

The Impact of Tom Management Team Heterogeneity on Corporate Performance - An Empirical Study Based on Chinese Listed Companies from 2008-2019

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Abstract

The study of TMT heterogeneity on corporate performance is a hot topic in corporate governance. However, the relationship between TMT heterogeneity and corporate performance is inconclusive, and there are fewer studies on TMT exogenous factors. Given this, this paper conducts a study using regression analysis based on the data of listed companies from 2008-2019 in the CSMAR database. The study finds that TMT functional background and educational heterogeneity have an "inverted U" effect on firm performance, and digital transformation has a positive effect on TMT heterogeneity. This study enriches the research on the impact of TMT heterogeneity on performance and explores the antecedent influences on heterogeneity. Based on the empirical results, we also propose management recommendations.

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Keywords: TMT heterogeneity, Strategic management, Competition, Firm performance.

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1. Introduction

In 1984, Hambrick and Mason proposed the "Upper Echelons Theory", which suggests that the demographic characteristics of Top Management Teams (TMT) (e.g., age, tenure, education, heterogeneity) are a proxy for the underlying characteristics and perceptions of team members, and that member characteristics and perceptions affect the quality of team decisions and, ultimately, corporate performance (Hambrick and Mason, 1984). However, there is no consensus among scholars on the impact of heterogeneity in top management teams on corporation performance. The debate on whether TMT is 'homogeneous' or 'heterogeneous' is currently based on the 'information/decision-making perspective' and 'social categorization perspective' (Homberg and Bui, 2013; Richard and Shelor, 2002; Watson et al., 1998; Feng Hu et al., 2020). The "Information/decision-making perspective" emphasizes the positive impact of heterogeneity. High heterogeneity means that team members have a broader pool of knowledge, skills, and resources. It helps TMT exchange and integrate information to produce high-quality, creative decisions that contribute to Corporation growth (Van Knippenberg et al., 2004). The "social categorization theory" focuses on the negative impact of heterogeneity. Based on the similarity of team members' characteristics, people classify team members as 'insiders' and 'outsiders'. And They tend to work with members who are similar to themselves and keep a distance from those who are more different (Hogg and Reid, 2006; Watson et al., 1998; Xinming Deng et al., 2020). As a result, TMT with high heterogeneity have lower cohesion and negatively affect corporate performance. In addition to the debate at the theoretical level, the results of empirical studies on the impact of TMT heterogeneity on corporate performance are also inconsistent: Xueli Wang et al. (Xueli Wang et al., 2013) (2005) found that heterogeneity in the functional background of TMT negatively affects corporation performance; Xinming Deng et al. (Xinming Deng et al., 2020) found that heterogeneity in the functional background of the TMT negatively affects the corporate performance of listed Chinese manufacturing companies; Yimin Wang et al. (Yiming Wang et al., 2015) found that heterogeneity in education and functional backgrounds positively influenced corporation performance based on Chinese pharmaceutical industry listed companies; Bengtsson et al. (Bengtsson et al., 2020) found that heterogeneity in the functional background of TMT positively influenced the competitiveness of teamwork, based on 315 companies' data published by Statistics Sweden; Wangbin Hu et al. (Wangbin Hu et al., 2014) based on the questionnaire data from Tianjin "Entrepreneurship Centre" found that TMT heterogeneity in education and functional background had an "inverted U-shaped" relationship with corporate performance. The above-mentioned two Inconsistent perspectives and empirical studies reveal that there is an unclear relationship between TMT heterogeneity and corporate performance (Horwitz and Horwitz, 2007).

Given the current research situation, this paper considers that there are three areas for further improvement. Firstly, previous empirical studies tend to have a small sample

size, cover a small number of industries and the data is mostly obtained from questionnaires. If the study only focuses on a specific field or industry and the number of observed enterprises is small, the results may be subject to change and the scope of application of the findings may be limited. It is also difficult to ensure the reliability and validity of data obtained using questionnaires: on the one hand, respondents may fill in false information because it will be detrimental to their careers., On the other hand, there is often a "retrospective bias" in interviews or questionnaires, whereby managers attribute success to themselves and failures to external factors (Xinming Deng et al., 2020). Therefore, it is difficult to draw realistic and valid conclusions by researching specific industries or using questionnaires to obtain sample data.

Secondly, most of the current research assumes that TMT heterogeneity has only a positive or negative one-sided effect on corporate performance. And only explores the linear relationship between TMT heterogeneity and corporate performance, but not the non-linear relationship between the two. In other words, these scholars do not consider both the information/decision-making perspective and the social categorization perspective. This paper argues that both the Information/decision-making perspective and the Social categorization Theory have validity, which means the relationship between TMT heterogeneity and corporate performance is influenced by two opposing forces at the same time. Therefore, the relationship between TMT heterogeneity and corporate performance should have an "inverted U" shape. Specifically, at low levels of TMT heterogeneity, the "information/decision-making" effects are dominant. That means TMT has more comprehensive knowledge, skills, and other resources. TMT heterogeneity is beneficial to corporate performance. As the level of heterogeneity increases beyond a "certain point", the "social categorization" effect dominates over the 'informational/decision-making' effect. Excessive internal differences exacerbate divisions and increased conflict. TMT heterogeneity is detrimental to corporate performance.

Thirdly, although there has been a considerable amount of research on TMT heterogeneity, the direction of research has mainly focused on what factors are affected by TMT heterogeneity, while few studies have explored what factors affect TMT heterogeneity, that is, few studies have explored the causes of TMT heterogeneity (Boone et al., 2004).

Given this, this paper will explore the linear and non-linear effects of TMT educational and functional background heterogeneity on corporate performance based on the data in Chinese listed companies from 2008 to 2019. Second, this paper seeks to explore the impact of corporate digital transformation on TMT heterogeneity.

2. Literature review and research hypothesis

2.1 Impact of functional backgrounds heterogeneity on corporate performance

TMT functional background heterogeneity refers to the variability of team members' previous experience in different industries or sectors. It can be seen as a reflection of

the knowledge and skills of the members of the TMT in different areas (Yue Huang et al., 2011). Concerning the classification of functional backgrounds, current scholars mainly follow Hambrick and Mason's three-sector classification (Hambrick and Mason, 1984). The classification of past work experience into "production", "managerial" and "peripheral" categories: "Production" includes positions in sales, R&D, design, etc.; "Management" includes positions in human resources management, operations management, etc.; "Peripheral" includes support positions in law, finance, etc. (Xueli Wang et al., 2013).

Based on the "information/decision-making perspective", the heterogeneity of the functional backgrounds of TMT has a positive impact on corporate performance. Firstly, teams with higher functional heterogeneity have a broader pool of resources. The knowledge, skills, and competencies of team members are unique and non-redundant (Van Knippenberg et al., 2004; Kai Sun et al., 2019). This allows members to look at issues with different ideas and thoughts. And team members are better able to communicate, integrate and interact with each other to respond to environmental changes. As a result, TMT enables a more comprehensive and insightful evaluation of multiple options and ultimately decision-making (Haiyan Huang et al., 2019; Zhaoguo Zhang et al., 2018). Secondly, heterogeneity can prevent teams from falling into "groupthink". Previous research has found that individuals tend to communicate with members from similar backgrounds. In less heterogeneous teams, knowledge, skills, and cognitive perspectives are closer and members will reach a consensus too quickly and easily. However, this consensus is often not negotiated, deliberated, and therefore not correct (Van Knippenberg et al., 2004). In more heterogeneous teams, TMT's cognitive conflicts stimulate constructive debate and explore uncharted territory for each other (Yuepan Sun et al., 2019; Xingyu Wang and YunXing, 2020). Thus gaining a broader, deeper perspective without falling into "groupthink" and causing poor decisions (Haiyan Huang et al., 2019). Thirdly, heterogeneity in functional backgrounds represents a broader range of contacts. Socially capital-rich teams can use their rich social networks to access more information about customers, suppliers, and government departments (Xingyu Wang and Yun Xing, 2020). This expands the breadth and depth of knowledge and information, which ultimately has a positive impact on corporate performance. There is a wealth of empirical evidence to support this view. Buly et al. found that heterogeneity in the functional background of the TMT has a positive effect on corporate performance and that this effect is influenced by CEO characteristics (Buyl et al., 2011). Based on a meta-analysis of 82,278 independent samples, Xiaoyu Cui et al. found that functional heterogeneity in TMT has a positive effect on organizational performance (Xiaoyu Cui et al., 2018). In addition, this effect is stronger than educational heterogeneity and tenure heterogeneity. Cannella et al. found that functional heterogeneity in TMT had a positive effect on corporate performance and that this effect was more pronounced in situations of high environmental uncertainty (Cannella Jr et al., 2008).

In contrast, those who support the 'social categorization perspective' argue that

heterogeneity in TMT harms corporate performance. Firstly, due to past different work characterization, managers from different functional backgrounds may have different perceptions when faced with the same issue. Some studies have shown that heterogeneity among team members can even lead to fear and uncertainty (Homberg and Bui, 2013). This can make it difficult to reach a consensus within the team, which in turn affects teamwork and reduces team cohesion and productivity (Xueli Wang et al., 2013; Zhaoguo Zhang et al., 2018). Secondly, as individuals tend to communicate with members from similar backgrounds, differences in professional backgrounds can lead to the formation of "small teams" within TMT. This will widen the psychological distance between members from different professional backgrounds and hinder the exchange and integration of information resources between team members. This phenomenon is particularly evident in societies with a high tendency towards collectivism (Ping Zhang, 2006). Due to the "relationship orientation" of cultures with high collectivist tendencies, it is easy to reach a "superficial agreement" between different small teams for the sake of harmonious relationships. However different small teams may disagree with each other and confront each in secret. The result is increased disagreement and conflict within the team, reducing the efficiency of the corporate (Van Knippenberg et al., 2004). Thirdly, in the East Asian cultural sphere, the distance of power between countries is large. And there is a sense of hierarchy and a spirit of obedience within the team that can easily lead to a "one voice" situation (Xinming Deng et al., 2020). As a result, members from different functional backgrounds are reluctant to raise their voices to secure their positions. They are more likely to choose to accept the views of their superiors or the majority directly. Ultimately leading to a negative impact of heterogeneity (Bingti Yao et al., 2015). There is much empirical evidence to support this view. Xinming Deng et al. (Xinming Deng et al., 2020) found that functional background heterogeneity creates team conflict, which in turn can further negatively affect corporate performance. Bingchi Yao et al. (Bingti Yao et al., 2015) found that functional background heterogeneity in TMT harms corporate performance. In addition, this effect is more pronounced when the CEO has more power.

A glance at scholars' research reveals that there has been a considerable amount of research on the heterogeneity of functional backgrounds of TMT and corporate performance, but still no unified conclusion has been reached. To address this phenomenon, this paper argues that two aspects can be discussed in depth. Firstly, top manager members usually have multiple work experiences. And top management members with multiple work experiences may look at issues from different perspectives. Although Xueli Wang et al. (Xueli Wang et al., 2013) have advocated for a focus on the "multi-functional" background of TMT members. Current research still only considers a single function of the executive. For example, Bingchi Yao et al. (Bingti Yao et al., 2015) emphasize the importance of the first job and therefore select the first job as the professional background. Haituo Qie et al. (Haituo Qi et al., 2021) classify executives by their most recent functional background. This paper argues that although it is reasonable to select the first and last job of a member. However, this choice does

not adequately take into account the 'multi-functional' nature of the executive members. Therefore, this paper will take full account of the multiple functional backgrounds of top manager members in subsequent studies. Secondly, most of the current research has been conducted from a single perspective of 'information/decision-making or 'social categorization. In other words, they only consider the linear effect of TMT heterogeneity on corporate performance. This paper argues that both effects are likely to have an impact on corporate performance. Specifically, at low levels of heterogeneity in the functional background of the TMT, the "information/decision-making perspective" plays a dominant role, where heterogeneity in the functional background of the TMT positively affects corporate performance. When the heterogeneity of the TMT's functional background is high, the "social categorization perspective " plays a dominant role, and the heterogeneity of the TMT's functional background negatively affects the firm's performance. Based on the above analysis, the following hypotheses are proposed.

H1: Heterogeneity in the functional background of the TMT has an "inverted U" effect on corporate performance.

2.2 The impact of educational background heterogeneity on corporate performance

Educational heterogeneity in TMT refers to the degree of variation in the educational level of members. On the one hand, based on "information decision theory", scholars have suggested that heterogeneity of executive team members' education positively affects firm performance for the following reasons: Firstly, TMT with lower levels of educational heterogeneity tend to have a uniform cognitive structure and mental maps, which can limit the ability of TMT to find creative solutions in the business environment (Auh and Menguc, 2005). In teams with a high degree of TMT educational heterogeneity, members have a different depth and breadth of perspective and access to different sources of information, allowing them to access richer, more comprehensive sources of information and to analyze problems more deeply (Xiaoyu Cui et al., 2018). Secondly, those with higher education usually trust theoretical expertise, while those with lower education use more empirical knowledge to deal with problems (Simons et al., 1999; Xiaoyu Cui et al., 2018; Wangbin Hu et al., 2014). The integration and analysis of collective cognition by team members enrich the depth and breadth of thinking. Ultimately, it improves the quality of team decisions and corporate performance. Xiaoyu Cui et al. scholars validated this view based on the results of a Meta-analysis of 118 empirical papers (Xiaoyu Cui et al., 2018). Díaz-Fernández et al. found that educational heterogeneity has a significant positive effect on those firms engaged in international trade (Díaz-Fernández et al., 2019).

On the other hand, some scholars have argued the opposite from the "social categorization perspective". They argue that heterogeneity in the educational background of TMT members negatively affects corporate performance for the

following reasons: Firstly, top management members with similar educational backgrounds have a more common language, which leads these individuals to trust and be closer to members with similar educational backgrounds. And will exclude and alienate members who have a large gap in education with them. This leads to a lack of communication and trust between members, which eventually leads to conflicts and disagreements and reduces team cohesion (Wangbin Hu et al., 2014). Secondly, the "social categorization perspective" suggests that different levels of education may lead to differences in cognition between members. For example, highly educated people usually believe in authoritative professional theories, while less educated people rely more on empirical knowledge, and this difference may further evolve into personal emotional conflicts (Yun Yue et al., 2021). This view is also supported by the empirical results of a large number of scholars. Bengtsson et al. (Bengtsson et al., 2020) found that the heterogeneity of educational qualifications in TMT was detrimental to team competitiveness, and they hypothesized that the difference in educational qualifications would lead to differences in power and status, which in turn would lead to emotional conflicts among members. Duangsheng Li and Xiaoyan Wang (Duangsheng Li and Xiaoyan Wang, 2019) showed that heterogeneity in educational heterogeneity of TMT can intensify conflicts within the company and ultimately discourage corporate performance.

A summary of the current research shows that the relationship between the educational heterogeneity of TMT and corporate performance is not yet clear. Given this, this study develops the following hypotheses from the perspectives of "information/decision-making" and "social categorization". Specifically, at low levels of heterogeneity in the education of the TMT, the "information/decision-making perspective" plays a dominant role, where heterogeneity in the education of the TMT positively affects corporate performance. When the heterogeneity of the TMT's education is high, the "social categorization perspective" plays a dominant role, and the heterogeneity of the TMT's education negatively affects the firm's performance. Based on the above analysis, the following hypotheses are proposed:

H2: The heterogeneity of the TMT's education has an "inverted U" effect on corporate performance.

2.3 The Impact of Digital Transformation on TMT Heterogeneity

Currently, the impact of executive team heterogeneity on corporate performance has been discussed in great depth, while research on the antecedent influences of executive team heterogeneity is still relatively rare (Boone et al., 2004). Pettigrew and Lawrence argue that an exploration of the antecedents of TMT heterogeneity is necessary (Lawrence, 1997; Pettigrew, 1992).

According to the A-S-A (Attraction-Selection-Attrition) theory, the characteristics of TMT will gradually evolve toward "homogeneity". While the increase of internal strategic changes and external uncertainties will break this "homogeneity" trend and

make the team develop towards "heterogeneity"(Nielsen, 2009). TMT is an important bridge between the company and the external environment (Keck and Tushman, 1993). The environment of high information iteration and intense competition means that companies need to face high levels of uncertainty and high risk. TMT with different background characteristics can provide the skills needed to address the complexity of the environment as well as a more holistic perspective. As a result, highly heterogeneous teams are more productive in turbulent environments (Carpenter, 2002). Many previous studies support this view. Keck et al. found that changes in the business environment and strategic goals of firms trigger changes in the composition of TMT (Keck, 1997; Keck and Tushman, 1993). Sharfman et al. argue that making decisions in highly complex situations requires a professional and scientific knowledge base and a high level of information processing skills (Sharfman and Dean, 1991). Boeke et al. found that faster or slower firm growth leads to changes in TMT. In addition, board and management ownership has an impact on TMT heterogeneity (Boeker and Wiltbank, 2005). Nielsen et al validate the applicability of the ASA(Attraction-Selection-Attrition) theory based on panel data from 165 Swiss-listed companies. Their study also shows that the level of internationalization increases the positive impact on TMT heterogeneity (Nielsen, 2009). By studying the entry and exit of executives at Dutch newspaper publishers, Boone et al found that a process of "homogenization" does occur within TMT and that this process is influenced by competitive pressures and environmental diversity in the industry (Boone et al., 2004).

Overall, current research on TMT antecedents is relatively scarce and has not yet reached a more uniform conclusion. Therefore, exploring the antecedents of TMT heterogeneity is helpful to improve the theoretical framework of the " Upper Echelons Theory"[36].

In addition, no scholars are exploring the causes of the heterogeneity of executive members of listed companies from the perspective of China's digital economy. We argue that: in the context of the digital economy, data drive has had a significant impact on corporate goals, operational approaches, and corporate human resource management (Ludong Qi and Xu Xiao, 2020). Facing the profound changes in technology in the digital economy, driving organizational change and digital transformation through digital tools and platforms has become a strategic choice for most companies to improve business performance and seek sustainable competitive advantage (Qingjiang Chen et al., 2021). Specifically: Firstly, the application of new technologies (big data, cloud computing, blockchain, Internet of Things, etc.) has broken the boundaries of different industries and sectors, providing the possibility of cross-border operations, and corporations are facing increased competition from different fields. Secondly, traditional business is dominated by enterprises. And customers have a low sense of involvement in the production. However, as new technologies become widely available, the distance between corporations and consumers is closer, consumers can participate directly in the process of creation. Corporations need to meet the diversified needs of their customers.

At the same time, the digital transformation of companies has also increased the demand for heterogeneous members. Firstly, the digital transformation of a Corporation is not simply a process of business reshaping, but a comprehensive change including organizational management, production management mode, business management mode, etc. (Shuchun Liu et al., 2021). Digital technology breaks down barriers between different business environments and functional departments, it promotes data integration between different segments, modules, and departments (Zao Sun and Yulin Hou, 2019). Companies need to quickly adapt to changes in the business environment and achieve technology alignment. This process increases the requirements for the heterogeneous member, leading to higher levels of TMT heterogeneity (Jinghua Xiao et al., 2021). Secondly, the current environment requires companies to quickly identify and meet the diverse and refined demands of consumers (Coviello and Joseph, 2012). TMT heterogeneity can more quickly and accurately capture the differentiated user needs in different areas, helping companies tap into long-tail needs outside the traditional market (Abebe, 2010), ultimately improve business competitiveness. Therefore, the diversification of consumer needs caused by digital transformation will increase the demand for heterogeneous members.

This paper argues that as the digital transformation of enterprises deepens, there is a greater need for TMT to have open knowledge, information processing capabilities, and cognitive flexibility (Keck, 1997), which can lead to a break in the process of "homogenization" within the team and ultimately to an increase in the level of heterogeneity in TMT. Based on the above analysis, the following hypotheses are proposed:

H3: Corporate digital transformation has a positive effect on TMT functional background heterogeneity.

H4: Corporate digital transformation has a positive effect on TMT educational heterogeneity.

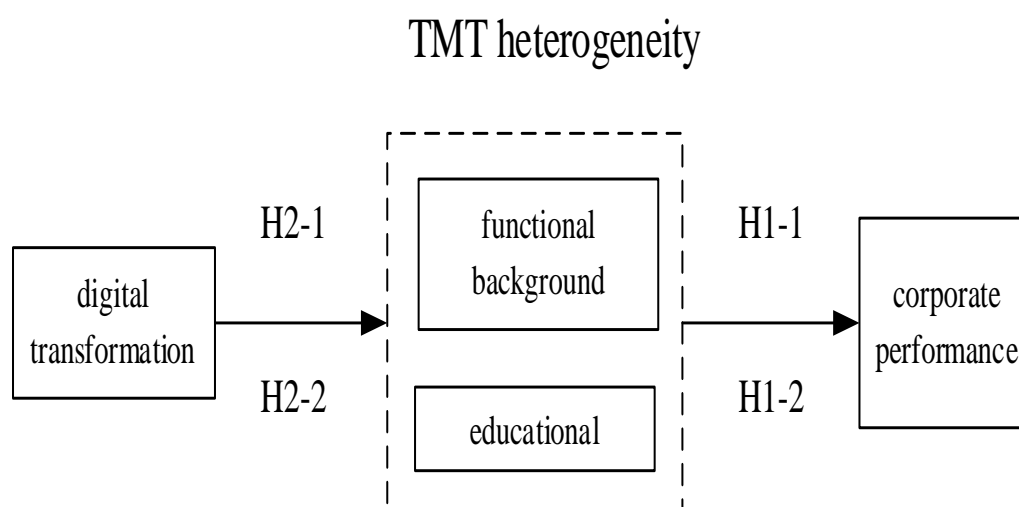


Figure 1: Framework diagram

3. Description of the data

3.1 Sample selection and data sources

This paper selects all listed Chinese A-share companies in the CSMAR database from 2008-2019 as the research sample. The data of A-share listed companies is complete, covers a wide range of industries, is universal, and can reflect the general characteristics of Chinese companies, and is therefore of some relevance.

This paper uses SAS and R software to filter and process the data according to the following criteria: Firstly, the samples of listed companies in the financial category were deleted (Bingti Yao et al., 2015); Secondly, removing the sample of listed companies in ST and *ST; Thirdly, removing the sample of companies with missing backgrounds of TMT members or company financial data. In addition, to eliminate the influence of extreme values, samples with Tobin's Q value greater than 10 were removed. Finally, the study sample contains 23,968 valid observations of 3,107 listed companies.

3.2 Variable design and description

Corporate performance: Scholars do not all share the same criteria for measuring corporate performance. Generally speaking, accounting performance such as return on assets (ROA) is suitable for measuring a firm's short-term business performance, while Tobin's Q measures the market value of a firm, reflecting the expected situation and growth potential of the firm (Haifa Sun et al., 2006; Xueli Wang et al., 2013; Bingti Yao et al., 2015). This study uses Tobin's Q to measure firm performance, given the lagged effect of TMT composition on corporate performance. In addition, Tobin's Q distribution is too concentrated. Therefore, this paper uses the logarithm of Tobin's Q + 1 to measure corporate performance.

TMT heterogeneity: According to the classification of the CSMAR database, members of the TMT include CEOs, CFOs, general managers, chief engineers, department directors, and other senior members of the company. This paper focuses on the impact of educational heterogeneity and functional background heterogeneity of the TMT on corporate performance. This paper measures heterogeneity using the Herfindal Index (Xingyu Wang and Yun Xing, 2020): $H = 1 - \sum_{i=1}^n p_i^2$. The higher the value of H, the higher the heterogeneity.

Heterogeneity of functional backgrounds: This paper reclassifies the functional backgrounds of the members of the TMT, as the CSMAR database is too detailed. Specifically, the CSMAR database classifies members' functional backgrounds into nine categories, namely "1=Production, 2=R&D, 3=Design, 4=HR, 5=Management, 6=Marketing, 7=Finance, 8=Finance, 9=Law". To address the situation where the classification of functional background data is too detailed and people have too much work experience. In this paper, the original functional backgrounds are first combined, and then the multiple work experiences of employees are classified. Firstly, we draw on Hambrick and Mason's three-sector classification (Hambrick and Mason, 1984) and

the actual situation of the Chinese workplace, the functional backgrounds in the CSMAR database are combined into three categories: production, management, and peripheral. Specifically, the former 1, 2, 3 and 6 are classified as production-oriented, which are mainly responsible for the product and research products, based on improving the quality of the company's products; the former 4 and 5 are classified as management-oriented, which are mainly responsible for the company's daily affairs and personnel management to improve the efficiency of the company's internal operation; the former 7, 8 and 9 are classified as peripheral-oriented, which are responsible for the development of the company provide support work(Hambrick and Mason, 1984). Secondly, those with production-oriented experience only are classified as category 1; those with management-oriented experience only are classified as category 2; those with peripheral-oriented work experience only are classified as category 3; those with production and management experience are classified as category 4; those with production and peripheral work experience are classified as category 5; those with management and peripheral work experience are classified as category 6; those with production, management and peripheral work experience are classified as category 7; the others are classified as the category 8. Given the current situation that scholars only consider the first or last job of executives, the classification in this paper can fully take into account the "multi-functional" background of executives (Xueli Wang et al., 2013).

Educational heterogeneity: Based on the CSMAR database, the educational qualifications are classified into five categories: specialist and below; undergraduate; master's (including MBA, etc.); Ph.D.; and other (including null values).

Digital transformation: it is difficult to classify the various digital applications as they have currently penetrated various industries (Chenyu Zhao et al., 2021). In this paper, we use the CSMAR database to measure the digital transformation of enterprises. The frequency of the terms "artificial intelligence technology, cloud computing technology, blockchain technology, big data technology, and digital technology application" in the reports of listed companies is measured by text analysis, and the degree of digital transformation of companies is measured by this method.

Considering that corporate performance may be influenced by other factors, this paper controls for the following factors: the average age of the TMT, size of the TMT, size of the company, balance sheet ratio, number of years the company has been listed, return on assets, and the Shareholding ratio of the largest shareholder.

Table 1: Description of variables

Variable type	Variable name	Variable Symbols	Variable Description
Explained variables	Corporate Performance	TBQ	Log(Tobin's Q + 1)
Explanatory variables	Functional background heterogeneity	FBH	$H = 1 - \sum_{i=1}^n p_i^2$
	Educational heterogeneity	EH	$H = 1 - \sum_{i=1}^n p_i^2$
Control variables	Average age	AGE	Total age of team members/number of team members
	Number of TMT	Num	Total number of the senior management team
	Enterprise scale	Size	Natural logarithm of the total assets of the business
	debt to asset ratio	Ratio	business assets / liabilities * 100%
	Number of years on the market	Year	Current year of business - the year of listing
	Return on Assets	ROA	Net profit / Total asset balance * 100%
	Number of board meetings	Meeting	Number of board meetings during the year
antecedent variables	Digital Transformation	DT	The frequency of the terms in the reports of listed companies

3.3 Constructing the econometric model

This paper constructs linear mixed regression models to test the research hypotheses. Model 1 shows the effect of functional background heterogeneity or educational heterogeneity in the TMT on corporate performance.

$$TBQ = \beta_1 FBH_{it} + \beta_2 FBH_{it}^2 + \sum CV_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

$$TBQ = \beta_1 EH_{it} + \beta_2 EH_{it}^2 + \sum CV_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (2)$$

Where TBQ is value for the *i*th firm in year *t*, and β_1 is the parameter to be estimated. FBH_{it} and EH_{it} are both calculated by Herfindal, and $\sum CV_{it}$ are the control variables for firm *i* in year *t*. μ_i measures additional firm-level heterogeneity, and δ_t measures additional heterogeneity at the time level, and ε_{it} measures heterogeneity at the observation side level.

Model 2 shows the impact of digital transformation on functional background heterogeneity or educational heterogeneity of the executive team.

$$FBH_{it} = \beta_1 DT_{it} + \sum CV_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (3)$$

$$EH_{it} = \beta_1 DT_{it} + \sum CV_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (4)$$

where DT_{it} is the degree of digital transformation of the i th firm in year t . Other variables are the same as above.

4. Empirical evidence test

4.1 Descriptive statistics

Table 2: Descriptive statistics of variables

VarName	Mean	SD	Min	Max
TBQ	1.031	0.305	0.142	2.398
FBH	0.590	0.129	0.000	0.840
EH	0.464	0.195	0.000	0.800
Ratio	0.424	0.486	0.007	58.082
Size	22.111	1.312	14.759	28.636
Age	46.933	3.739	32.333	61.000
Num	7.213	2.729	1.000	45.000
Year	9.044	6.809	-1.000	29.000
DT	9.184	25.957	0.000	518.000
Meetings	5.846	2.210	1.000	20.000
ROA	0.041	0.095	-8.463	0.946

Table 2 gives the number of observations, mean, standard deviation, and minimum and maximum values for the variables used in this paper. The fluctuation range of the explanatory variable corporate performance is large with a maximum value of 9.998 and a minimum value of 0.153; the mean value is 1.957. The mean value of the core explanatory variable TMT educational heterogeneity is 0.464; the mean value of TMT overseas background heterogeneity is 0.590, the level of educational heterogeneity and functional background heterogeneity lies approximately in the middle of the maximum and minimum values, indicating that Chinese listed companies The level of heterogeneity of the TMT's academic and functional backgrounds are evenly distributed, covering people with multiple academic and functional backgrounds. Among the control variables, the average age of the TMT members is 46.944 years old, and the size of the TMT ranges from 1 to 45 members, with an average size of 7. Total assets were measured by taking the natural logarithm of the size of the firm, with a mean value of 22.124. The average corporate gearing ratio was approximately 41.7%, and the average time on the market for the selected sample firms was 9 years.

Table 3: Variable correlation coefficient matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1)Ratio	1.000										
(2)Size	0.500	1.000									
(3)Meeting	-0.062	0.041	1.000								
(4)Age	0.136	0.345	-0.003	1.000							
(5)Num	0.154	0.317	0.070	0.130	1.000						
(6)Year	0.368	0.374	-0.147	0.254	0.025	1.000					
(7)EH	-0.085	-0.088	0.083	-0.004	0.122	-0.286	1.000				
(8)FBH	0.031	0.065	0.081	-0.059	0.160	-0.003	0.035	1.000			
(9)TBQ	-0.323	-0.430	-0.009	-0.112	-0.100	-0.083	0.014	-0.034	1.000		
(10)DT	-0.066	0.018	0.172	-0.018	0.066	-0.027	0.032	0.033	0.090	1.000	
(11)ROA	-0.338	-0.053	-0.025	-0.028	-0.014	-0.151	0.008	-0.031	0.235	-0.040	1.000

Table 2 reports the results of the correlation analysis matrix for the variables used in this paper. In addition, this paper examined the covariance of the independent variables and found that the VIF coefficients were all below 3 and much less than 10, so there was no problem with multicollinearity.

4.2 Regression analysis

4.2.1 Analysis of regression results on functional background, educational heterogeneity of the TMT, and corporate performance

Table 4: Regression results of functional background, educational heterogeneity of the TMT and corporate performance

	TBQ	
FBH	0.17**	
	(2.48)	
I(FBH)2	-0.17***	
	(-2.60)	
EH		0.10***
		(2.83)
I(EH) 2		-0.11**
		(-2.36)
Ratio	0.12***	0.13***
	(9.73)	(10.34)
Size	-0.13***	-0.13***
	(-54.21)	(-53.46)
Age	-0.001*	-0.001**
	(-1.74)	(-2.50)
Num	-0.0002	-0.0004
	(-0.25)	(-0.56)
Year	0.01***	0.01***
	(13.08)	(13.20)
ROA	0.49***	0.49***
	(23.41)	(23.51)
Constant	3.87***	3.89***
	(55.54)	(57.27)

Number of observations 23,968 Number of groups 3107 t-values in brackets *** p<0.01, ** p<0.05, * p<0.1

As the regression results in columns 1 and 2 of Table 4 show, the heterogeneity in the functional background of TMT is significant at the 1% level and the heterogeneity in education is significant at the 5% level, thus validating H1 and H2. i.e., the heterogeneity in the functional background of TMT, the heterogeneity in education, and the performance of the firm have an "inverted U" type relationship. The relationship between functional background heterogeneity, education heterogeneity, and TBQ is "inverted U".

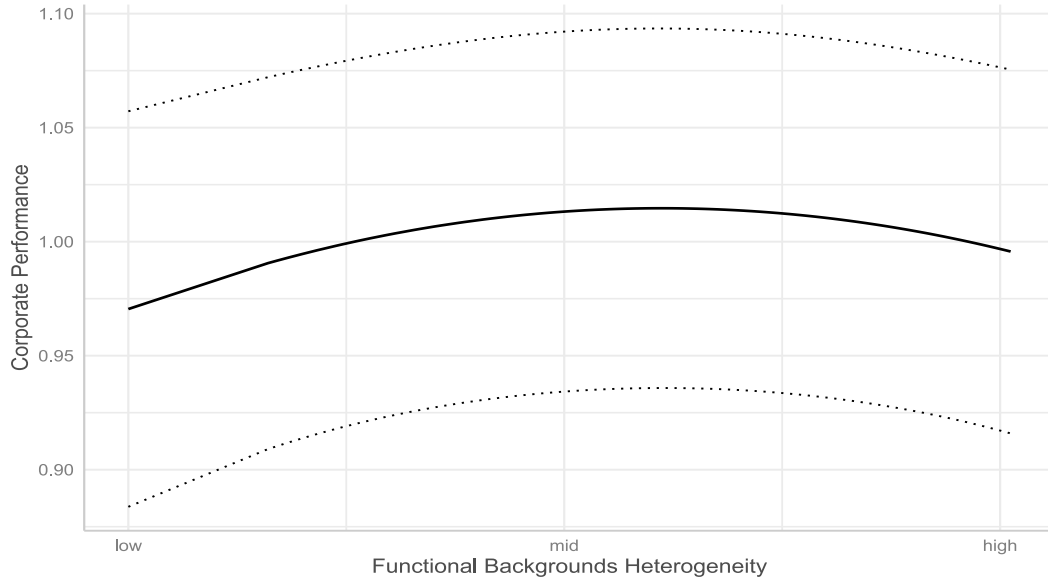


Figure 2: Diagram showing the relationship between functional background heterogeneity of the TMT and corporate performance

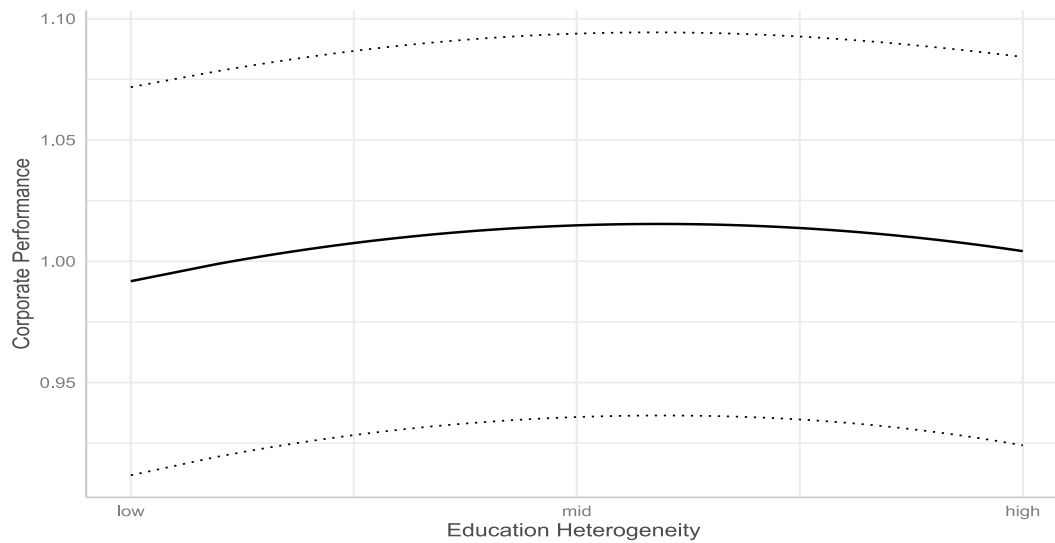


Figure 3: Graph showing the relationship between executive education heterogeneity and corporate performance

4.2.2 Analysis of regression results of digital transformation on the functional background and educational heterogeneity of the executive team

Table 5: Regression results of digital transformation and heterogeneity of functional background and education of the executive team

	FBH	EH
DT	0.0002***	0.0002**
	(2.79)	(2.01)
Ratio	-0.001	-0.003
	(-0.73)	(-1.26)
ROA	-0.02	-0.003
	(-1.24)	(-0.18)
Num	0.003***	0.003***
	(5.54)	(4.15)
Meetings	0.0005	0.0003
	(0.74)	(0.34)
Year	0.0002	-0.01***
	(0.46)	(-22.00)
Constant	0.56***	0.51***
	(76.69)	(61.27)

Number of observations 23,968 Number of groups 3107 t-values in brackets *** p<0.01, ** p<0.05, * p<0.1

As the regression results in columns 1 and 2 in Table 5 show, digital transformation and executive team functional background heterogeneity are significant at the 1% level; digital transformation and educational heterogeneity are significant at the 5% level, thus validating H3 and H4. i.e., digital transformation has a positive effect on executive team functional background heterogeneity and educational heterogeneity.

5. Research findings and insights

5.1 Research findings

The impact of TMT heterogeneity on corporate performance has been a hot topic, yet research results are mixed and there are few studies on the antecedents of TMT heterogeneity.

Given this, this paper uses the CSMAR database of companies from 2008-2019 as the basis. The empirical study using SAS and R software concludes the following: First, the heterogeneity of TMT education and functional background has an "inverted U" effect on firm performance. In other words, when the level of heterogeneity is low, it

has a positive impact on firm performance; while as the level of heterogeneity increases beyond a certain "specific point", heterogeneity hurts firm performance. Second, digital transformation has a positive effect on TMT educational and functional background heterogeneity, and this finding suggests that the demand for heterogeneous members increases when companies are in a complex and competitive business environment.

5.2 implications

First, this study breaks through the linear framework of heterogeneity theory and reveals the non-linear relationship between TMT heterogeneity and corporate performance. The heterogeneity of functional backgrounds and educational attainment of the TMT has an "inverted U" effect on corporate performance. This finding is a breakthrough from the existing research framework of "higher level of heterogeneity is better" in the "information/decision-making perspective " or "lower level of heterogeneity is better" in the "social categorization perspective ". This finding also reveals more precisely the applicability of both theories to Chinese listed companies. Second, the conclusions drawn have stronger external validity. Although there is a wealth of research on the relationship between TMT heterogeneity and corporate performance, the findings are mixed (Horwitz and Horwitz, 2007) The reasons for this are that many scholars have selected companies in a particular industry or sector as their sample, resulting in findings that are valid only for certain industries. Or their research is only selected for a short period, which makes it difficult to reflect on the development of the company and the changing trends (Kai Sun et al., 2019; Bingti Yao et al., 2015). This paper selects all listed A-share companies in the CSMAR database from 2008-2019 as the research sample, selecting a large number of listed companies and covering a wide range of industries, the conclusions drawn have stronger external validity and enrich the empirical research results on TMT heterogeneity and corporate performance. Third, the antecedents of TMT heterogeneity are explored. "Executive team heterogeneity" is a complete concept, but the current literature has mainly explored the possibility that TMT heterogeneity may have some impact (Boone et al., 2004). The results of this paper demonstrate that digital transformation leads to higher levels of TMT heterogeneity, which expands the study of TMT heterogeneity antecedents and enriches the theoretical framework of the Upper Echelons Theory.

5.3 Management Insights

Based on the hypotheses confirmed in this study, this paper offers the following management insights. The "inverted U" shaped relationship between TMT functional background, educational heterogeneity, and corporate performance suggests that TMT heterogeneity should be at the "middle" level. On the one hand, the different functional and educational backgrounds of TMT can bring knowledge, experience, and perspectives from different fields and perspectives. This facilitates mutual learning among members and ultimately improves the quality of decision-making and implementation. On the other hand, when the characteristics of TMT members are too

different, they can easily form "cliques" and lead to conflicts. Therefore, companies should optimize the structure of their TMT according to their current composition, keeping the heterogeneity of the team members as "middle" as possible.

In addition, as digital transformation continues, the demand for digital talent increases. Therefore, companies need to build a team with diverse backgrounds and skills to respond to the new business environment and the diverse needs of consumers to maintain their competitiveness.

5.4 Research outlook

As companies do not fully disclose the background information of their TMT members, and certain characteristics of executive members are difficult to measure (e.g. executive personality, risk appetite, values, etc.), this paper selects functional background and educational heterogeneity of TMT for this study. Future research can be conducted through questionnaires and interviews to address the less observable characteristics of TMT members such as "personality and values".

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