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The upper echelons theory and R&D investment; A case study of China's high-tech companies

La teoría de los escalones superiores y la inversión en I+D; un estudio de caso de las empresas de alta tecnología de China

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Abstract

Under the assumptions of Upper Echelons Theory, this paper aims to evidence whether Top Management Team characteristics (TMT) influence R&D intensity management, in the scope of Chinese listed high-tech companies. Using information from Chinese high-tech firms listed on the STAR Market, for the period 2019-2021, a pooled regression and random effects panel regression was conducted, under a positivist approach. R&D investment in high-tech companies in China is significantly influenced by the overseas experience of the chairperson and general manager, average age, and the education level of the top management team. An integrated overview of the TMT characteristics applicable to high-tech listed Chinese companies was obtained. Innovation intensity is positively driven by the level of education, overseas experience, and tenure. It contributes to a better understanding of how executive characteristics affect the mechanism of corporate R&D investment and expands and enriches the application scenarios of upper echelons theory. This study adds value to the current literature by exploring the effects of TMT characteristics on Chinese technological firms listed on the new Exchange STAR Market. This study provides a new and complementary overview of firms that are strongly marked by innovative strategies.

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Resumen

Bajo los supuestos de la teoría de los escalones superiores, este artículo tiene como objetivo demostrar si las características del equipo directivo superior (TMT) influyen en la gestión de la intensidad de la I+D, en el ámbito de las empresas chinas de alta tecnología que cotizan en bolsa. Utilizando información de empresas chinas de alta tecnología que cotizan en el mercado STAR, para el periodo 2019-2021, se llevó a cabo una regresión agrupada y una regresión de panel de efectos aleatorios, bajo un enfoque positivista. La inversión en I+D de las empresas de alta tecnología en China se ve significativamente influenciada por la experiencia en el extranjero del presidente y el director general, la edad media y el nivel educativo del equipo directivo superior. Se obtuvo una visión general integrada de las características de TMT aplicables a las empresas chinas de alta tecnología que cotizan en bolsa. La intensidad de la innovación se ve impulsada positivamente por el nivel educativo, la experiencia en el extranjero y la antigüedad en el cargo. Contribuye a comprender mejor cómo las características de los ejecutivos afectan al mecanismo de inversión en I+D de las empresas y amplía y enriquece los escenarios de aplicación de la teoría de los escalones superiores. Este estudio aporta valor añadido a la bibliografía actual al explorar los efectos de las características del TMT en las empresas tecnológicas chinas que cotizan en el nuevo mercado bursátil STAR. Este estudio ofrece una visión general nueva y complementaria de las empresas que se caracterizan por sus estrategias innovadoras.

Código JEL: M12, M14, M52, O32
Palabras clave: teoría de los escalones superiores; I+D; empresas de alta tecnología; características de las TMT; formación de ejecutivos; innovación; mercado STAR; China

Introduction

Over the last decade, it has been widely assumed that a new round of technological revolution and industrial change is reshaping the global economic landscape. Countries are speeding up their search for breakthroughs in science and technology innovation to become the first movers for future economic development (Liao & Li, 2024; Yang & Cho, 2023; Wang et al., 2024; Wenyi, 2024). Thus, to optimize industrial structure and enhance comprehensive national power, the Chinese government has attached great importance to science and technology innovation, vigorously promoted the innovation-driven development strategy, introduced a series of science and technology plans and incentive policies, and made significant breakthroughs in both R&D input and outcomes.

R&D investment continues to grow with a significant increase in specialized personnel, funding, and government support. Talent is a primary resource for science and technology innovations. China has long adhered to a strategy of developing a high-quality workforce. With the continuous improvement in the mechanism for cultivating, utilizing, and incentivizing research talent, the science and technology

innovation workforce has been growing. With the leap in China's economic strength and full implementation of the innovation-driven development strategy, China's R&D spending has also been growing continuously and rapidly. It has become the world's second-largest R&D spender, after the United States. The level of R&D investment mirrors a company's attitude toward innovation, and the overall position of innovation in corporate strategy can even be a barometer of corporate value, especially for technology-intensive companies. External announcements by firms that show a sustained increase in R&D investment usually increase firm value, which has a positive impact on the stock market (Xiang, 2023; Han & Manry, 2004), performance (Agazu et al., 2025; Tan et al., 2022), and sustainable practices (Wang et al., 2025). Effective R&D investment usually significantly increases firms' value-added, namely the number of invention patents granted and the technology-based intangible assets of firms, as argued by Hassanein et al. (2023). For technological companies, intangible assets are an important driver towards business performance, as evidenced by Lopes (2019) in the scope of technological companies worldwide. Thus, R&D investment plays an irreplaceable role in enhancing firm competitiveness of firms (Zha, 2024). Stimulating the innovation vitality of high-tech companies is an urgent task for the government and the companies themselves. An in-depth analysis of the factors affecting firms' R&D investment, optimizing R&D resource allocation, and enhancing firms' innovation capability and competitiveness have become key topics of concern for society, firms, and academia. Thus, firm performance is R&D driven (Xiang, 2023; Hassanein et al., 2023; Bae & Han, 2020), and in many cases, deeply supported by macroeconomic policies and incentives, as explored by Liao & Li (2024), Yang & Cho (2023), Wang et al. (2024), and Wenyi (2024).

Theoretical analysis

In the literature, studies on the factors influencing firms' R&D investment are mainly conducted from three perspectives: government, industry, and firms (Liao & Li, 2024; Yang & Cho, 2023; Wang et al., 2024; Agazu et al., 2025;Wang et al., 2025; Bae & Han, 2020). When analyzing the influencing factors at the government level, studies based on endogenous growth theory and new institutional economics usually favor the government's role, with a focus on government subsidy policies (Shao & Hua, 2024; Gorg & Strobl, 2007; Lach, 2003; Lerner, 2000), tax incentives (Wenxin & Yongjun, 2023), and intellectual property policies (Luo & Zhoo, 2024; Hammami, 2021). In analyzing the influencing factors at the industry level, relevant studies based on industrial organization theory consider that market competition (Wang et al., 2025; Yaghi & Tomaszewski, 2024), market size (Cao, 2021), and industrial agglomeration (Sun et al., 2024) have major effects on R&D investment. At the corporate level, discussions are mainly

based on theories of corporate governance, such as the nature of firm ownership, equity structure, financial status, executive characteristics, and incentives (Chen et al., 2025; Yang & Shao, 2024; Melis & Nawaz, 2024; Chen et al., 2023a; Thapa & Shah, 2023; Zhushk et al., 2023; Zhang et al., 2022; Ataay, 2020; Luo & Lin, 2020).

In modern firms, the top management team (TMT), as the most influential group in the organization, develops and implements corporate strategies (Collevecchio et al., 2025; Achi, 2024; Yang & Shao, 2024; Ma & Huang, 2023; Zhao & Yuan, 2023). and play an important role in R&D investment decisions. According to the upper echelons theory by (Hambrick & Mason, 1984), the TMT combines their education, work experience, values, age, gender, personality, and other characteristics with the business environment in making strategic and operating decisions and pursuing firms' capitalization (Hu et al., 2025; Zhang & Zhang, 2023; Lu & Sheng, 2020). These characteristics undoubtedly play a pivotal role in R&D investment (Chen et al., 2025; Ma & Huang, 2023; Chen et al., 2023a; Collevecchio et al., 2025; Barua et al., 2010; Barber & Terrance, 2001) and in the process of firm value creation (Alessandri & Pattit, 2014; Zhang & Mohen, 2022). Research suggests that executives' information processing and strategic decision-making tendencies are influenced by their past work experiences in different industries, sectors, and positions (Melis & Nawaz, 2024; Achi, 2024; Zhushk et al., 2023; Luo & Lin, 2020). For example, if executives have R&D work experience, they may pay more attention to the technological development of the firm, have stronger risk-taking abilities, and are more willing to invest more in product and technological innovation. If executives have overseas work experience, they tend to be better equipped with cutting-edge international technology and management concepts, show higher self-expectations, and are thus more willing to increase R&D investment and apply the accumulated overseas work experience to current corporate strategic decision-making activities.

Upper echelons theory is an important theoretical foundation for studying executives and the TMT (Yang & Shao, 2024; Zhao & Yuan, 2023; Hambrick & Mason, 1984; Hiebl, 2017). This theory emphasizes the characteristics of managers and links these characteristics to organizational behavior towards innovation decision making. This suggests that managers' characteristics can influence their decision preferences, thereby affecting an organization's strategic choices and operational performance. The earliest origin of the upper echelons theory can be traced back to new classical economics, as referred by Hambrick & Mason (1984). Based on the assumption of rational agents, it has been considered the theoretical foundation for management studies for a long time. Characteristics such as age and experience of managers are important factors influencing organizational decision-making and performance (Zhushk et al., 2023; Collevecchio et al., 2025), associated with remuneration and other incentives (Hoskisson et al., 1993), and political connections (Chen et al., 2023b; LaRocca et al., 2022) . Upper echelons theory

posits that executive characteristics such as tenure, gender, age, and educational background reflect their values and cognitive foundations. These characteristics influence executive risk preferences, ultimately affecting behavioral choices and management decisions. The introduction of upper echelons theory sparked a series of studies on the relationship between executives, the TMT, organizational strategic choices, and operational performance. It also provides a broad perspective and scientific method for corporate governance research.

Furthermore, R&D investments are usually characterized by large scale, long period, and uncertain returns. Thus, some corporate executives may abandon some R&D investments that are beneficial to enhance firm value due to risk aversion and the short-sighted effect of their own returns (Liang et al., 2015). In complement, the incentive theory suggests that an effective incentive mechanism will act on the inner activities of the person concerned, fully mobilizing his or her motivation and creativity, which in turn can stimulate and drive the person's behavior. Although there are differences in the background characteristics of TMT members with different experiences, they follow similar patterns in dealing with the relationship between individual needs, motives, goals, and behaviors, and usually generate behavioral motives and choose specific behaviors due to their own needs. Therefore, motivating executives to innovate and make R&D investment decisions consistent with maximizing firm value through a reasonable incentive mechanism has also become a key concern in academia. Executive incentive was first studied by Jensen & Meckling (1976), and then scholars expanded the discussion from many different dimensions. Smith &Watts (1982) argued that the executive compensation mainly includes basic salary, bonus, allowance, restricted stock, and stock options, so monetary and equity incentives are a good place to start from. In terms of incentive duration, studies considered the impact of near-term and long-term goals, and divided executive incentives into short-term and long-term incentives, where short-term incentives are mainly manifested as remuneration incentives and long-term incentives as equity incentives (Chen et al., 2015; Yin et al., 2018). Coles et al., 2006), and Li & Song (2010) gave a positive answer to whether remuneration incentives for executives are conducive to increasing R&D investment, Hoskisson et al. (1993), Lu et al. (2020), and Liang et al. (2015) had a different conclusion. As for equity incentives, Miller et al. (2002), and Alessandri & Pattit (2014) held that managers' ownership of shares can effectively curb the principal-agent problem and facilitate the increase of R&D investment. However, there are also researchers who hold different views, such as Shi & Lu (2018) who argued that equity incentives somehow inhibit the level of R&D investment. Most of them in the existing literature address the direct effect of incentives for executives on R&D investment, while others have examined the moderating role of incentives on the effect of executive characteristics on R&D investment for given executives (Hu et al., 2025; Zuo et al., 2025; Zhang et al., 2022; Shazad et al., 2021; Zhou et al., 2021).

In the scope of characteristics and strategic choices, over the past few years, researches have evidenced the influence of executive characteristics in three complimentary aspects: diversification, mergers and acquisitions, and internationalization. In terms of diversification strategies, Jensen & Zajac (2004) suggested that executive characteristics can influence corporate diversification and mergers and acquisitions strategies but have no impact on firm size, performance, and resource scarcity. Their research also highlighted that demographic characteristics of executives and their preferences may lead to extreme behaviors, and analyzing the board of directors or TMT as a comprehensive unit has certain limitations. Cao (2021) investigated the relationship between social capital and diversification strategies and found that executives with prior experience as members of the National People's Congress or the Chinese People's Political Consultative Conference, or those who have held managerial positions in government or the military, can be considered as possessing political social capital. Similarly, executives with a background of teaching or postgraduate studies at universities can be regarded as having academic social capital. It also revealed that both political and academic social capital of executives have a significant positive impact on a firm's diversification strategy. However, it is important to note that the influence of social capital on diversification strategies varies across different regions. In the case of firms located in first-tier cities, the facilitating effect of social capital on the degree of diversification tends to be attenuated. Shi & Geng (2017) used a sample of 189 patent-intensive listed companies from 2007 to 2013 and revealed that executive overconfidence has a positive impact on a company's technological diversification level, and the board of directors' structure can weaken this relationship.

In terms of corporate mergers and acquisitions, scholars both domestically and internationally have primarily focused their research on CEO individual characteristics and TMT characteristics (Collevecchio et al., 2025). Chatterjee & Hambrick (2007) conducted a research from the perspective of CEO traits to examine the impact of executive characteristics on merger and acquisition strategies. The study found that CEOs with narcissistic tendencies tend to display more enthusiasm and confidence, leading to decisions that lean towards risk-taking. As the degree of CEO narcissism increases, the number and scale of merger and acquisition activities also tend to increase, ultimately impacting the firm's performance positively. Jenter & Lewellen (2015) proposed that younger CEOs often exhibit greater openness and a propensity for risk-taking, leading to a more positive attitude towards merger and acquisition activities. Additionally, when the CEO of the target firm is about to retire, it increases the likelihood of a successful acquisition. Huang et al. (2013), using A-share manufacturing enterprises listed on the Shanghai and Shenzhen stock markets from 2006 to 2008 as their research sample, found that the younger the average age of the TMT, the more likely the company is to engage in mergers and acquisitions. Similarly, a shorter average tenure of the TMT also makes the company more inclined toward

mergers and acquisitions. However, the presence of female executives in the TMT can to some extent inhibit the occurrence of corporate mergers and acquisitions. Zhan et al. (2022), after analyzing data from Chinese A-share listed companies from 2010 to 2019, argued that CEOs with academic experience in the company are more inclined to engage in mergers and acquisitions, which not only enhances the likelihood of mergers and acquisitions but also improves their performance while reducing the associated risks. These evidences are aligned with the theoretical background stated in Campbell et al. (2022).

In the realm of internationalization strategy, the consensus among scholars is that there exists a relationship between executive characteristics and a firm's approach to international development. Broadly speaking, internationalization for a firm refers to expanding its products and services beyond its domestic market. As a firm's capabilities grow and domestic markets become saturated, internationalization emerges as a feasible option for maintaining competitiveness. Tihanyi et al. (2004) studied the interplay between executive characteristics and internationalization. Their findings indicated a noteworthy negative correlation between the average age of the TMT and a firm's internationalization. As executives age, they tend to adopt a more conservative stance, while internationalization introduces a high degree of uncertainty. Consequently, many executives may shy away from international development due to risk aversion. Furthermore, the study highlighted a significant positive correlation between the average tenure of the TMT and a firm's internationalization. With longer tenures, executives gain a deeper understanding of the firm and develop a stronger sense of belonging. Consequently, they are more inclined to align their personal growth with the firm's progress, making internationalization strategies more likely to elevate the firm to new heights. Such TMTs are often strong proponents of international development strategies. Carpenter & Fredrickson (2001) studied U.S. industrial companies and found a positive correlation between the heterogeneity of education levels, tenure, and international experience of the TMT and a firm's global strategies. Diverse education levels and tenure make the team better equipped to handle complex information and more inclined to internationalization strategies. Additionally, the study also found a negative correlation between functional heterogeneity in the TMT and a firm's global strategies, which leads to different ideas and goals within the team, reducing the efficiency of information processing. Chen et al. (2023) studied companies listed on the Shanghai and Shenzhen stock markets from 2007 to 2016, and found that compared to firms with non-overconfident executives, those with overconfident executives have faster and wider internationalization. However, the internationalization pace of overconfident firms tends to be irregular. Compared to non-state-owned enterprises, overconfidence among executives has less positive impact on the pace of internationalization in state-owned enterprises, but more positive impact on the scope of internationalization. Yuan & Wei (2022), based on data from listed companies from 2008 to 2015, argued that executives' overseas experiences drive corporate

internationalization, concluding that when comparing overseas work experience with overseas study experience, the former stands out as having a more significant advantage in promoting corporate internationalization. However, there are also some scholars who hold different views on the relationship between executive characteristics and a firm's internationalization strategy. Dauth & Tomczak (2016) measured the internationalization degree of executives of Polish firms in terms of various dimensions such as international education, international experience, and foreign language skills. They found no significant relationship between the internationalization degree of Polish firm executives and a firm's international business activities. Research conducted by Wang et al. (2018) suggested that characteristics such as the tenure, gender, and work experience of TMTs do not exhibit significant correlations with a firm's internationalization strategy. Such outcomes may be attributed to the model's setup but are more likely related to the choice of the sample. In practice, research conclusions can vary significantly depending on the industry and region under study. Therefore, when considering specific firms, it is essential to first use explanatory research methods to objectively analyze the different contexts faced by firms. This should be followed by an exploration of the specific impacts of executive characteristics on firm behavior, based on the summary of the essential intrinsic features of the TMT (Melis & Nawaz, 2024).

Relating the impact on innovation, existing research has found that gender, age, tenure, and education level of executives have a significant impact on corporate innovation behavior (Zhang & Zhang, 2023). Research by Gu et al. (2017) on companies listed on the Shenzhen Stock Exchange from 2008 to 2014 showed a significant negative correlation between the proportion and number of female executives and a company's R&D investment. The nature of corporate ownership significantly moderates the inhibitory effect of female executives' participation on R&D investment. Li & Gao (2022) collected samples from A-share listed companies from 2012 to 2018, and found that the average age and tenure of the TMT are negatively correlated with corporate innovation behaviors. However, the average education level of the TMT is positively correlated with innovation behaviors, especially in state-owned enterprises.

The deep characteristics of executives, such as personality and values, also have a significant impact on corporate innovation behavior. Ruppel et al. (2016) pointed out that the personality of managers plays a crucial role in promoting organizational innovation behavior. Managers with an innovative spirit are more likely to recognize and encourage employees' creative work and new ideas within the organization by improving internal norms, thus stimulating innovation within the organization. Wang et al. (2019) argued that the greater the difference in values between the chairperson and the general manager, the higher the R&D intensity of the company. This study further suggested that in companies with high equity concentration, the impact of differences in values between the chairperson and the general

manager on R&D intensity would be weakened. However, in organizations with relatively more redundancy, the impact would be strengthened.

In terms of the personal experience of executives, Zhan & Liu (2016) collected data from Chinese Growth Enterprise Market (GEM)-listed companies disclosed from 2009 to 2014, and found that executives with entrepreneurial experience tend to increase a company's R&D investment. They also held that when executives have political connections, the R&D intensity of the company significantly decreases. Chen et al. (2023) pointed out that companies operated by executives with military experience tend to have higher R&D investment compared to those operated by executives without military experience. Furthermore, with the increase in market competition intensity, the positive effect of executives' military experience on a company's R&D investment is further enhanced. After analyzing data from pollution-intensive manufacturing companies listed from 2008 to 2019, Yang & Cheng (2022) confirmed that the academic background of the TMT is conducive to enhancing a company's low-carbon innovation. In comparison to state-owned enterprises, the academic background of the TMT in non-state-owned enterprises has a more pronounced facilitating effect on a company's low-carbon innovation.

Thus, based on echelons theory and drawing on previous research, such as Collevecchio et al. (2025), Melis & Nawaz (2024), Darouichi et al. (2021), and Zhang & Zhang (2023), a statistical analysis was conducted based on the available data of 206 STAR-listed companies for the period 2019-2021, relating executive information and R&D intensity. This study aims to answer the question of whether and how executive characteristics affect R&D investments. In the scope of upper echelons theory, combined with the management practices of Chinese high-tech companies, the executive characteristics examined include political connections, academic experience, and overseas experience of the chairperson and general manager, in addition to age, gender, education level, tenure, and technical experience, to explore the influencing factors of R&D investment from the perspective of corporate managers.

Methodology and methods

This study focuses on Chinese high-tech companies, represented by those listed on the STAR Market for the period 2019-2021. This exchange market index is still under consolidation, the reason why the range of time could not be yet consistently extended. During the literature review phase, we collected pertinent information and data specific to STAR Market-listed companies and analyzed and summarized their purposes, functions, performance, distribution, top management teams, and R&D investment status. This is supported by upper echelons theory (Collevecchio et al., 2025; Hambrick & Mason, 1984; Hiebl, 2017) and the specific context of Chinese high-tech companies as the starting point for research. Building on the

comprehensive literature review, we formulated the conceptual model for this study based on the variables identified in Table 1.

Table 1
Variables description and framework

Type	Variable	Definition
Dependent	REI	R&D intensity
Independent	CC	Academic experience of the chairperson
	CB	Overseas experience of the chairperson
	MC	Academic experience of the general manager
	MB	Overseas experience of the general manager
	AGE	Average age of executives
	EDU	Average education level of executives
	TEN	Average tenure of executives
	FEM	Percentage of female executives
	TEC	Percentage of technical executives
	POL	Political connections: The chairperson or general manager has been or is currently a delegate to the National People's Congress or a member of the Chinese People's Political Consultative Conference
Moderating	EQ	The proportion of company shares held by executives
	lnRET	Average remuneration of executives (10,000 RMB)
Control	lnRP	The natural logarithm of net profit
	lnTA	The natural logarithm of total assets
	lnTD	The natural logarithm of total liabilities
	DR	Debt-to-asset ratio
	ROA	Return on total assets

R&D investment by high-tech companies is a key driver of technological innovation and advancement. Understanding the factors affecting R&D investment is more conducive to the government's formulation of relevant policies to promote the development of high-tech companies and thus accelerate high-quality development across society. Finally, after reviewing annual reports, prospectuses, and commercial databases and excluding companies with missing data, we collected data from 206 high-tech companies listed on the STAR Market for the years 2019-2021 as the final sample data for this research. Examining these companies can offer valuable insights into management strategies for high-tech companies, facilitating the optimization of R&D resource allocation, increased innovation investment, and enhanced innovation capabilities. Thus, a set of hypotheses was fixed as follows:

H1: High-tech companies whose chairperson has experience working in universities have higher R&D investment.

H2: High-tech companies whose chairperson has overseas experience have higher R&D investment.

H3: High-tech companies with general managers who have experience working in universities have higher R&D investment.

H4: High-tech companies with general managers who have overseas experience have higher R&D investment.

If the chairperson and/or general manager have overseas experience, it provides them with an international perspective on the firm's strategic planning and day-to-day operational management (Collevecchio et al., 2025; Yang & Shao, 2024; Chen et al., 2023; Kalasin, 2021). They can promptly assimilate advanced technology and management experience, while being more receptive to new ideas, thus adapting to new markets and technological changes.

H5: There is a negative correlation between the average age of the TMT and the R&D investment of high-tech companies.

A significant amount of research indicates that a firm's executive age directly influences corporate management decisions (Collevecchio et al., 2025; Yang & Shao, 2024; Zhao & Yuan, 2023; Thapa & Shah, 2023; Bae & Han, 2020). Some studies indicate a positive correlation between the age of the TMT and R&D investment, while others suggest a negative correlation (Barua et al., 2010; Barber & Terrance, 2001).

H6: The education level of executives in high-tech companies is positively correlated with the company's R&D investment.

The upper echelons theory also provides a theoretical basis for studying the relationship between executives' education level and R&D investment. Relevant studies have confirmed that the TMT's education level can significantly drive R&D investment (Chen et al., 2025; Zhaao & Yuan, 2023; Ataay, 2020; Luo & Lin, 2020; Zhang & Zhang, 2023).

H7: The tenure of the TMT of high-tech companies is positively correlated to the company's R&D investment.

Most scholars believe that longer executive tenure has a positive impact on a firm's R&D investment (Darouichi et al., 2021). Thus, TMTs with short tenures may not have time to focus on R&D investment that does not immediately yield benefits, potentially leading to insufficient R&D investment. As TMTs' tenure increases, their accumulated experience, enhanced management abilities, and reduced resistance may make them more inclined to increase R&D investment.

H8: There is a negative correlation between the proportion of female executives in high-tech companies and the company's R&D investment.

Psychological research suggests that, compared to males, females often exhibit personality traits that are more meticulous, cautious, and possess higher levels of insight (Thapa & Shh, 2023; Melis & Nawaz, 2024; Zhushk & Zengtian, 2023).

H9: The proportion of technical executives in high-tech companies is positively correlated to the company's R&D investment.

Studies have also suggested a positive correlation between technical expertise and R&D intensity (Agazu et al., 2025; Bae & Han, 2020; Ataay, 2020; Achi, 2024). If there are members in the TMT with a technical background or prior experience in R&D, it can help the firm make informed R&D decisions, effectively execute R&D plans, and provide necessary resources for R&D. Having TMT members with technical backgrounds can promote the quality of a firm's R&D innovation.

H10: Stronger political connections will increase R&D investment in China's high-tech companies.

The impact of TMTs' political connections on R&D investment seems to have been less examined. Even with the limited research available, the conclusions drawn by scholars are inconsistent (Chen et al., 2023b; LaRocca et al., 2022).

To test our research hypothesis, the main empirical model for this study was designed as follows.

$$REI_{it}=C+\alpha_i IV_{it}+\sum \beta_i \, Control_{it}+\boldsymbol{\varepsilon}_{it} \tag{1}$$

Where, where $\hat{Y}$ = REI; IV = Independent variables; and i=company; t=year

Results and discussion

Descriptives and correlation

The intensity of R&D activities was relatively high. The mean R&D intensity for the sample companies is 11.8%, which is significantly higher than that of companies listed on other boards, and exceeds the national threshold for high-tech companies. This indicates that STAR-listed companies play a leading and exemplary role in fostering an environment conducive to technological innovation. However, there is a considerable disparity in R&D intensity, up to 76.6% and down to 1.2%. The distribution exhibits a noticeable right-skewed trend, suggesting that some companies have a relatively low R&D intensity and room for further improvement.

Table 2
Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
REI	618	0.118	0.089	0.012	0.766
RE	618	1.411	3.641	0.082	47.445
CC	618	0.155	0.363	0.000	1.000
CB	618	0.233	0.423	0.000	1.000
MC	618	0.107	0.309	0.000	1.000
MB	618	0.228	0.420	0.000	1.000
AGE	618	47.046	4.955	21.200	61.000
EDU	618	3.497	0.575	2.000	5.000
TEN	618	3.571	2.633	0.000	15.333
FEM	618	20.044	20.846	0.000	100.000
TEC	618	74.049	18.427	0.000	100.000
POL	618	0.199	0.400	0.000	1.000
RET	618	100.770	75.390	12.375	603.825
EQ	618	26.968	25.286	0.000	94.56
RP	618	2.262	6.591	-9.527	112.025
TA	618	41.517	154.385	1.249	2299.328
TD	618	14.522	63.679	0.177	679.580
lnRP	582	0.201	1.016	-4.902	4.719
lnTA	618	2.918	0.950	0.222	7.740
lnTD	618	1.018	0.337	-1.503	2.046
DR	618	24.660	16.130	1.983	83.839
ROA	618	7.728	6.997	-13.745	60.424

The overall education level of executives was relatively high. The mean level of education was 3.497, with a maximum value of five and a minimum value of 0.575, ranging from a doctoral degree to a level below the diploma. Only a small number of executives have low educational qualifications. The mean percentage of technical executives was 74.049%, with a maximum of 100% and minimum of 18.427%. This result indicates that most companies have a high proportion of technical executives. This aligns with the practical situation of high-tech companies, in which long-term technical accumulation is necessary for technological innovation. Many executives in such companies have risen from front-line technical positions, with a significant number coming from initial R&D teams.

Table 3
Pearson coefficients

	REI	RE	CC	CB	MC	MB	AGE	EDU	TEN	FEM	TEC	POL	RET	EQ	RP	TA	TD	DR	ROA
REI	1																		
RE	0.205	1																	
CC	-0.013	-0.081	1																
CB	0.268	0.022	0.017	1															
MC	-0.062	-0.068	0.589	-0.042	1														
MB	0.213	0.002	0.086	0.685	0.037	1													
AGE	-0.095	0.090	0.067	0.103	0.009	0.039	1												
EDU	0.240	0.206	0.172	0.269	0.158	0.243	0.101	1											
TEN	-0.009	0.083	-0.005	-0.007	0.077	0.050	0.025	0.070	1										
FEM	0.039	-0.041	0.040	0.192	0.001	0.151	0.059	0.112	-0.126	1									
TEC	-0.020	0.000	0.015	-0.004	-0.027	-0.060	0.028	0.008	-0.060	-0.168	1								
POL	-0.074	0.171	0.088	-0.073	0.103	0.048	0.070	0.031	0.260	-0.114	0.001	1							
RET	0.139	0.400	0.005	0.230	-0.028	0.180	0.158	0.287	0.158	0.008	-0.049	0.094	1						
EQ	-0.002	-0.235	-0.060	-0.094	-0.047	-0.052	-0.168	-0.257	-0.042	-0.179	0.037	-0.056	-0.282	1					
RP	-0.163	0.692	-0.036	-0.057	-0.028	-0.005	0.100	0.145	0.109	0.034	0.009	0.139	0.309	-0.171	1				
TA	-0.058	0.803	-0.055	-0.044	-0.054	-0.053	0.198	0.226	0.062	-0.041	0.004	0.201	0.380	-0.196	0.775	1			
TD	-0.085	0.742	-0.060	-0.076	-0.043	-0.072	0.178	0.179	0.040	-0.046	-0.006	0.200	0.319	-0.144	0.733	0.974	1		
DR	-0.328	0.223	-0.060	-0.162	0.023	-0.205	0.005	-0.045	-0.099	-0.152	0.040	0.074	0.043	-0.138	0.156	0.271	0.327	1	
ROA	-0.272	-0.137	0.008	-0.008	-0.013	0.120	-0.087	-0.067	-0.047	0.112	-0.011	-0.047	0.007	0.168	0.253	-0.133	-0.120	-0.130	1

According to the values reflected by the correlation indicators in Table II, it can be observed that there are the following preliminary relationships between the characteristics of the TMT and REI: a. R&D intensity (REI) was negatively correlated with the academic experience of the chairperson (CC), academic experience of the general manager (MC), average age of executives (AGE), average tenure of executives (TEN), percentage of technical executives (TEC), and political connections (POL). b. The R&D intensity (REI) showed a positive correlation with the overseas experience of the chairperson (CB), overseas experience of the general manager (MB), average educational level of executives (EDU), and percentage of female executives (FEM).

Regression models

We used pooled regression and random effects regression to test our research hypotheses. Both estimation methods arrived at the same conclusion: chair-person's overseas experience, general manager's overseas experience, and TMT education level had significant positive impacts on R&D investment. The regression results obtained by replacing the dependent variable and adding control variables also support this conclusion. Therefore, we consider that the relationship between the chair-person's overseas experience, general manager's overseas experience, and TMT education level and R&D investment exhibits strong robustness.

Table 4
Pooled regression results (REI)

	Modle 1 REI	Modle 2 REI	Modle 3 REI	Modle 4 REI	Modle 5 REI	Modle 6 REI	Modle 7 REI	Modle 8 REI	Modle 9 REI	Modle 10 REI
Constant	0.0894***	0.0800***	0.0894***	0.0810***	0.196***	0.0074	0.0874***	0.0855***	0.0994***	0.0827***
	(0.0277)	(0.0256)	(0.0273)	(0.0259)	(0.0482)	(0.0360)	(0.0279)	(0.0276)	(0.0313)	(0.0270)
CC	-0.0085									
	(0.0105)									
CB		0.0291**								
		(0.0131)								
MC			-0.0087							
			(0.0106)							
MB				0.0376***						
				(0.0124)						
AGE					-0.0024***					
					(0.0008)					
EDU						0.0274***				
						(0.0077)				
TEN							9.10e-05			
							(0.0015)			
FEM								8.65e-05		
								(0.0002)		
TEC									-0.0002	
									(0.0002)	
POL										-0.0172*
										(0.0104)
lnRP	-0.0264***	-0.0263***	-0.0262***	-0.0255***	-0.0271***	-0.0255***	-0.0265***	-0.0266***	-0.0270***	-0.0282***
	(0.0090)	(0.0082)	(0.0089)	(0.0082)	(0.0089)	(0.0085)	(0.0090)	(0.0089)	(0.0089)	(0.0088)
lnTA	0.0306**	0.0312***	0.0305**	0.0309***	0.0389***	0.0216*	0.0311**	0.0315***	0.0313***	0.0360***
	(0.0118)	(0.0117)	(0.0118)	(0.0116)	(0.0125)	(0.0118)	(0.0121)	(0.0117)	(0.0119)	(0.0119)
lnTD	-0.0217	-0.0251	-0.0220	-0.0271	-0.0399	-0.0132	-0.0229	-0.0237	-0.0224	-0.0294
	(0.0232)	(0.0232)	(0.0233)	(0.0224)	(0.0250)	(0.0227)	(0.0236)	(0.0229)	(0.0243)	(0.0225)
DR	-0.0017***	-0.0016***	-0.0017***	-0.0015***	-0.0018***	-0.0016***	-0.0017***	-0.0017***	-0.0017***	-0.0017***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
ROA	0.0002	0.0002	0.0002	-0.0001	1.59e-05	7.13e-05	0.0002	0.0002	0.0002	0.0003
	(0.0007)	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Observations	582	582	582	582	582	582	582	582	582	582
R-squared	0.1850	0.2120	0.1850	0.2310	0.2100	0.2280	0.1830	0.1840	0.1860	0.1920

Table 5
Random effects regression results (REI)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Variables	REI	REI	REI	REI	REI	REI	REI	REI	REI	REI
Constant	0.0888***	0.0795***	0.0900***	0.0771***	0.1160***	0.0128	0.0828***	0.0862***	0.0986***	0.0887***
	(0.0135)	(0.0135)	(0.0134)	(0.0135)	(0.0297)	(0.0255)	(0.0134)	(0.0138)	(0.0166)	(0.0133)
CC	-0.0021									
	(0.0125)									
CB		0.0381***								
		(0.0105)								
MC			-0.0122							
			(0.0147)							
MB				0.0445***						
				(0.0105)						
AGE					-0.00061					
					(0.0006)					
EDU						0.0229***				
						(0.0066)				
TEN							0.0032**			
							(0.0013)			
FEM								9.42e-05		
								(0.0002)		
TEC									-0.0001	
									(0.0001)	
POL										-0.0031
										(0.0101)
lnRP	-0.0196***	-0.0195***	-0.0195***	-0.0196***	-0.0197***	-0.0195***	-0.0198***	-0.0198***	-0.0197***	-0.0196***
	(0.0031)	(0.0031)	(0.0031)	(0.0031)	(0.0031)	(0.0031)	(0.0031)	(0.0032)	(0.0031)	(0.0031)
lnTA	0.0154**	0.0154**	0.0152**	0.0159**	0.0162**	0.0127*	0.0132**	0.0155**	0.0153**	0.0156**
	(0.0066)	(0.0066)	(0.0066)	(0.0066)	(0.0067)	(0.0067)	(0.0066)	(0.0066)	(0.0066)	(0.0067)
lnTD	-0.0056	-0.0059	-0.0054	-0.0066	-0.0067	-0.0020	-0.0057	-0.0058	-0.0055	-0.0059
	(0.0146)	(0.0145)	(0.0146)	(0.0145)	(0.0146)	(0.0146)	(0.0144)	(0.0146)	(0.0145)	(0.0146)
DR	-0.0004***	-0.0004***	-0.0004***	-0.0004***	-0.0004***	-0.0004***	-0.0004***	-0.0004***	-0.0004***	-0.0004***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
ROA	-0.0004	-0.0004	-0.0004	-0.0005	-0.0004	-0.0004	-0.0004	-0.0004	-0.0004	-0.0004
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Observations	582	582	582	582	582	582	582	582	582	582
Number of SCODE	203	203	203	203	203	203	203	203	203	203

According to the results of Models 1 and 2, there is no significant relationship between the chairperson's academic experience (CC) and R&D intensity. The chairperson's overseas experience (CB) is significantly positively correlated with R&D intensity, indicating that chairpersons with overseas experience are more willing to invest in R&D. Therefore, the results of Model 2 support H2, but the results of Model 1 do not support H1 (Chen et al., 2025; Bae & Han, 2020). From the results of Models 3 and 4, it is evident that there is no significant relationship between general managers' academic experience (MC) and R&D intensity (Chen et al., 2025). The general manager's overseas experience (MB) has a significant positive correlation with R&D intensity, suggesting that general managers with overseas experience are more willing to invest in R&D. Therefore, the results of Model 4 supported Hypothesis 4, but those of Model 3 did not support H3. The regression results of Model 5 did not support Hypothesis 5; that is, in high-tech companies, there is no significant correlation between the age of the TMT and R&D intensity (Collevecchio et al., 2025; Yang & Shao, 2024; Barua et al., 2010; Barber & Terrance, 2001). This finding is inconsistent with the conclusions drawn from the pooled regression model. Regarding the impact of education level on R&D investment, the conclusions under the random effects regression are consistent with those under the pooled regression and according to a literature review. Specifically, the regression results of Model 6 support H6, indicating that in high-tech companies, the education level of the TMT has a significant positive correlation with R&D intensity, similar to TMTs in other companies (Chen et al., 2025; Yang & Shao, 2024;; Zhang & Zhang, 2023; Zhao & Yuan, 2023; Ataay, 2020).

Regarding the impact of TMT tenure on R&D investment, H7 was clearly supported by the random effects regression. Specifically, the longer the average tenure of the TMT, the more likely it is to increase its R&D investment. However, this conclusion is inconsistent with the results obtained using a pooled regression (Darouichi et al., 2021). Similar to the pooled regression, the regression results for Models 8-9 do not support the corresponding hypotheses, including H8, which suggests a negative correlation between the percentage of female executives and R&D expenditure. The regression results show that the former did not have a significant impact on the latter. Likewise, H9, which suggests a positive correlation between the percentage of technical executives and R&D intensity, was not supported because the regression results showed that there was no significant relationship between the two (Agazu et al., 2025; Ataay, 2020; Achi, 2024).

Finally, the regression results of Model 10 do not support H10. However, the lack of support differs from that in the pooled regression. The results indicate that there is no significant relationship between the political connections of the TMT and R&D investment (Chen et al., 2023b; LaRocca et al., 2022), whereas the pooled regression results show a significant negative impact.

Discussion and implications

Some TMT characteristics significantly impact R&D investment in high-tech companies (Chen et al., 2025; Hu et al., 2025; Zhao & Yuan, 2023; Ataay, 2020; Thapa & Shah, 2023; Hassanein et al., 2023; Zhang & Zhang, 2023; Bae & Han, 2020). However, there are also other factors that influence R&D investment in high-tech companies, examining the role of executive incentive mechanisms in high-tech companies and exploring whether this mechanism can moderate the relationship between executive characteristics and R&D investment, according to upper echelons theory (Hambrick & Mason, 1984; Hiebl, 2017).

When the personal characteristics of actual managers are at odds with the long-term interests of the firm, managers may prioritize their personal interests in decision making, leading to decisions that are detrimental to both the firm's owners and their overall development. R&D innovation activities are typically high-risk endeavors, with costs incurred in R&D often taking a considerable amount of time to yield returns, and sometimes these returns may only materialize after the manager's term ends.

The literature review presented earlier shows that most scholars believe that remuneration incentives can promote R&D investment (Yang & Shao, 2024; Lu & Sheng, 2020; Zhang & Mohnen, 2022; Alessandri & Pattit, 2014; Hoskisson et al., 1993). This is because appropriate remuneration mechanisms can alleviate the principal-agent problems arising from the separation of ownership and management in firms, effectively increasing the proactiveness of executives in carrying out R&D innovation activities (Zhang & Mohnen, 2022). To earn more income, executives tend to adopt a more objective perspective of industry trends and business development opportunities, rationally assess the risks and returns of R&D investment, and further enhance R&D investment. However, some scholars hold a different view, suggesting that the higher the monetary compensation for executives, the more they may prioritize short-term interests over the long-term development of the firm, leading to a reduction in R&D investment (Hoskisson et al., 19939. Considering the innovative nature of high-tech companies and the composition of TMTs, executive remuneration incentives can play a positive moderating role in the relationship between executive characteristics and R&D investment. Equity incentives are the primary representatives of long-term incentives (Jiang et al., 2024; Zhang et al., 2022; Alessandri & Pattit, 2014).

The potential theoretical implications of this study are primarily manifested in the following four aspects. First, it further enriches the research content and perspectives of the upper echelons theory. When exploring the relationship between executive characteristics and R&D investment, it introduces the chairperson's overseas experience as an independent variable. Previous research has extensively studied executive backgrounds, primarily focusing on financial, technical, educational, political, or military

backgrounds (Chen et al., 2025), with little attention paid to overseas experience. While a limited number of scholars have studied the relationship between executive overseas experience and R&D investment, their perspectives revolved around the top management team and the CEO (Melis & Nawaz, 2024; Achi, 2024; Ataay, 2020). There is a lack of literature that directly links a chairperson's overseas experience to R&D investment. For many developing high-tech companies in China, corporate governance mechanisms are relatively underdeveloped, and the chairperson's perspective and experience play a crucial role in the company's strategic decision-making process. Therefore, this study considers the chairperson's overseas experience as a separate independent variable to examine its impact on R&D investment. The results indicate that a chairperson's overseas experience has a significant positive effect on a company's R&D investment, supporting our hypothesis (Chen et al., 2023a; Melis & Nawaz, 2024; Luo & Lin, 2020; Achi, 2024; Hiebl, 2017). Empirical findings also support the moderating role of remuneration incentives (Jiang et al., 2024) in the relationship between a chairperson's overseas experience and R&D investment. The research conclusions provide theoretical and empirical support for future studies that consider a chairperson's overseas experience as a variable in related fields.

Conclusions

Executives, as pivotal managers within a firm, play a significant role in the decision-making process regarding corporate strategy and execution. A thorough review of the literature reveals that most research findings indicate a notable association between executive characteristics and R&D investment within firms. From the perspective of the upper echelons theory and using executive and financial data of companies listed on the STAR Market, we consider demographic variables such as executive age, gender, education level, work experience, and tenure as important factors influencing corporate R&D investment behavior by empirically examining the impact of executive characteristics on R&D investment in high-tech companies, as well as investigating the moderating effect of executive incentives on the relationship between executive characteristics and R&D investment. The research conclusions contribute to a better understanding of how executive characteristics affect the mechanism of corporate R&D investment and expand and enrich the application scenarios of upper echelons theory.

The R&D investment of high-tech companies is significantly and positively affected by executives from an international perspective. The variable for the international perspective of the TMT is whether the chairperson or general manager has overseas experience, and the analysis shows a significantly positive impact of the variable on R&D investment. A broad perspective and rich experience lead the chairperson or general manager to be key members of the top management team, placing greater

emphasis on long-term interests. They are capable of effectively balancing long- and short-term interests, which in turn directs an inclination towards R&D investment in the formulation of firm strategies, ensuring a continuous increase in the firm's R&D investment. Furthermore, R&D investment in high-tech companies is negatively influenced by the age of executives and positively influenced by their tenure. This finding indicates that older executives are less inclined to take risks and tend to pursue more conservative strategies in high-tech industries. However, once executives have a longer tenure at a firm and gain a more detailed and comprehensive understanding of the firm and industry, they may prioritize the firm's long-term interests and increase R&D investment. Thus, we believe that frequent changes in firm executives are detrimental to the continuity of a firm's R&D investment strategy.

In relation to the implications for management, this research evidences that the selection of a chairperson or general manager with an international perspective is of positive significance for promoting a company's R&D investment. Results indicate that their overseas experiences have a positive impact on a company's R&D investment. This provides a new perspective on how high-tech companies could spend more on R&D. In recent years, with China stepping up its openness and reform, executives with overseas experience are getting more attention. These executives tend to quickly embrace new ideas and technologies. Furthermore, their expertise and management experience gained abroad, as well as their international perspective and network of connections, make them more enthusiastic participants in corporate innovation activities, thereby providing an intrinsic impetus to increase R&D spending. The chairperson and general manager, as the most important decision-makers and implementers within a company, have a significant influence on R&D investment due to their overseas experience. This proposition has received both theoretical and empirical support in this study. Based on this, in order to further promote R&D investment, high-tech companies can take the following measures: 1) Further refine the selection and appointment mechanism for executives. When electing a chairperson and appointing a general manager, companies shall consider overseas experience or a relevant background as an important criterion to build a more reasonable top management team and fully leverage the positive impact of the chairperson and general manager's overseas experiences on R&D investment; and 2) Establish and improve mechanisms for overseas training and exchanges for executives. Management is fundamentally a practice, and in certain circumstances, the experiences of executives are more critical than their resumes. Providing executives, especially the general manager and chairperson, with more opportunities for overseas training and exchanges could enhance their overseas experiences and expertise. This, in turn, could help them develop diverse thinking, broaden their horizons, and increase their enthusiasm for R&D innovation, leading to more R&D investment and innovation activities and effectively driving the company's technological innovation. Furthermore, building a highly-educated top management team

could promote a company's R&D investment as shown in the research findings which suggest that the average education level of the TMT has a significant positive impact on corporate R&D investment. Therefore, to further enhance R&D investment, efforts could be made to improve the overall education level of the entire top management team. This is because the higher the educational qualifications of executives, the more they have been exposed to specialized skills and knowledge training, which leads to a deeper understanding of technology and innovation. Consequently, they are more likely to drive R&D investment within the company. To enhance the education level of TMTs, efforts can be made in the following three aspects. First, when selecting and optimizing TMTs, education level should be regarded as an important criterion. Under equal conditions, priority should be given to recruiting executives with higher academic qualifications. However, it is essential to note that for high-tech companies, quality development is the main focus, with high demands for innovation and R&D. This imposes higher requirements on executives. Therefore, the consideration of education levels of executives should involve multiple dimensions. It is crucial to consider the long-term development strategy and product development direction of the firm, comprehensively assess the professional literacy and competence of executives, and avoid falling into the misconception of prioritizing diplomas or degrees alone. Second, firms can provide various learning channels and support for TMTs, encouraging them to explore new technologies and knowledge, cultivate their ability for continuous learning, and strive to enhance the overall education level. China is currently at a crucial stage of optimizing and upgrading its industrial structure. In order to support the development of SMEs, the government has organized free training programs aimed at improving the professional skills and overall quality of firm management personnel. These training programs usually invite influential experts and scholars in the industry to share their insights and provide guidance. They also facilitate in-depth learning exchanges with representative large and established enterprises. For executives of high-tech companies, these programs offer excellent opportunities to broaden their horizons and enhance their capabilities. Executives can actively participate in and engage with such training programs to contribute to the overall education level of the firm. Third, firms can establish collaborative talent development mechanisms with universities. In the contemporary era, universities are not only tasked with nurturing diverse professional talents but also engaging in forward-looking scientific research and offering services for the community. Among these roles, partnering with pertinent firms for the joint cultivation of management talents stands out as a vital societal contribution by universities. While executives in high-tech companies often demonstrate robust practical and innovative acumen, they may exhibit limitations in forward-looking basic research, constraining their innovative outlook. As integral components of the national strategic scientific and technological landscape, universities spearhead fundamental research, possessing profound insights into innovation and

development. Through the establishment of collaborative talent development mechanisms for management personnel, firms and universities can mutually complement each other in both basic and applied research endeavors. This not only enhances the education level of TMTs but also propels the nation's technological advancement.

In this scope, we can also argue that building a young TMT and maintaining its stability is beneficial for promoting the company's R&D investment. Our research indicates that the youthfulness of the TMT is conducive to R&D investment, which may be related to the innovative nature of high-tech companies and the management style of younger individuals. With the rapid advancement of science and technology, high-tech companies must continuously innovate to enhance their core competitiveness. R&D investment serves as a crucial lever for nurturing the core competitiveness of companies if they aim for sustained and stable development. Young executives are often vigorous and adept at embracing new challenges and opportunities. They typically exhibit a management style characterized by openness, innovation, and a willingness to take risks, which translates to a higher propensity for engaging in R&D activities. Furthermore, our research also indicates a positive impact of the tenure of the TMT on R&D investment, underscoring the significance of maintaining stability within the TMT for R&D investment.

Regarding the limitations, we underline that the STAR Market was launched in 2019, the longest period of time that companies have been listed on this market is only four years, which is shorter than those listed on the Main Board, GEM, and SME Board. Thus, the information in this database is still under consolidation. Additionally, during the research process, there are areas where variable coding and classification lack rigor, such as the measurement of executive education level, which is solely based on educational attainment, without considering major. These aspects will require further refinement in future studies.

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