CEO age.

MER: Male executives ratio, measured as the number of male executives divided by the total number of executives.

TOBIN'S Q : Tobin's Quotient, measured as the market value of a firm divided by the replacement cost of its assets.

Empirical Results and Discussion

Descriptive Statistics

Table 1(a) presents the descriptive statistics of the continuous variables. The maximum value of the dependent variable innovation performance (PG) is 272, the minimum value is 0, and the mean value is 18.54, which indicates that different Chinese listed companies have great differences in the level of innovation, and the overall level is low. The maximum value of firm size (FSIZE) is 26.22, and the minimum value is 19.77, indicating that Chinese listed companies show significant differences between large and small enterprises, and they may take different actions in response to innovation activities. The maximum value of the firm age (FAGE) index is 27, the minimum value is 2, and the mean value is 11.17, indicating the distribution of the years since establishment among listed companies shows significant differences. The maximum value of the male executives ratio (MER) index is 100%, and the minimum value is 50%, with a standard deviation value of 11.16, which indicates that the proportion of male executives in the management team is at a relatively high level and has a significant variation ratio among Chinese listed companies. The maximum value of the CEO age (CEOAGE) index is 66, and the minimum value is 33, with a standard deviation value of 6.532, indicating a significant variation in CEO age. The maximum value of Tobin's Quotient (TOBIN'S Q) is 7.901, the minimum value is 0.863, and the mean value is 2.063, indicating that the market valuation of firms' assets exceeds replacement costs.

Table 1(a)

Descriptive statistics of the continuous variables

| Variable | Obs | Mean | Std.Dev | Min | Max |
|-----------|--------|-------|---------|-------|-------|
| PG | 28,565 | 18.54 | 44.73 | 0 | 272 |
| FSIZE | 28,565 | 22.32 | 1.291 | 19.77 | 26.22 |
| FAGE | 28,565 | 11.17 | 7.052 | 2 | 27 |
| MER | 28,565 | 81.34 | 11.16 | 50 | 100 |
| CEOAGE | 28,565 | 50.00 | 6.532 | 33 | 66 |
| TOBIN'S Q | 28,565 | 2.063 | 1.296 | 0.863 | 7.901 |

Table 1(b) shows that 23466 (82.15 percent) CEOs have no academic experience, indicating that CEOs of Chinese firms have limited access to academic resources. 5099 (17.85 percent) CEOs have academic experience may have access to and assimilation of external knowledge and experience, as well as connections to academic networks. These resources are crucial for implementing innovative activities. Furthermore, it shows that 21369 observations (74.81

percent) are non-CEO duality, implying that most CEOs in Chinese firms may be less autonomous in their decision-making. 7196 observations (25.19 percent) are CEO duality, indicating that a few Chinese firms' CEOs may result in better decision-making unity and efficiency than when the functions of chair and CEO are separated.

Table 1(b)

Descriptive Statistics for the Dummy Variables

| VARIABLES | Numbers of public listed companies Frequency of 1s | Numbers of public listed companies Frequency of 0s |
|-----------|-------------------------------------------------------|-------------------------------------------------------|
| ACA | 5099 (17.85%) | 23466 (82.15%) |
| DUA | 7196 (25.19%) | 21369 (74.81%) |

Correlation Analysis

The Pearson correlation matrix for variables is presented in Table 2. All the correlation coefficients are <0.3, which rules out the problem of multilinearity. The correlation coefficients between firm size (FSIZE) and PG are positively significant at the 1% level, which indicates that larger size of firms and boards are more inclined to improve innovation performance. As for the relationship between firm age (FAGE) and PG, there is no clear linear correlation. The correlation coefficients between male executives ratio (MER) and PG are positively significant at the 1% level, which indicates that male executives may have large networks and resources both inside and outside the company, which helps them find new opportunities and encourages innovation. The variable of CEO age (CEOAGE) shows a significant positive correlation with PG. There is a negative relationship between Tobin's Quotient (TOBIN's Q) and PG.

Table 2

Pearson Correlation Matrix

| | PG | FSIZE | FAGE | MER | CEOAGE | TobinQ |
|-----------|-----------|-----------|-----------|-----------|-----------|--------|
| PG | 1 | | | | | |
| FSIZE | 0.280*** | 1 | | | | |
| FAGE | -0.00400 | 0.344*** | 1 | | | |
| MER | 0.071*** | 0.183*** | 0.074*** | 1 | | |
| CEOAGE | 0.033*** | 0.121*** | 0.066*** | 0.019*** | 1 | |
| TOBIN's Q | -0.050*** | -0.412*** | -0.117*** | -0.100*** | -0.034*** | 1 |

Notes: ***, ** and * indicate significant at 1%, 5% and 10%, PG: Patent grant, measured as the total number of patents grants. ACA: Dummy variable for CEOs' academic experience, measured as CEO has academic experience as 1, otherwise 0. DUA: Dummy variable for CEO duality, measured as a combination of CEO and board chair as 1, otherwise 0. FSIZE: Firm size, measured as the natural logarithm of total assets. FAGE: Firm age, measured as the number of years since the firm was founded. MER: Male executives ratio, measured as the number of male executives divided by the total number of executives. CEOAGE: CEO age, measured as CEO age. TOBIN's Q : Tobin's Quotient, measured as the market value of a firm divided by the replacement cost of its assets.

Empirical Tests and Discussion of the Impact of CEOs' Academic Experience on Innovation Performance

The regression results in Table 3 of Model 5 reveal that after controlling for time-level fixed effects, CEOs' academic experience has a positive and significant impact on innovation performance at a 1% significance level, with a coefficient of 6.056. This suggests that CEOs' academic experience is associated with greater levels of innovation performance, thus confirming hypothesis H1, which posits that CEOs' academic experience increases innovation performance. Our empirical findings show that CEOs' academic experience in China positively correlates with innovation performance (Ju et al., 2023).

Regarding the control variables, firm size (FSIZE) positively and significantly affects innovation performance at a 1% significance level, indicating that larger companies are able to invest in more innovative ventures, which is similar to previous studies (Li & Shi, 2010). Larger corporations often possess greater power and resources, which they use for business operations and innovation activities (Ettlie & Rubenstein, 1987). Firm age (FAGE) has a negative and significant effect on innovation performance at a 1% significance level, indicating that innovation declines with firm age which is similar to previous study (Balasubramanian & Lee, 2008). Male executives ratio (MER) exhibits a positive and significant impact on innovation performance at a 1% significance level, signifying that a higher male executives ratio is more inclined to improve innovation performance, which aligns with previous research (Wang et al., 2022). CEO age (CEOAGE) has a negative and significant effect on innovation performance at a 1% significance level, indicating that younger CEOs may be more motivated to signal their innovativeness, which is consistent with an earlier study (Serfling, 2014). Tobin's Quotient (TOBIN's Q) positively and significantly affects innovation performance at a 1% significance level, indicating that a higher Tobin's Q value indicates market optimism for a firm's future growth, providing financial resources and motivation for innovation activities, which is in accordance with prior studies (Rossi et al., 2023).

Model 6 shows the results of the fixed-effect model. CEOs' academic experience has a positive correlation with innovation performance at a 1% significance level, indicating that CEOs' academic experience enhances innovation performance, thus validating hypothesis H1. The interaction term between CEOs' academic experience and CEO duality positively affects innovation performance with a coefficient of 5.032 at a 1% significance level. The result indicates that CEO duality positively moderates the relationship between CEOs' academic experience and innovation performance. This result confirms hypothesis H2, indicating that the combination of CEO and board chair enhances the positive effect of CEOs' academic experience on innovation performance, which has the potential to contribute to their establishment of technological barriers and gain an advantage over competitors in the market. The signs of the control variables are consistent with Model 5 and comparable to those reported in the literature.

Table 3

The effect of CEOs' academic experience on innovation performance

| VARIABLES | OLS | OLS | REM | REM | FEM | FEM |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------------|------------------------------|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
| | PG | PG | PG | PG | PG | PG |
| ACA | 6.328*** (9.34) | 3.736*** (4.20) | -0.258 (-0.47) | -0.191 (-0.29) | 6.056*** (8.93) | 3.354*** (3.77) |
| DUA | | 2.768*** (3.88) | | -0.205 (-0.39) | | 2.038*** (2.85) |
| ACAXDUA | | 4.442*** (3.23) | | -0.0909 (-0.09) | | 5.032*** (3.67) |
| FSIZE | 12.13*** (52.80) | 12.25*** (53.20) | 6.241*** (21.44) | 6.241*** (21.44) | 11.93*** (51.11) | 12.04*** (51.44) |
| FAGE | -0.684*** (-17.80) | -0.645*** (-16.58) | 0.335*** (7.07) | 0.333*** (7.01) | -0.722*** (-18.73) | -0.687*** (-17.61) |
| MER | 0.106*** (4.62) | 0.123*** (5.32) | -0.0329 (-1.54) | -0.0333 (-1.56) | 0.170*** (7.22) | 0.183*** (7.73) |
| CEOAGE | -0.0590 (-1.50) | -0.110*** (-2.74) | 0.0795*** (2.73) | 0.0827*** (2.76) | -0.133*** (-3.35) | -0.175*** (-4.34) |
| TOBIN's Q | 2.797*** (13.12) | 2.791*** (13.10) | 0.504*** (3.34) | 0.503*** (3.34) | 2.971*** (13.31) | 2.972*** (13.32) |
| _cons | -257.1*** (-47.33) | -259.6*** (-47.70) | -124.4*** (-18.95) | -124.4*** (-18.96) | -260.8*** (-46.64) | -262.8*** (-46.93) |
| N | 28565 | 28565 | 28565 | 28565 | 28565 | 28565 |
| R ² | 0.099 | 0.100 | | | 0.104 | 0.106 |
| F | 520.3 | 397.0 | | | 175.1 | 160.6 |
| Firm FE | NO | NO | | | | |
| Year FE | NO | NO | | | YES | YES |

Notes: ***, ** and * indicate significant at 1%, 5% and 10%, PG: Patent grant, measured as the total number of patents grants. ACA: Dummy variable for CEOs' academic experience, measured as CEO has academic experience as 1, otherwise 0. DUA: Dummy variable for CEO duality, measured as a combination of CEO and board chair as 1, otherwise 0. FSIZE: Firm size, measured as the natural logarithm of total assets. FAGE: Firm age, measured as the number of years since the firm was founded. MER: Male executives ratio, measured as the number of male executives divided by the total number of executives. CEOAGE: CEO age, measured as CEO age. TOBIN's Q : Tobin's Quotient, measured as the market value of a firm divided by the replacement cost of its assets. The standard errors are corrected for potential heteroskedasticity, and two-tail t-statistics are reported in brackets.

Robustness Test

To test the robustness of the empirical analysis, this study employs modified dependent variable and independent variable measurements for examination. The dependent variable innovation performance measurement is replaced by using patent applications (PA) (Dosi et al., 2006; Shao et al., 2020) instead of patent grants. The independent variable of CEOs' academic experience, is replaced with the proportion of academic experience within top management teams (Shen et al., 2020). The proportion of academic experience within top

management teams is measured as the number of top management team members who have academic experience divided by the total number of top management team members (ACA2) (Shen et al., 2020). Table 4 of Model 1 shows that the the proportion of academic experience within top management teams positively correlates with innovation performance at a 1% significance level, indicating that CEOs' academic experience exacerbates innovation performance, thus validating hypothesis H1. After introducing CEO duality, Table 4 of Model 2 shows that the interaction term between the proportion of academic experience within top management teams and CEO duality (ACA2 x DUA) exhibits a positive correlation with innovation performance at a 10% significance level, with a coefficient of 12.18. This suggests that CEO duality can enhance the impact of CEOs' academic experience on innovation performance, further validating hypothesis H2.

Table 4
Robustness Test

| VARIABLES | FEM | FEM |
|----------------|-----------------------------------------|-----------------------------------------|
| | Model 1 | Model 2 |
| | PA | PA |
| ACA2 | 32.32^{***} (11.02) | 28.89^{***} (8.50) |
| DUA | | 2.932[*] (1.85) |
| ACA2XDUA | | 12.18[*] (1.87) |
| FSIZE | 16.28^{***} (52.69) | 16.45^{***} (53.11) |
| FAGE | -0.912^{***} (-17.90) | -0.848^{***} (-16.37) |
| MER | 0.244^{***} (7.81) | 0.265^{***} (8.47) |
| CEOAGE | -0.157^{***} (-3.03) | -0.235^{***} (-4.42) |
| TOBIN's Q | 4.580^{***} (15.48) | 4.538^{***} (15.35) |
| _cons | -363.3^{***} (-49.14) | -366.0^{***} (-49.40) |
| N | 28565 | 28565 |
| R ² | 0.110 | 0.112 |
| F | 186.4 | 171.3 |
| Firm FE | | |
| Year FE | YES | YES |

Notes: ^{***}, ^{**} and ^{*} indicate significant at 1%, 5% and 10%. PA: Patent applications, measured as the total number of patent applications. ACA2: The proportion of academic experience within top management teams, measured as the number of top management team members who have academic experience divided by the total number of top management team members. DUA: Dummy variable for CEO duality, measured as a combination of CEO and board chair as 1, otherwise 0. FSIZE: Firm size, measured as the natural logarithm of total assets. FAGE: Firm age, measured as the number of years since the

firm was founded. MER: Male executives ratio, measured as the number of male executives divided by the total number of executives. CEOAGE: CEO age, measured as CEO age. TOBIN's Q: Tobin's Quotient, measured as the market value of a firm divided by the replacement cost of its assets. The standard errors are corrected for potential heteroskedasticity, and two-tail t-statistics are reported in brackets.

Conclusions

This study takes Chinese A-share listed firms in Shanghai and Shenzhen Stock Exchanges from 2009 to 2022 as research samples to analyze the impact of CEOs' academic experience on innovation performance, moderated by CEO duality. This study affirms previous research conclusions and proposes its own, novel views. The major findings are as follows:

Firstly, CEOs' academic experience is more likely to promote innovation performance than that of those who do not have academic experience. CEOs' academic experience possesses knowledge, experience, and academic networks. Successful implementation of activities leads to intangible assets and invention patents, enhancing sustainable competitiveness and innovation performance. The study verifies the positive effect of a CEO's academic experience on corporate innovation performance and recognizes the significant role that a CEO's academic experience plays in promoting Chinese firms' innovation initiatives. Secondly, this study expands the stewardship theory by introducing CEO duality as a moderator, demonstrating that CEO duality positively impacts CEOs' academic experience on innovation performance, which means CEOs who are chairman will have more power in conducting innovation performance. The agency theory literature has undervalued the influence of social interactions between managers and major shareholders in determining a firm's innovation performance and has presented contradictory ideas regarding the significance of large shareholders in firm innovation performance. This study uses the stewardship theory to propose that differences in a firm's innovation may be explained by the traits of the relationship between significant shareholders and management, which show up as shared aims and trust. These findings are meaningful for the Chinese government, firms, and academics to find ways to improve innovation performance.

The research findings from this study provide a theoretical basis for policymakers. The Chinese government should foster collaboration between enterprises and research institutes to encourage researchers to drive innovation, accelerate the pace, and enhance efficiency. Firms' policymakers should prioritize academic experience in executive recruitment, combine innovative abilities, focus on the training and development of academic executives, give academic CEOs decision-making power, and establish an academic management team. Academically experienced executives can use their own advantages to obtain high-quality scientific research projects for enterprises, and fully mobilize available resources to promote enterprise breakthrough innovation and promote the transformation of scientific research results.

This study has certain limitations. Specifically, it focused primarily on the impact of CEO duality on innovation performance. Future research could explore the moderating effects of other variables, thus gaining a more comprehensive understanding of the factors influencing innovation performance.

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