

# The Impact of Top Management Team Technical Background on Corporate Innovation: Evidence from China

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## Abstract

How to stimulate corporate innovation through the optimization of corporate governance structures has become an important issue for both academia and practice. Based on the Upper Echelons Theory, this article takes the Shanghai-Shenzhen A-share listed companies in China from 2012 to 2023 as a research sample, and uses a two-way fixed effect model to explore the impact of the technical background of top management teams on the level of corporate innovation of enterprises. The research results show that the technical background of the top management team of the enterprise can improve the level of corporate innovation of the enterprise; Mechanism analysis indicates that the technical background of the top management team promotes corporate innovation by increasing enterprise R&D investment and easing financing constraints; Heterogeneity analysis shows that the positive effect of the technical background of top management teams on innovation is more significant in large-scale, high-digital and non-state-owned enterprises. This article provides a new theoretical perspective on how enterprises can solve the innovation dilemma through executive characteristics.

## Keywords

top management team (TMT), technical background, corporate innovation, R&D investment, financing constraints

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## 1. Introduction

At present, the process of industrial transformation and high-quality development continues to deepen, and innovation has become a key driving force for enterprises to achieve long-term operation and build core competitiveness. How to continuously stimulate its own innovation momentum and overcome key core technical barriers is not only an important issue for the stable operation of enterprises, but also the core strategy of listed companies to seek long-term development.

The Upper Echelons Theory clearly points out that the strategic decision-making and development direction of the enterprise are essentially the response to the cognitive level of the top management team, and the characteristics of the executive will deeply affect the importance of the enterprise to innovation. With the development of information technology and artificial intelligence, the competition of corporate innovation

highlights the technical level and ability, so the influence of executives with technical backgrounds in corporate innovation is becoming more and more important. The existing research has carried out a lot of discussions on the characteristics of executives and corporate innovation, confirming that the age, education, work experience and other characteristics of executives will have an impact on the innovation output of enterprises. However, in the current era of artificial intelligence, the impact of the technical background of the top management team on corporate innovation and its inherent mechanism still need to be further verified. At the actual level, listed companies have also actively introduced executives with background in technology research and development to boost the innovation performance of enterprises, but whether this initiative can be effectively transformed into innovative effectiveness has not been fully empirically responded to.

Based on this, this paper is based on the sample of China's A-share listed companies from 2012 to 2023, using a two-way fixed effect model to explore the impact of the technical background of the top management team on the level of corporate innovation of the enterprise, and further analyzes its mechanism path and heterogeneity. Compared with the existing research, the marginal contribution of this study is: (1) Expand the application of Upper Echelons Theory in the context of emerging markets. This article focuses on the professional attribute of "technical background", which enriches the impact of executive characteristics on corporate innovation. (2) The role mechanism of executive technical background on corporate innovation is analyzed, and the specific transmission path of executive technical background to corporate innovation is clarified from the aspects of R&D investment and financing constraints. (3) Enrich the cross-field research of corporate governance and innovation management. It explains the implementation process of macro innovation strategy from the micro perspective of executives' personal experience and cognition, and provides a new theoretical perspective for understanding how enterprises can solve innovative financing problems through executive characteristics under the constraints of China's special institutional environment and capital market.

## **2. Literature Review and Theoretical Analysis**

### **2.1 Literature Review**

#### **2.1.1 Research on Executive Characteristics**

The study of the background characteristics of executives originates from the Upper Echelons Theory [1], which believes that the strategic choice and performance of enterprises are the embodiment of executives' cognition, values and risk preferences. Demographic characteristics (age, gender, education, term of office, professional experience, etc.) are important proxy variables of its psychological characteristics, which directly affect decision-making behavior and organization. Follow-up research confirmed that the age of executives is negatively related to risk-taking. Older executives tend to be conservative and reduce R&D investment [2], while younger executives are more innovative and promote radical investment and technology exploration [3]. In terms of gender characteristics, the increase in the proportion of female executives can enhance board supervision, curb overinvestment, improve the quality of information disclosure [4], and be more positive in environmental social responsibility (ESG) performance [5]. The educational background and term of office of executives will have an impact on enterprise management. Highly educated executives have stronger information processing and complex decision-making ability, which significantly improves enterprise performance and innovation output [6]; The extension of the term allows executives to accumulate industry experience and organizational capital, and make decision-making more stable but may solidify thinking and hinder change [7]. In addition, the diversity of professional experience (such as cross-industry and international service) can expand the cognitive boundaries of executives, integrate diversified resources, and promote strategic change and international expansion [8]; Although the experience of a single industry is conducive to deep cultivation, it is easy to cause an "ability trap" and reduce environmental adaptability [9]. On the whole, the background characteristics of executives deeply shape the strategy, governance and long-term value of the enterprise through the three core paths of cognitive filtering, resource acquisition and risk preference.

Among them, the technical background of executives (research and development, engineering, technical management, etc.), as a professional human capital, has a decisive impact on corporate innovation, technical strategy and core competitiveness, and is the extension and deepening of the Upper Echelons Theory under the technology-driven situation [1, 10]. First of all, executives with technical background have cutting-edge technology insight and R&D management ability, can accurately identify technical opportunities, optimize

resource allocation, and significantly improve the intensity of R&D investment and the quantity and quality of patent output [11, 12]. For example, CEOs with R&D experience are more inclined to invest resources in basic research and breakthrough innovation than short-term gradual improvement [13]; Executives with inventor backgrounds can improve the innovation efficiency and technical barriers of enterprises through professional expertise and knowledge spillovers [14]. Secondly, executives with technical background can alleviate information asymmetry and strengthen the rationality of technical decision-making. In the high-tech industry, their technical expertise can reduce the evaluation deviation of R&D projects and suppress inefficient investment [15]; In traditional industries, technical executives promote digital transformation, process upgrading and intelligent manufacturing to help industrial upgrading [16]. In addition, executives with technical background build an innovation-oriented organizational atmosphere through the imprinting effect and organizational culture shaping. Their technical values and risk tolerance can penetrate to the team level, stimulate the willingness of R&D personnel to innovate, reduce the interference of short-sightedness [17], and thus improve the sustainability and long-term performance of innovation. Under the heterogeneous situation, the role of executives with technical background is more prominent in high-tech industries, private enterprises, and areas with perfect intellectual property protection [12], which proves that their value depends on the matching of the institutional environment and industry attributes. In summary, the technical background of executives can increase the innovation investment of enterprises and provide a core driving force for the construction of enterprise technical capabilities, strategic transformation and sustainable competitive advantages.

### 2.1.2 Determinants of Corporate Innovation

corporate innovation is a complex process of synergy of internal and external factors. The existing research mainly analyzes its impact mechanism from the four dimensions of executive characteristics, corporate governance, resource base and external environment, forming a multi-perspective and multi-level theoretical consensus and empirical conclusions.

As the core decision-making body, executive characteristics directly determine the formulation and implementation of innovation strategies. Based on the Upper Echelons Theory, the demographic characteristics and professional background of executives deeply affect their innovation preferences. Young executives are more inclined to invest in high-risk and high-return innovation, which promotes breakthrough technology exploration [3]. Increasing the proportion of female executives can enhance the robustness of innovative decision-making and promote social responsibility-oriented green innovation [5]; Executives with R&D, engineering and other technical backgrounds can accurately identify innovation opportunities, optimize the allocation of R&D resources, and significantly improve the quantity and quality of patent outputs with professional knowledge and technical networks [11]. In addition, the heterogeneity of the age, educational background and professional experience of the top management team can expand cognitive boundaries, stimulate pluralistic thinking, and have a significant role in promoting ambidextrous innovation [18].

The corporate governance structure shapes an innovative institutional environment through incentive and constraint mechanisms. In terms of equity structure, state-owned enterprises undertake major innovation projects with resource advantages, but agency problems may reduce innovation efficiency; Private enterprises have flexible decision-making, perfect incentive mechanism, and higher innovation efficiency [19]; Institutional investors' shareholding can alleviate short-sightedness and promote long-term innovation investment [4]. In the governance of the board of directors, technical and academic independent directors can provide professional advice, strengthen supervision, and suppress inefficient innovative investment [15]; Executive equity incentives and compensation incentives can coordinate the interests of management and shareholders, and significantly improve the willingness to innovate and the intensity of investment [17]. In addition, the appointment of directors by non-state-owned shareholders in the reform of mixed ownership can reduce government intervention, optimize the governance mechanism, and promote the innovation of green technology of state-owned enterprises [20].

The resource foundation is the material and capacity guarantee for corporate innovation. R&D investment (funds and manpower) is the core driving force of innovation. Sufficient R&D funds and high-quality R&D talents can directly improve innovation output [21]; Digital transformation reshapes the innovation model through technology empowerment, process optimization and knowledge spillovers, and significantly improves innovation efficiency and sustainability [22]; Enterprises with good ESG performance can provide support for

innovation by easing financing constraints, improving information transparency and reputation to obtain resources [23]. At the same time, the internal knowledge reserve, technological diversification and organizational innovation atmosphere of the enterprise can enhance the ability of knowledge integration, reduce innovation risks, and promote sustainable innovation [24].

The external environment provides opportunities and constraints for corporate innovation. In the policy environment, tax incentives and government subsidies can reduce innovation costs, compensate for risk losses, and encourage enterprises to increase investment in research and development [2]; The improvement of intellectual property protection can guarantee innovation benefits, suppress imitation, and enhance innovation enthusiasm [12]. In terms of market environment, fierce industry competition forces enterprises to innovate to maintain competitive advantages, and the expansion of market demand provides application scenarios and revenue expectations for innovation [25]; The marketization process can optimize resource allocation, ease financing constraints, and create a good institutional environment for innovation [24]. In addition, digital economic development, technological transformation and global industrial chain restructuring provide technical opportunities and cooperation space for corporate innovation, while intensifying innovation competition [26].

In summary, corporate innovation is the result of the coupling of executive decision-making, governance mechanism, resource endowment and external environment. Existing research has revealed multi-dimensional influencing factors, but under new situations such as digital transformation, ESG development and mixed ownership reform, the mechanism and boundary conditions of each factor still need to be explored in depth to provide more accurate theoretical guidance for corporate innovation practice.

### **2.1.3 Upper Echelons Theory**

The Upper Echelons Theory is the core theoretical framework for explaining the relationship between management characteristics and enterprise decision-making and organizational behavior. It was officially proposed by Hambrick & Mason (1984). The theory breaks through the traditional assumption of “completely rational economic people”, pointing out that enterprises do not simply make optimal decisions based on the objective environment, but a concrete reflection of the cognitive structure, values, risk preferences and behavioral characteristics of the senior management team. Limited by individual information processing ability, executives will rely on their own past experience, knowledge reserve and personal characteristics to form an inherent cognitive framework to screen and interpret internal and external information, which ultimately affects the strategic choice, investment behavior and business performance of the enterprise, and demographic characteristics become effective alternative indicators for measuring the inherent psychological and cognitive characteristics of executives [27].

After the birth of the theory, the academic community has carried out a large number of expansions and empirical tests around the Upper Echelons Theory. Early research mainly focuses on the individual characteristics of single executives, and explores the impact of age, gender, education, tenure, professional experience and other basic characteristics on enterprise behavior [6]. With the deepening of research, scholars have gradually shifted the research perspective from a single CEO to the overall senior management team, and team heterogeneity has become the key research direction. Carpenter et al. (2004) systematically sorted out the evolutionary vein of the Upper Echelons Theory, confirming the heterogeneity of the top management team in terms of age, educational background, professional history, overseas experience and other dimensions, which can enrich the team's thinking mode, broaden information channels, and then affect strategic change, international layout and innovative decision-making; However, excessive heterogeneity will also exacerbate team communication conflicts and reduce decision-making efficiency, showing a dual effect.

## **2.2 Theoretical Analysis**

### **2.2.1 TMT Technical Background and Corporate Innovation**

Based on the Upper Echelons Theory [1], the cognitive mode, value orientation and risk attitude of senior managers are determined by their past experience, professional skills and other background characteristics, and further dominate the strategic decision-making and business behavior of the enterprise. The top management team has a technical background, which means that the team members have systematic professional knowledge, front-line technology research and development experience and industry technology

research and judgment ability. Unlike pure management executives, they have a deeper understanding of the laws of technological evolution, innovation opportunities and research and development risks.

Executives with experience in technology and research and development, with stronger technical awareness and risk tolerance, will be more inclined to increase R&D investment and lay out long-term innovative projects [11]. Judging from the willingness to innovate, technical executives have been deeply engaged in the field of technology for a long time, and more recognize the core value of technological innovation to the long-term competitive advantage of enterprises. They can effectively weaken the short-sighted behavior of management and take the initiative to promote the implementation of innovation strategies [11]. From the perspective of innovation decision-making, executives with technical background can accurately identify the feasibility of innovative projects with their professional ability, reduce misjudgment and blind investment in innovation decision-making, and reduce the probability of innovation failure. At the same time, such executives are more willing to accept cutting-edge technology and disruptive changes, have a higher tolerance for the innate high risks of innovation activities, and will not terminate the innovation strategy due to short-term revenue fluctuations. From the organizational level, the technical characteristics of the top management team will form an organizational imprinting effect, creating an innovative atmosphere that encourages exploration and tolerating trial and error from top to bottom, driving the innovative enthusiasm of all R&D personnel and business teams, and activating the internal innovative vitality of the enterprise.

Based on the above logic, the technical background of the top management team can promote innovation activities from multiple dimensions of innovation orientation, decision-making quality, risk tolerance and organizational atmosphere, and ultimately promote the improvement of the level of corporate innovation of enterprises. Based on this, the research hypothesis is put forward:

H1: The technical background of the enterprise top management team can improve the level of corporate innovation of the enterprise.

### **2.2.2 The Mediating Role of R&D Investment**

R&D investment is the basic premise for enterprises to carry out innovative activities. The continuous investment of R&D resources such as funds and manpower is a necessary condition for the transformation of technological achievements, patent output and technological iteration. Combining the resource foundation theory and the Upper Echelons Theory, the technical background of the top management team will directly affect the decision-making of the enterprise's R&D resource allocation, which in turn affects the innovation output. R&D investment plays a mediating role between the two.

On the one hand, technical executives are clearly aware of the resource needs of innovation activities and the key significance of R&D funds and R&D personnel to technological breakthroughs. In the annual budget and resource allocation, they will take the initiative to lean towards R&D activities, continuously expand the scale of R&D capital investment and expand the R&D talent team [13]. On the other hand, in the face of pressure from shareholders and the outside world on short-term performance, executives with non-technical backgrounds tend to reduce long-term investment in research and development to ensure current profits, while executives with technical background can fully demonstrate the long-term value of R&D investment, adhere to a stable and continuous R&D investment strategy, and avoid interruption of R&D activities.

When the scale of enterprise R&D investment increases and resource security is sufficient, the R&D project can be promoted smoothly, the efficiency of knowledge accumulation, technical testing and product iteration is significantly improved, and the number of enterprise patents, innovation quality and other innovative achievements will also increase. In short, the technical background of the top management team first promotes the enterprise to increase R&D investment, and then relies on sufficient R&D resources to achieve innovation and upgrading. Based on this, the research hypothesis is put forward:

H2: The technical background of the enterprise top management team can increase the investment in R&D of the enterprise, thus improving the level of corporate innovation of the enterprise.

### **2.2.3 The Mediating Role of Financing Constraints**

Innovation projects have the characteristics of large investment, long cycle, high uncertainty, strong asset specialization, etc. Naturally, there is a strong information asymmetry problem, which leads to enterprises generally facing financing constraints, and it is more difficult to obtain external funds, which seriously restricts

the development of innovative activities. Therefore, for the development of enterprise research and development activities, it is necessary to consider the capital elements and financing constraints of the enterprise.

The technical background of the top management team can effectively ease the financing constraints. First of all, in terms of information transmission, executives with technical background can use their professional ability to clearly interpret the enterprise's technical route, R&D project prospects and profit potential to financial institutions and investors, effectively reduce the information asymmetry of both investment and financing, and dispel external capital's concerns about the risks of innovative projects [15]. Secondly, top management teams with technical backgrounds often represent that enterprises have stronger technical strength and development potential, release positive signals to the capital market, improve the external reputation and credit rating of enterprises, enhance the willingness of financial institutions to lend and invest institutional investors, and broaden the external financing channels of enterprises. Finally, stable technological innovation planning and good development expectations can also improve the internal cash flow management of the enterprise, reduce the problem of internal capital tightness, and further alleviate the overall financing pressure. When the financing constraints of enterprises are eased, the disposable funds are more abundant, which can not only ensure the continuous operation of existing research and development projects, but also lay out more medium- and long-term innovation projects, break through the restrictions of capital shortages on innovation activities, and finally improve corporate innovation of enterprises. Based on this, the research hypothesis is put forward:

H3: The technical background of the enterprise top management team can ease the financing constraints of the enterprise, thus improving the level of corporate innovation of the enterprise.

### 3. Research Design

#### 3.1 Sample Selection and Data Sources

This article takes China's Shanghai-Shenzhen A-share listed companies from 2012 to 2023 as a research sample. And the data is pre-processed as follows: (1) Listed firms in the financial and insurance industries are excluded. (2) Eliminate ST and PT companies; (3) Observations with missing key financial data or executive background information are excluded.; (4) In order to eliminate the impact of extreme values. All continuous variables are winsorized at the 1% level. The data source is the CSMAR database.

#### 3.2 Model Specification

To examine the impact of executives' technical backgrounds on corporate innovation, this paper constructs the following multiple regression model:

$$inno_{i,t} = \alpha + \beta ITBack_{i,t} + \gamma Controls_{i,t} + Year + Firm + \varepsilon_{i,t} \quad (1)$$

Here,  $i$  denotes the firm and  $t$  denotes the year.  $inno$  represents firm innovation,  $ITBack_{i,t}$  represents the executive's technical background,  $Controls$  represents a set of control variables,  $Year$  and  $Firm$  represent year fixed effects and firm fixed effects respectively, and  $\varepsilon$  is the random error term.

#### 3.3 Variable Definitions and Descriptive Statistical Analysis

The dependent, independent, and control variables of this study are presented in Table 1.

Table 2 presents the results of the descriptive statistical analysis of the research variables. It can be observed that among the 35,461 observations, the mean value for corporate innovation ( $inno$ ) is 1.591, with a standard deviation of 1.638; the minimum and maximum values are 0.000 and 9.358, respectively, and the median is 1.386. These figures indicate significant individual variation in corporate innovation among the sample firms and a high degree of data dispersion, with some enterprises exhibiting corporate innovation far above the industry average, while others show relatively insufficient innovation activity. The information technology background variable ( $ITBack$ ) is a 0-1 dummy variable with a mean of 0.054, indicating that approximately 5.4% of board members have an information technology background; the vast majority of the sample does not exhibit this characteristic, and the variable's distribution shows a distinct skew. This indicates that the

proportion of top management teams with information technology backgrounds among listed companies in China remains relatively low. Overall, the ranges, means, and dispersion of the variables align with real-world economic logic and findings from existing literature; the sample data exhibit good representativeness and heterogeneity, providing a reliable foundation for subsequent empirical analysis.

*Table 1: Variable Definitions*

| Variable Type             | Variable                            | Symbol        | Definition                                                                                                          |
|---------------------------|-------------------------------------|---------------|---------------------------------------------------------------------------------------------------------------------|
| Dependent Variable        | Corporate Innovation                | <i>inno</i>   | Natural logarithm of one plus the total number of patents independently applied for by the firm in the current year |
| Core Explanatory Variable | TMT Technical Background            | <i>ITBack</i> | Proportion of board members with an information technology background                                               |
| Control Variable          | Firm Size                           | <i>Size</i>   | Natural logarithm of the firm's total assets at year-end                                                            |
|                           | Leverage Ratio                      | <i>Lev</i>    | Total liabilities divided by total assets at year-end                                                               |
|                           | Firm Age                            | <i>Age</i>    | Natural logarithm of the number of years since the firm's establishment                                             |
|                           | Return on Assets                    | <i>ROA</i>    | Net profit divided by total assets                                                                                  |
|                           | Revenue Growth Rate                 | <i>Growth</i> | Increase in operating revenue divided by operating revenue in the previous year                                     |
|                           | Ownership Concentration             | <i>Top 1</i>  | Shareholding ratio of the largest shareholder                                                                       |
|                           | Proportion of Independent Directors | <i>Indep</i>  | Number of independent directors divided by the total number of board members                                        |

*Table 2: Descriptive Statistics*

| VarName | Obs   | Mean   | SD     | Min    | Median | Max    |
|---------|-------|--------|--------|--------|--------|--------|
| inno    | 35461 | 1.591  | 1.638  | 0.000  | 1.386  | 9.358  |
| ITBack  | 35461 | 0.054  | 0.110  | 0.000  | 0.000  | 1.000  |
| size    | 35461 | 22.184 | 1.308  | 19.656 | 21.997 | 26.215 |
| lever   | 35461 | 0.424  | 0.213  | 0.053  | 0.411  | 0.964  |
| age     | 35461 | 10.230 | 7.882  | 0.000  | 9.000  | 28.000 |
| roa     | 35461 | 0.032  | 0.075  | -0.361 | 0.036  | 0.203  |
| grow    | 35461 | 0.384  | 1.044  | -0.789 | 0.131  | 7.384  |
| top1    | 35461 | 33.634 | 14.750 | 8.410  | 31.220 | 74.000 |
| indep   | 35461 | 0.377  | 0.054  | 0.333  | 0.364  | 0.571  |

## 4. Empirical Analysis

### 4.1 Baseline Regression Analysis

In order to empirically test the impact of information technology background (ITBack) on corporate innovation (inno), this paper constructs a gradual benchmark regression model, and adds fixed effects and control variables on the basis of the ordinary OLS regression model. The regression results are shown in Table 3. Column (3) shows that the regression coefficient of ITBack is 0.245, indicating that a one-unit increase in the proportion of directors with technical background of the top management team, the innovation performance of the enterprise will increase by 0.245. In summary, the results of the benchmark regression consistently show that the information technology background of the top management team has a significant positive role in promoting corporate innovation, and technical knowledge plays an important impact on corporate innovation.

*Table 3: Baseline Regression Results*

|        | (1)                  | (2)                 | (3)                   |
|--------|----------------------|---------------------|-----------------------|
|        | inno                 | inno                | inno                  |
| ITBack | 0.964***<br>(12.212) | 0.262***<br>(3.044) | 0.245***<br>(2.853)   |
| size   |                      |                     | 0.058***<br>(4.526)   |
| lever  |                      |                     | -0.175***<br>(-3.676) |
| age    |                      |                     | -0.113***             |

|         | (1)       | (2)       | (3)      |
|---------|-----------|-----------|----------|
|         | inno      | inno      | inno     |
|         |           |           | (-3.622) |
| roa     |           |           | 0.346*** |
|         |           |           | (4.261)  |
| grow    |           |           | -0.007   |
|         |           |           | (-1.568) |
| top1    |           |           | 0.001    |
|         |           |           | (1.453)  |
| indep   |           |           | 0.011    |
|         |           |           | (0.074)  |
| cons    | 1.538***  | 1.576***  | 1.457*** |
|         | (158.983) | (247.738) | (3.390)  |
| Firm FE | NO        | YES       | YES      |
| Year FE | NO        | YES       | YES      |
| N       | 35461     | 35461     | 35461    |
| r2      | 0.004     | 0.793     | 0.793    |

Note: *t*-statistics are reported in parentheses. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively. The same applies to the tables below.

## 4.2 Robustness Tests

In order to test the robustness of the research results and alleviate common problems such as variable measurement bias, inverse causality, and sample selection bias, this paper carries out the following multi-dimensional robustness test:

(1) Alternative Variable Measures. In order to alleviate the measurement error caused by variable measurement, this paper conducts a robustness test on the replacement of variable measurement. First of all, the enterprise level of corporate innovation of the explained variable is replaced. This paper uses the total number of patents independently obtained in the current year to measure. The results are shown in Column (1) of Table 4, and the results still have significant positive effects. Secondly, replace the core explanatory variables and use whether the CEO of the enterprise has a technical background to measure. The results obtained have a positive and significant effect. The results are shown in column (2) of Table 4.

(2) Alternative Estimation Method. Due to the left truncation of the number data of enterprise patents, the two-way fixed effect model may cause sample selection bias problems. Therefore, this paper uses the tobit model to process, and the results obtained are shown in column (3) of Table 4, and the results are still positive and significant.

(3) Alternative Standard Error Specification. Using the enterprise cluster robust standard error, the results obtained are shown in column (4) of Table 4, and the results are still positive and significant.

(4) Alternative Sample Periods. This article uses samples from 2012 to 2023 for research. Due to the possible impact of the 2012 national innovation policy and the 2020 COVID-19 epidemic, this paper uses the data of 2012-2019 and 2014-2023 respectively for analysis. The results obtained are shown in column (1) and column (2) of Table 5, and the results obtained are positive and significant.

(5) Excluding the Pandemic Year. Due to the impact of the COVID-19 epidemic in 2020, which has a significant impact on the innovation of enterprises, this article excludes the 2020 data and analyzes it, and the results obtained are still positive and significant.

(6) Lagged Independent Variable. In order to further make causal inferences and exclude reverse causality concerns, this paper uses the technical background characteristics of the top management team in the previous year to analyze the impact on innovation. The results are shown in column (4) of Table 5, and the results are still positive and significant.

Table 4: Robustness Test Results (I)

|         | (1)       | (2)       | (3)       | (4)       |
|---------|-----------|-----------|-----------|-----------|
|         | inno2     | inno      | inno      | inno      |
| ITBack  | 0.149*    |           | 0.779***  | 0.245*    |
|         | (1.959)   |           | (6.415)   | (1.881)   |
| ITBack2 |           | 0.055*    |           |           |
|         |           | (1.653)   |           |           |
| size    | 0.067***  | 0.059***  | 0.371***  | 0.058***  |
|         | (6.572)   | (4.593)   | (24.627)  | (2.700)   |
| lever   | -0.055    | -0.177*** | -0.508*** | -0.175**  |
|         | (-1.456)  | (-3.718)  | (-6.112)  | (-2.562)  |
| age     | -0.093*** | -0.113*** | -0.121*** | -0.113*** |
|         | (-3.670)  | (-3.613)  | (-58.018) | (-3.305)  |
| roa     | 0.280***  | 0.348***  | 2.758***  | 0.346***  |
|         | (4.306)   | (4.276)   | (12.901)  | (3.489)   |
| grow    | -0.006*   | -0.007    | -0.199*** | -0.007    |
|         | (-1.814)  | (-1.610)  | (-13.759) | (-1.456)  |
| top1    | 0.001     | 0.001     | -0.008*** | 0.001     |
|         | (0.731)   | (1.395)   | (-8.351)  | (0.863)   |
| indep   | -0.028    | 0.005     | -0.118    | 0.011     |
|         | (-0.232)  | (0.037)   | (-0.457)  | (0.057)   |
| cons    | 0.552     | 1.450***  | -5.613*** | 1.457**   |
|         | (1.591)   | (3.375)   | (-17.229) | (2.406)   |
| Firm FE | YES       | YES       | YES       | YES       |
| Year FE | YES       | YES       | YES       | YES       |
| N       | 35461     | 35461     | 35461     | 35461     |
| r2      | 0.779     | 0.793     | /         | 0.793     |

Table 5: Robustness Test Results (II)

|          | (1)      | (2)       | (3)       | (4)       |
|----------|----------|-----------|-----------|-----------|
|          | inno     | inno      | inno      | inno      |
| ITBack   | 0.247**  | 0.243**   | 0.209**   |           |
|          | (2.036)  | (2.477)   | (2.246)   |           |
| L.ITBack |          |           |           | 0.224**   |
|          |          |           |           | (2.314)   |
| size     | 0.008    | 0.096***  | 0.056***  | 0.047***  |
|          | (0.506)  | (5.361)   | (4.173)   | (3.226)   |
| lever    | -0.032   | -0.238*** | -0.161*** | -0.205*** |
|          | (-0.519) | (-3.995)  | (-3.179)  | (-3.934)  |
| age      | 0.026    | -0.141*** | -0.112*** | -0.116*** |
|          | (0.119)  | (-4.814)  | (-3.401)  | (-3.712)  |
| roa      | 0.501*** | 0.201**   | 0.350***  | 0.301***  |
|          | (4.613)  | (2.303)   | (3.909)   | (3.550)   |
| grow     | -0.006   | -0.003    | -0.006    | -0.002    |
|          | (-1.044) | (-0.513)  | (-1.210)  | (-0.438)  |
| top1     | 0.000    | 0.001     | 0.001     | 0.001     |
|          | (0.259)  | (0.462)   | (1.482)   | (1.086)   |
| indep    | -0.146   | 0.064     | 0.026     | 0.070     |
|          | (-0.786) | (0.370)   | (0.160)   | (0.440)   |
| cons     | 1.111    | 1.021**   | 1.446***  | 1.839***  |
|          | (0.497)  | (2.042)   | (3.199)   | (3.829)   |
| Firm FE  | YES      | YES       | YES       | YES       |
| Year FE  | YES      | YES       | YES       | YES       |
| N        | 22598    | 28332     | 31560     | 30363     |
| r2       | 0.817    | 0.823     | 0.792     | 0.805     |

### 4.3 Mechanism Analysis

The previous study found that the technical background of enterprise executives can improve the level of corporate innovation of enterprises. This article will further explore its impact mechanism. On the basis of benchmark regression, this paper further conducts a mechanism analysis. Since R&D is the core growth engine of the enterprise, financing constraints directly determine the supply of funds. Financing difficulties will restrict the investment of R&D funds, which is the key transmission path for interpreting the innovation behavior of enterprises. Therefore, this article selects enterprise R&D investment and financing constraints for mechanism analysis.

#### (1) The Mediating Role of R&D Investment

Because executives with information technology background pay more attention to R&D investment, which will have an impact on the innovation output of the enterprise, this paper selects the technical background of executives as the mechanism variable. R&D investment is measured by the ratio of R&D expenditure to operating revenue. The results obtained are shown in Column 6 (1) in Table. The technical background of the top management team has a positive effect on R&D investment, which shows that the greater the proportion of executives with technical backgrounds, the more attention the firm pays to R&D investment, so as to improve the level of corporate innovation of the enterprise.

#### (2) The Mediating Role of Financing Constraints

The innovation process of enterprises requires capital investment, and enterprises need external financing. Therefore, this paper uses financing constraints as a mechanism variable, and the results obtained are shown in column (2) of Table 6. The technical background of the top management team of the enterprise has a negative impact on the financing constraints. It shows that the team with more executives with technical background can reduce the financing constraints of the external market on the enterprise, and the enterprise can raise more funds from the outside.

Table 6: Mechanism Analysis Results

|         | (1)       | (2)       |
|---------|-----------|-----------|
|         | RD        | SA        |
| ITBack  | 0.649**   | -0.030*** |
|         | (2.252)   | (-5.008)  |
| size    | 0.142***  | -0.018*** |
|         | (3.036)   | (-8.918)  |
| lever   | -2.587*** | -0.017*** |
|         | (-13.024) | (-2.927)  |
| age     | -0.038    | -0.008    |
|         | (-0.163)  | (-1.394)  |
| roa     | -7.864*** | -0.011    |
|         | (-18.452) | (-1.099)  |
| grow    | -0.028    | -0.001    |
|         | (-1.384)  | (-1.102)  |
| top1    | -0.006**  | 0.001***  |
|         | (-2.182)  | (6.833)   |
| indep   | -0.511    | 0.017     |
|         | (-1.235)  | (1.484)   |
| _cons   | 3.272     | -3.355*** |
|         | (1.274)   | (-45.302) |
| Firm_FE | YES       | YES       |
| Year_FE | YES       | YES       |
| N       | 35461     | 35461     |
| r2      | 0.840     | 0.961     |

### 4.4 Heterogeneity Analysis

In order to further explore the differences between different enterprises in the impact of the technical background of enterprise executives on corporate innovation, this article conducts a heterogeneity analysis based on the differences in firm size, ownership type and the difference in the digital level of the enterprise.

(1) Firm size. Due to the differences in innovation performance of different enterprises, this paper selects the scale of enterprises for heterogeneity analysis. This article takes the total asset value of the enterprise as the median for group regression. The results are shown in column (1) and column (2) of Table 7. The positive effect of the information technology background of the top management team on corporate innovation is only significant in large enterprises, indicating that executives with information technology background in large enterprises can give full play to their expertise and promote the effect of corporate innovation.

(2) Ownership type. Because the overall average results will cover up the differences in the behavior of state-owned enterprises, private enterprises, etc., grouping can see the real impact. This article groups non-state-owned enterprises and state-owned enterprises. As shown in Column (3) and Column (4) of Table 7, the positive effect of the information technology background of the top management team on corporate innovation is only significant in non-state-owned enterprises, which may be due to the weak innovation intention of state-owned enterprises, and non-state-owned enterprises face more fierce market competition.

(3) The level of enterprise digitalization. Since the overall average results will cover up the differences in roles at different digital levels, group regression can reveal the real impact more clearly. This article conducts group regression analysis. As shown in Column (5) and Column (6) of Table 7, the positive effect of the information technology background of the top management team on corporate innovation is only significant in highly digitalized firms. This shows that the innovative effect of enterprises needs to rely on a solid digital foundation, and the advantages of executives with information technology background are more likely to be transformed into innovative results in enterprises with high digital level.

Table 7: Heterogeneity Analysis Results

|         | (1)         | (2)         | (3)       | (4)      | (5)                | (6)                 |
|---------|-------------|-------------|-----------|----------|--------------------|---------------------|
|         | Small Firms | Large Firms | Non-SOEs  | SOEs     | Low Digitalization | High Digitalization |
|         | inno        | inno        | inno      | inno     | inno               | inno                |
| ITBack  | 0.059       | 0.373***    | 0.213**   | -0.523   | 0.168              | 0.358***            |
|         | (0.486)     | (2.713)     | (2.074)   | (-1.584) | (0.972)            | (3.279)             |
| size    | 0.238***    | 0.126***    | 0.105***  | -0.072   | 0.032*             | 0.209***            |
|         | (9.758)     | (4.857)     | (6.432)   | (-1.156) | (1.684)            | (8.852)             |
| lever   | -0.244***   | -0.107      | -0.252*** | 0.391    | -0.186***          | -0.166**            |
|         | (-3.740)    | (-1.189)    | (-4.364)  | (1.567)  | (-2.916)           | (-1.965)            |
| age     | -0.261***   | -0.032      | -0.208*** | 0.107    | -0.173***          | -0.137***           |
|         | (-4.329)    | (-0.855)    | (-3.343)  | (0.922)  | (-3.871)           | (-3.572)            |
| roa     | 0.097       | 0.617***    | 0.332***  | 0.775**  | 0.259**            | 0.210*              |
|         | (0.936)     | (4.314)     | (3.484)   | (2.101)  | (2.281)            | (1.695)             |
| grow    | -0.012*     | 0.009       | -0.020*** | 0.036*** | -0.002             | -0.000              |
|         | (-1.823)    | (1.476)     | (-3.242)  | (2.810)  | (-0.354)           | (-0.006)            |
| top1    | 0.008***    | -0.000      | 0.004***  | -0.005   | 0.001              | 0.003*              |
|         | (5.020)     | (-0.223)    | (3.205)   | (-1.531) | (0.438)            | (1.673)             |
| indep   | -0.407*     | 0.224       | -0.177    | 0.207    | -0.008             | 0.000               |
|         | (-1.735)    | (1.098)     | (-0.857)  | (0.442)  | (-0.038)           | (0.000)             |
| cons    | -1.551**    | -0.951      | 1.011*    | 1.435    | 2.604***           | -1.577**            |
|         | (-2.281)    | (-1.253)    | (1.695)   | (0.669)  | (4.141)            | (-2.449)            |
| Firm FE | YES         | YES         | YES       | YES      | YES                | YES                 |
| Year FE | YES         | YES         | YES       | YES      | YES                | YES                 |
| N       | 17511       | 17512       | 23349     | 3428     | 19197              | 15434               |
| r2      | 0.762       | 0.847       | 0.773     | 0.870    | 0.776              | 0.847               |

## 5. Conclusion

Under the macro background of China's economy moving towards high-quality development and implementing innovation-driven strategies, how to stimulate the innovative vitality of micro-enterprises by optimizing the corporate governance structure is an important proposition that needs to be solved urgently. Based on the Upper Echelons Theory, this paper uses a sample of Chinese A-share listed firms from 2012–2023, and uses a two-way fixed effect model to explore the impact of the technical background of the top management team on the level of corporate innovation of enterprises and its intrinsic mechanism. The research results show that the higher the proportion of members with technical background in the top management team

of the enterprise, the greater the improvement of the level of corporate innovation, that is, the executive technical background has a significant positive effect on corporate innovation. Mechanism analysis indicates that the technical background of the top management team promotes corporate innovation by increasing enterprise R&D investment and easing financing constraints. Heterogeneity analysis shows that the technical background of the top management team on the positive effect of innovation shows differentiated influence characteristics in different enterprise characteristics and external environments, which further clarifies the applicable boundary of this effect.

The research conclusion of this article provides the following three important insights for managerial practice and public policymaking:

(1) Scientifically optimize the structure of the top management team and pay attention to the introduction of technical talents. When building a high-level team, listed companies should break the traditional single-oriented inertia of financial and marketing, and actively integrate professionals with science and engineering, research and development or IT background into the core decision-making level. By improving the structural proportion and right of speech of technical executives, we can shape an innovative culture that respects technology and tolerates trial and error from top to bottom.

(2) Improve the long-term mechanism of R&D investment and give technical executives the right to allocate resources. Since R&D investment is the core intermediary for the transformation of technological background into innovative achievements, enterprises should establish a sustainable and stable R&D capital guarantee system. At the same time, in terms of internal governance, technical executives should be given greater autonomy in the selection of technical routes and the use of innovative funds, so as to ensure that innovative resources can be accurately invested in core technological breakthroughs with long-term value.

(3) Give full play to the “signal” function of technical executives to broaden the external financing channels of enterprises. In view of the fact that technical executives can effectively alleviate financing constraints, enterprises should give full play to the professional endorsement and communication role of technical executives when conducting major financing roadshows, investor relations management or declaring science and technology projects. By clearly showing the technical prospects to financial institutions and investors, they reduce the risk concerns of external capital, so as to obtain more low-cost innovative capital support.

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