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Research article

Research on the moderate range of enterprise financialization and R&D innovation from a nonlinear perspective

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Abstract: The impact of financialization on R&D innovation in enterprises exhibits typical nonlinear dynamic characteristics. Based on this, in this study we constructed a threshold regression model to test the moderate range that can maintain the positive relationship between financialization and R&D innovation of enterprises, and also analyzed the nonlinear influencing mechanism by setting the interaction term. Considering the differences in factor intensity of various industries, in this research we also tested the heterogeneity in the moderate range among different industries. Using annual data of Chinese listed companies from 2010 to 2019, the following empirical findings were obtained: First, the impact of enterprise financialization on R&D innovation presents a nonlinear feature, i.e., a typical threshold feature. The level of enterprise financialization first positively affects the R&D innovation of enterprises, and after it reaches a certain turning point, the financialization behavior negatively affects the R&D innovation of enterprises. Second, the nonlinear feature of the mechanism by which enterprise financialization affects R&D innovation is reflected in the substitute effect, and there are disparities among different financialization levels. Third, industries with varying levels of factor intensity not only demonstrate differences in moderate intervals, but also exhibit significant disparities in the degree of impact exerted by financialization on innovation.

Keywords: threshold model; mediating effect model; moderate range; R&D innovation; nonlinear feature

1. Introduction

The increasing prominence of the global economy's shift from the real to the virtual highlights a severe inadequacy in corporate innovation capabilities during this economic transformation. Enterprise financialization behavior has led market funds to bypass the real economy and circulate within financial markets, gradually eroding the service function of the virtual economy for the real economy. Simultaneously, non-financial enterprise financialization is explained by motivations of preventive and substitutive targets. The enterprise financialization level can achieve a preventive goal within a moderate range, while enterprise financialization behavior tends to favor the substitutive objective, often characterized by a "capital-driven" nature, forming a trend of "from the real to the virtual". Theoretically, the enterprise financialization level should ideally maintain a moderate balance. Hence, investigating the relationship between moderate financialization levels and corporate R&D innovation holds significant importance.

Presently, research on the impact of enterprise financialization on corporate R&D innovation focuses on two primary explanatory theories. One perspective explains it from the macro-level of financial development. According to this category of literature, financialization plays a positive role in corporate R&D innovation since capital investment is an endogenous variable for enterprise technological innovation. Corporate financialization behavior broadens financing channels, alleviates financing constraints, enhances financing efficiency, and increases capital supply for technological innovation [1–4]. However, excessive financialization shifts the industrial focus from the real economy sector to the virtual economy sector, leading to the hollowing out of industries and subsequently weakening the foundation of technological innovation [5–7]. The other perspective studies corporate financialization behavior at the micro-level. A majority of micro-level literature argues that financialization behavior has negative effects as the continuous movement of industrial capital towards the financial sector further strengthens the inducement effect of corporate financial investment due to increased financial asset allocation and short-term financial investment returns [8,9]. Some scholars found that non-financial enterprises investing more in financial assets and financial institutions would lead to a "crowding-out effect" on corporate tangible investment [10–12]. Some studies suggest that excessive financialization in manufacturing exacerbates deindustrialization, weakens the manufacturing sector's development foundation, and consequently restrains corporate innovation capabilities [13–15].

The typical features of China's economic development indicate various negative effects of financialization behavior on corporate R&D innovation, with a certain degree of consensus achieved, mainly reflected in the crowding-out effect of financialization on R&D investment. Many studies that employ listed companies as samples have discovered that corporate financial asset allocation significantly reduces current-period corporate R&D innovation [16–18]. Results from tests controlling endogeneity indicate that the financialization behavior of real entities crowds out corporate R&D innovation investment, and there exists a highly significant negative correlation between corporate financialization and R&D investment intensity [19–21]. The aforementioned literature employs dynamic investment models, market arbitrage analyses, and linear regression models to calculate the extent of financialization behavior's crowding-out impact on corporate R&D innovation investment.

Financialization behavior has a certain degree of negative impact on R&D innovation in companies, and this negative effect is strongly associated with the motives behind corporate financialization behavior. Research on the motives for financialization behavior predominantly aims

to explain decision-making behavior: First, it involves a precautionary motive, that is, the allocation of financial assets through financialization behavior to address future liquidity issues. Holding financial assets assists in reducing high adjustment costs, thereby smoothing tangible investments and R&D innovation activities [22–25]. Second, it serves a "substitutability" objective, wherein corporate managers and enterprise objectives constrain their decision-making patterns. According to the resource allocation theory, the rise in the proportion of financial asset holdings signifies a decline in tangible assets [26]. Given the funds available for investment, the decision of enterprises regarding financial asset investment versus tangible asset investment depends on the profitability of funds. The correlation between whether financialization behavior crowds out R&D innovation and the difference in returns between financial asset investment and tangible asset investment is significant [27–29].

Upon reviewing the literature, the relationship between corporate financialization levels and R&D innovation provides ample literature foundation for this study, yet there exist further research opportunities. Based on this, the marginal contributions of this paper are as follows: First, by employing econometric methods to examine the existence of a moderate range in corporate financialization levels. Second, exploring the mechanisms of corporate financialization's moderate level of R&D innovation. Third, studying the heterogeneity of the impact of corporate financialization levels on R&D innovation from an industry perspective.

The subsequent sections of this paper are structured as follows: Section 2 outlines the research design, Section 3 conducts econometric tests on the impact of corporate financialization's moderate levels on R&D innovation, Section 4 analyzes the mechanisms through which corporate financialization levels affect R&D innovation, Section 5 explores industry heterogeneity in the impact of corporate financialization levels on evolutionary innovation, and Section 6 comprises the conclusion.

2. Research design

2.1. Theoretical analysis of the moderate range of financialization and R&D innovation

There exists a dynamic relationship between the level of financialization and corporate R&D innovation. On the one hand, financialization behavior stimulates corporate R&D innovation. Regarding the motivation for financial asset allocation, scholars suggest that asset reserve motivation is a primary factor in allocating financial assets within enterprises. Tornell argues that, in response to future uncertainties, firms might choose to invest in liquid financial assets rather than fixed assets [30]. Allocating financial assets aims to smooth profits, enhance asset liquidity, and build reserves for production and operations. Furthermore, some scholars propose that corporate financialization widens the financing channels for enterprises, timely alleviating financial constraints and supporting R&D innovation. Theurillat et al. point out that financialization aids spatial resource allocation, to some extent increasing resources for core business investment. Additionally, financialization could improve a firm's balance sheet, enhancing its financing capability [31]. Brown and Petersen suggest that, due to the high costs of adjusting R&D flow in response to short-term financing shocks, firms facing financial frictions typically rely on cash reserves to smooth R&D innovation spending [32]. On the other hand, financialization behavior has a suppressive effect on corporate R&D innovation. With increasing levels of corporate financialization, more research focuses on the crowding-out effect of financialization behavior on R&D innovation. Most scholars argue that financialization behavior may crowd out real economic investment within enterprises, hampering the development of R&D

innovation projects. Allen et al. assert that as financialization intensifies, financial capital gradually disconnects from industrial capital, squeezing industrial funds and profits, resulting in a decline in capital accumulation [33]. This, in turn, further diminishes the enthusiasm for real economic investment, prompting companies to allocate more financial assets, thereby increasing the degree of corporate financialization. Ultimately, this diminishes corporate investment in the real economy. Many scholars present compelling evidence, using non-financial corporations in the US and the UK as samples, suggesting that corporate financial activities ultimately lead to a reduction in core business investment, thereby squeezing spending on R&D innovation and diminishing a company's capacity for independent innovation, consequently stagnating economic growth [34–36]. From the perspective of arbitrage speculation motivation, in pursuit of pure capital appreciation and maximizing shareholder interests, corporations may excessively allocate financial assets. When a company's profit model relies more on investing in financial assets, it further crowds out its R&D innovation activities. Seo et al. examine non-financial Korean companies from 1994 to 2009 and suggest that corporate investment in financial assets is a market arbitrage behavior [37]. Firms, in pursuit of higher returns, increase investments in financial assets by purchasing stocks with higher returns, thereby squeezing investment in R&D innovation activities.

There are two main motivations for enterprises to allocate financial assets, namely "preventive" motivation and "substitute" motivation. Preventive motivation suggests that enterprises should hold monetary assets such as cash in order to avoid a shortage of funds affecting their production and operation. The demand for cash flow varies among different stages of a company's production cycle. The reason for the substitute motivation lies in the shortcomings of the principal-agent mechanism. As the goal of the principal is to maximize their own profits and value, while the goal of the entrusted agent is to improve their own salary and benefits, there is a certain degree of conflict of interest between the two, especially between medium - and long-term interests and short-term interests. The principal-agent mechanism may lead to information asymmetry, which can lead to difficulties in the supervision of agents by the principal. Agents are likely to harm the interests of the principal for their own benefit. The maximization of utility pursued by the principal is based on the premise of continuous operation of the enterprise, and starts from medium - and long-term strategic planning, pursuing the medium - and long-term development of the enterprise, with the utility of maximizing profits in the medium - and long-term. At the same time, for the principal, factors like corporate social responsibility will also be considered. Agents seek to maximize their own utility and are more focused on maximizing their short-term economic benefits. Under the condition of pursuing maximum economic benefits, agents will allocate assets to asset categories with higher current profit margins. Based on these two motivations, companies will make discretionary decisions when allocating financial assets based on internal and external environments such as uncertainty. However, the degree of uncertainty in R&D innovation and the return on financial assets vary at different stages, indicating a dynamic non-linear relationship between enterprise financialization and R&D innovation investment.

Therefore, the impact of financialization behavior on corporate R&D innovation is not a simple linear relationship. Investigating how financialization behavior affects corporate R&D innovation and measuring the moderate range in which financialization behavior positively influences R&D innovation is pivotal in addressing this issue.

Based on the above theoretical analysis, we propose the following hypotheses:

Hypothesis 1: There is a nonlinear dynamic relationship between the level of enterprise financialization and R&D innovation. This nonlinear dynamic change leads to a discretionary decision-

making process in maintaining financial asset allocation, resulting in a moderate range of corporate financialization levels.

Hypothesis 2: The principal-agent mechanism makes executive shareholding affect the allocation of financial assets in the enterprise. Therefore, at different levels of financialization, executive shareholding will affect the direction of financialization, supporting research and development.

Hypothesis 3: The savings motivation of financial asset allocation in different industries is heterogeneous, and the moderate range of financialization level is also heterogeneous due to the attributes of each industry.

2.2. Model construction of the moderating effect of financialization on R&D innovation

The dual objectives of financial asset allocation by enterprises might result in both positive and negative effects of financialization on R&D innovation. Financialization driven by precautionary motives could enhance asset liquidity within enterprises, aiming to maintain and augment capital. To a certain extent, this practice could prevent potential funding shortages for future primary investments, alleviate external financing constraints, and thereby foster R&D innovation. However, financialization driven by market arbitrage motives leads non-financial enterprises to allocate more resources into financial assets, consequently limiting the funds available for equipment upgrades and product R&D, inhibiting innovation within these enterprises. Thus, the impact of financialization on R&D innovation exhibits a moderate range. Based on this premise, in studying the effect of financialization on R&D innovation, borrowing from Hansen panel data threshold models, this paper constructs a panel threshold regression model [38]. Initially, a single threshold model is set as follows:

$$\begin{aligned} Rd_{it} = {} & \mu_i + \gamma_1 CFO_{it} + \gamma_2 Lnsize_{it} + \gamma_3 Lev_{it} + \gamma_4 Lnage_{it} + \gamma_5 Fixed_{it} + \\ & \gamma_6 Roa_{it} + \gamma_7 Shrcr_{it} + \beta_1 Fin_{it} I(Fin_{it} \le \eta) + \beta_2 Fin_{it} I(Fin_{it} > \eta) + \varepsilon_{it}, \end{aligned} \tag{1}$$

In Eq (1), subscripts *i* and *t* represent enterprises and years, respectively. *Rd* represents the explained variable, indicating the level of R&D innovation within enterprises, while *Fin* is the threshold variable representing the level of financialization. η denotes the threshold value, and $I(\bullet)$ is an indicator function. Defined as follows:

$$\gamma = \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \\ \gamma_4 \\ \gamma_5 \\ \gamma_6 \\ \gamma_7 \\ \beta_1 \\ \beta_2 \end{bmatrix}, X_{it}(\eta) = \begin{bmatrix} CFO_{it} \\ Lnsize_{it} \\ Lev_{it} \\ Lnage_{it} \\ Fixed_{it} \\ Roa_{it} \\ Shrcr_{it} \\ Fin_{it} I(Fin_{it} \le \eta) \\ Fin_{it} I(Fin_{it} > \eta) \end{bmatrix}$$

Thus, the single threshold model can be transformed into matrix form:

$$Rd_{it} = \mu_i + \gamma' X_{it}(\eta) + \varepsilon_{it} \tag{2}$$

Conducting threshold analysis primarily involves addressing two key issues: first, jointly estimating the threshold value η and slopeγ; second, conducting tests for threshold effects. To estimate the parameters for model (2), it is essential to mitigate the influence of individual effects μ_i.

A common approach is to subtract the within-group mean from each observation value, resulting in the transformed model:

$$Rd_{it}^{*} = \gamma' X_{it}^{*}(\eta) + \varepsilon_{it}^{*} \tag{3}$$

In Eq (3), $Rd_{it}^{*} = Rd_{it} - T^{-1}\sum_{t=1}^{T} Rd_{it}$, $X_{it}^{*}(\eta) = X_{it}(\eta) - T^{-1}\sum_{t=1}^{T} X_{it}(\eta)$, and $\varepsilon_{it}^{*} = \varepsilon_{it} - T^{-1}\sum_{t=1}^{T} \varepsilon_{it}$. By stacking all observed values, model (3) can be represented in the following matrix form:

$$Rd^{*} = X^{*}(\eta)\gamma + \varepsilon^{*} \tag{4}$$

If a given threshold value η is provided, the OLS method can be employed to estimate the slope γ as:

$$\hat{\gamma} = \left(X^{*}(\eta)'X^{*}(\eta)\right)^{-1} X^{*}(\eta)'Rd^{*} \tag{5}$$

Once the slope γ is estimated, the corresponding sum of squared residuals $S_1(\eta)$ can be obtained. Minimizing the sum of squared residuals $S_1(\eta)$ helps in obtaining an estimate of the threshold value η, i.e., $\hat{\eta} = argmin S_1(\eta)$. A grid search method can be utilized to solve the problem of minimizing the sum of squared residuals. After determining the threshold value, the slope $\gamma(\hat{\eta})$ can be derived.

After obtaining the parameter estimates of the threshold model, it is crucial to conduct relevant tests for threshold analysis, primarily encompassing two aspects: the significance test of the threshold effect and the test for the accuracy of the threshold estimate. The null hypothesis of the first test is: $H_0: \gamma_1 = \gamma_2$, and the test statistic at this juncture is:

$$F_1 = \left(S_0 - S_1(\hat{\eta})\right)/\left(\hat{\sigma}^2(\hat{\eta})\right) \tag{6}$$

In Eq (6), S_0 represents the sum of squared residuals obtained after parameter estimation under the null hypothesis, while $\hat{\sigma}^2(\hat{\eta})$ stands for the residual variance obtained under the alternative hypothesis. Under the null hypothesis, the threshold value η is uncertain, and thus the distribution of the statistic F_1 is non-standard. Nonetheless, the "bootstrap" method can simulate its asymptotic distribution, thereby constructing the corresponding p-value.

The null hypothesis of the second test is: $H_0: \hat{\eta} = \eta_0$, and the corresponding likelihood ratio test statistic is:

$$LR_1(\eta) = \left(S_1 - S_1(\hat{\eta})\right)/\left(\hat{\sigma}^2(\hat{\eta})\right) \tag{7}$$

The distribution of the statistic LR_1 is also non-standard, yet Hansen provided a simple formula to compute its rejection region. Specifically, when $LR_1(\eta) > -2log\left(1-(1-\alpha)^{1/2}\right)$ is true, the null hypothesis is rejected, where α denotes the significance level.

The aforementioned parameter estimations and hypothesis tests are applicable to single-threshold scenarios. In the case of dual thresholds, the model is formulated as follows:

$$\begin{aligned} Rd_{it} = {} & \mu_i + \gamma_1 CFO_{it} + \gamma_2 Lnsize_{it} + \gamma_3 Lev_{it} + \gamma_4 Lnage_{it} + \gamma_5 Fixed_{it} + \\ & \gamma_6 Roa_{it} + \gamma_7 Shrcr_{it} + \phi_1 Fin_{it} I(Fin_{it} \le \eta_1) + \phi_2 Fin_{it} I(\eta_1 < Fin_{it} \le \eta_2) + \\ & \phi_3 Fin_{it} I(Fin_{it} > \eta_2) + \varepsilon_{it}. \end{aligned} \tag{8}$$

The estimation method first utilizes the previously described approach to estimate the threshold value $\hat{\eta}_1$ of the dual-threshold model. Then, a grid search method is used to search for the threshold value η_2, such that $S_2(\eta_2)$ is minimized, at which point $\hat{\eta}_2$ represents the second threshold value.

The hypothesis tests for multiple-threshold models are similar to single-threshold models, and will not be further elaborated here.

3. Impact of corporate financialization on R&D innovation: quantitative analysis

3.1. Model variable selection and data

For the measurement of corporate research and development innovation (*Inno*), this study draws from the approach of G. Liu [16], utilizing the proportion of intangible assets net value to total assets. The rationale behind this choice is threefold. First, intangible assets primarily encompass patents, non-patented technologies, trademarks, and copyrights. These are the outcomes of corporate investment in research and development innovation, closely associated with a company's innovation activities, thus capable of comprehensively reflecting R&D innovation. Second, corporate investment in R&D innovation covers a wide scope, not confined solely to R&D expenditure, which only represents a fraction of a company's innovation activities. Relying solely on R&D expenditure does not provide a comprehensive picture of corporate R&D innovation. In contrast, intangible assets contain richer information about a company's R&D innovation activities, offering a more comprehensive assessment. Third, among publicly listed companies in China, only a few disclose indicators related to R&D expenditure.

Regarding the measurement of financialization behavior (*Fin*), this chapter adopts the calculation method from Demir [24], using the ratio of financial assets to total assets at the end of the period. Financial assets comprise four categories, specifically, transactional financial assets, investment properties, long-term financial equity investments, and entrusted wealth management and trust products. Among these, transactional financial assets mainly encompass assets such as trading securities, derivative financial assets, net short-term investments, net available-for-sale financial assets, net held-to-maturity investments, and net long-term debt investments. Investment properties refer to net investment properties in the balance sheet. Long-term equity investments are primarily obtained from detailed information on long-term equity investments in the balance sheet. Entrusted wealth management and trust products encompass entrusted loans, wealth management products, and balances of trust products, specifically acquired through details of other liquid assets.

Moreover, considering the multitude of factors influencing corporate R&D innovation, this paper introduces relevant control variables to manage the impact of other corporate characteristics on the level of R&D innovation. Combining the characteristics of publicly listed companies in China with factors affecting corporate R&D innovation, this study introduces seven control variables: operating cash flow *CFO*, company size *Lnsize*, enterprise capital intensity *Fixed*, enterprise age *Lnage*, enterprise operating profit margin *ROA*, company capital structure *Lev*, and equity concentration *Shrcr*. Specific details of the variables are outlined in Table 1.

Considering data availability, this study focuses on 1221 non-financial listed companies in China. The data spans from 2010 to 2019 and is derived from the China Stock Market & Accounting Research (CSMAR) database. In addition to data availability, there are also the following reasons for selecting this sample range: first, it is necessary to exclude the impact of major events, such as the significant impact of the international financial crisis in 2008–2009 on financial markets, which will seriously affect the level of financialization of enterprises; second, since 2020, the global COVID-19 epidemic has affected the global economy, and the global economic downturn after the epidemic has affected

the R&D expenditure of enterprises. To ensure the robustness of the regression results against outliers, all variables underwent Winsorization by trimming the top and bottom 1% of the data.

Table 1. Variable description.

Variable Types	Variable Names	Variables	Measurement
Dependent Variable	Enterprise R&D Innovation	Inno	The proportion of intangible assets to total assets.
Explanatory Variable	Enterprise Financialization	Fin	The ratio of financial assets to total assets at the end of the period.
Control Variables	Operating Net Cash Flow	CFO	The ratio of net cash flow from operating activities to total assets at the end of the period.
	Company Size	Lnsize	The natural logarithm of total assets at the end of the period.
	Enterprise Capital Intensity	Fixed	The ratio of fixed assets to total assets at the end of the period.
	Enterprise Age	Lnage	The natural logarithm of the current year minus the company's year of registration plus 1.
	Enterprise Operating Profitability	ROA	The ratio of net profit to total assets at the end of the period.
	Company Capital Structure	Lev	The ratio of total liabilities to total assets at the end of the period.
	Equity Concentration	Shrcr	The sum of the shareholdings of the top ten shareholders.

Table 2. Descriptive statistics.

Variable	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Inno	12,210	0.0465	0.0556	0.0000	0.3602
Fin	12,210	0.1026	0.1251	0.0004	0.6380
CFO	12,210	0.0456	0.0676	-0.1528	0.2353
Lnsize	12,210	22.5460	1.3255	20.1727	26.4153
Lev	12,210	0.4622	0.2037	0.0557	0.8751
Roa	12,210	0.0389	0.0485	-0.1645	0.1864
Growth	12,210	0.1547	0.3889	-0.7541	2.3429
Fixed	12,210	0.2193	0.1712	0.0019	0.7251
Lnage	12,210	2.9175	0.2991	1.9459	3.5264
Shrcr	12,210	56.1159	15.5468	22.5200	90.3800

Table 2 presents the descriptive statistics of each variable, totaling 12,210 observations. The statistics include the number of observations, mean, standard deviation, minimum, and maximum values. For *Inno*, the minimum and maximum values are 0.0000 and 0.3602, respectively, with a mean of 0.0465. This indicates that the proportion of intangible assets to total assets is only 4.65%, suggesting a relatively low overall level of R&D innovation within enterprises. Regarding *Fin*, the minimum and maximum values are 0.0004 and 0.6380, with a mean of 0.1026. This reveals that

financial assets account for only 10.26% of total assets, suggesting a relatively low financialization level across enterprises. Examining the control variables' descriptive statistics, except for *Shrcr*, the standard deviations are relatively small, indicating a relatively concentrated data distribution among different enterprises for these variables. The overall levels of other control variables, as indicated by their mean, minimum, and maximum values, are not particularly high, except for *Lnsize*, *Lev*, *Lnage*, and *Shrcr*.

3.2. Level of financialization and quantitative test results for adequate interval of R&D innovation

To measure the impact range of financialization behavior on enterprise R&D innovation, this study employs a panel threshold regression model for quantitative analysis. This primarily involves three steps: first, testing the significance of threshold effects to determine whether there exists a threshold effect and whether it is a single or multiple threshold; second, determining the threshold value; and third, estimating the parameters of the threshold regression. Initially, the Bootstrap method is used for repeated sampling to test the threshold effects, as illustrated in Table 3.

Table 3. Threshold effect of the test results.

Threshold Model	F Value	P Value	Threshold Type	Estimation	Confidence Interval
Single Threshold	28.23	0.0067	Threshold 1	0.1392	(0.1329, 0.1403)
Double Threshold	18.88	0.0967			

From Table 3, it is apparent that the single threshold model passes the significance test at the 0.01 level, whereas the double threshold model does not achieve significance at the same level. Consequently, it implies that financialization's impact on enterprise R&D innovation operates within a single threshold. Following the threshold effect test, the threshold value is determined. As shown in Table 3, the estimated threshold point is 0.1392, and, within a 95% confidence level, the estimated threshold value falls within the range of (0.1329, 0.1403).

To further investigate the impact of financialization levels on enterprise R&D innovation within distinct threshold-formed intervals, after obtaining the threshold value, a panel double threshold model is employed for parameter estimation. Simultaneously, for comparative purposes, this study conducts a fixed-effects regression, resulting in the parameter outcomes depicted in Table 4.

From Table 4, it is evident that the level of financialization initially has a positive impact on corporate R&D innovation. However, after reaching a certain turning point, financialization behavior starts exerting a negative influence on R&D innovation within enterprises.

Empirical analysis results, through examination, reveal a single-threshold effect of financialization level on R&D innovation, with a point estimate value of 0.1392. Further, in line with the principles of interval estimation, the moderate range of financialization level is determined to be (0.1329, 0.1403). It is noteworthy that Table 4 solely demonstrates the static empirical direction of financialization level on R&D innovation within the threshold values. However, in reality, within this moderate range, the relationship between enterprise financialization level and R&D innovation is not universally positive. This divergence can be attributed to two primary factors.

First, within the moderate range, the financialization level's impact on R&D innovation possesses dynamic characteristics influenced by external conditions, inherent attributes, and economic situations, among others. Due to these influencing features, even when internal enterprise attributes are identical, agents might implement dissimilar financial asset allocation behaviors due to preferences during decision-making processes. Second, the moderate range of financialization level is a statistical regularity, while enterprises have individual characteristics. The calculated moderate range of projects results from empirical evidence derived from numerous samples and is based on statistical regularities. Therefore, in the context of national economic management processes, it serves as a reference standard. However, when considering specific enterprises or formulating related policies, it requires a specific investigation based on statistical regularities or the formulation of "precision policies" according to industry, region, and stage.

Table 4. Regression results of financialization level and enterprise R&D innovation.

	Fixed Effects Model	Threshold Effects Model
Variables	Rd	Rd
Fin	-0.0341***	-
	(-8.43)	-
Fin ⩽ 0.1392	-	0.0254***
	-	(2.61)
Fin > 0.1392	-	-0.0266***
	-	(-6.89)
CFO	0.0155***	0.0153***
	(3.49)	(3.43)
Lnsize	0.0024***	0.0024***
	(3.15)	(3.15)
Lev	0.0068**	0.0065**
	(2.19)	(2.08)
Lnage	0.0037	0.0029
	(1.61)	(1.26)
Fixed	0.0158***	0.0157***
	(4.03)	(4.01)
Roa	-0.0012	-0.0014
	(-0.36)	(-0.42)
Shrcr	-0.0001***	-0.0001***
	(-3.76)	(-3.47)
Constant	-0.0119	-0.0118
	(-0.94)	(-0.93)
Observations	12,210	12,210
Number of firm code	1221	1221

Note: t values are in parentheses; ** and *** indicate a significance level of 5%, and 1%, respectively.

The moderate range of enterprise financialization level can be explained from the managerial behavior perspective. Corporate asset allocation embodies two motivations: "savings" and "substitutability." In the process of enterprise asset allocation, maintaining a certain level of

financialization is necessary to ensure sustainable operations by allocating relevant financial assets to cope with liquidity crises. When corporate allocation of financial assets exceeds a critical value, enterprises often encounter a shortage of liquidity, which hinders their ability to meet the capital demands of R&D innovation. Therefore, when the level of financialization exceeds the threshold value by a considerable margin, it adversely affects R&D innovation (since managers generally exhibit a preference for liquidity, the occurrence of excessively high allocation of financial assets in enterprise operations is relatively rare). Driven by a preference for liquidity and self-interest maximization, enterprise managers, in the process of financial asset allocation, exhibit a "substitutability" motive. When various choices for asset allocation exist in the external environment, managers tend to choose assets with higher returns, leading to a propensity for financialization behavior. Meanwhile, the long cycle, substantial investment, and strong uncertainty associated with R&D innovation prompt other asset allocations to act as substitutes, which ultimately restrain the impact of enterprise financialization level on R&D innovation. Hence, considering the positive promotion of R&D innovation, the level of enterprise financialization should ideally fall within a moderate range.

4. Impact mechanism of moderate financialization levels on R&D innovation

4.1. Construction of the impact mechanism model

There exists a remarkably close connection between the influence mechanism of corporate financialization levels on R&D innovation and the principal-agent relationship. Within the principal-agent framework, the agents, namely corporate executives, hold the authority over corporate resources and decision-making power regarding financial asset investment and R&D innovation. Thus, the conduct of corporate executives influences the relationship between corporate financialization and R&D innovation. Modern corporations have undergone a "separation of ownership and control," where the actual control of companies is held by a "controlling group" comprised of professional managers. Chandler argued that intensified equity dispersion and management specialization enabled managers possessing specialized management knowledge and monopolizing specific operational information to effectively control enterprises, leading to the "separation of powers." The most immediate issue arising from the separation of ownership and control is how owners, having lost control, can supervise and restrict managers who have control, steering operational decisions toward maximizing owner interests, rather than abusing decision-making authority. This simultaneously represents the core issue addressed by agency theory. The agency theory, an essential part of corporate governance theory, summarizes the characteristics of the relationship between owners (principal) and managers (agent) in a system where ownership and control are separated: incomplete alignment of economic interests, unequal risk-bearing, and asymmetric information regarding company operations and capital utilization. Managers are responsible for the day-to-day operations of the company and possess an absolute information advantage. Pursuing the maximization of their self-interest, their behavior is likely to be inconsistent with the interests of owners and the company, possibly undermining owner and company interests, thereby triggering risks. To mitigate this risk, ensure capital safety, and maximize investment returns, the corporate governance mechanism is introduced to incentivize and supervise managers. Appropriate incentive compensation aligns managerial interests with shareholder interests, enabling managers to make investment decisions more cautiously.

CEO incentives have a significant impact on R&D innovation investment and financial asset

allocation. Therefore, in this section, the CEO's shareholding ratio is used to gauge the CEO incentive mechanism, and the CEO incentive status is taken as the mediating variable affecting R&D innovation concerning financialization levels. In the sample used for this project, some companies have CEOs who do not hold shares, while others have CEOs with a considerably high shareholding ratio, leading to apparent truncation features in the data. Therefore, the CEO shareholding ratio is incremented by 1 and then natural logarithmized to define this variable.

Based on the aforementioned classification of the moderate range, and considering the focus on the impact mechanism of non-moderate financialization levels on R&D innovation in this study, two key sub-samples are selected from the entire sample, below the moderate range ($Fin < 0.1329$) and above the moderate range ($Fin > 0.1403$), to investigate the impact mechanisms within different ranges. In the mechanism study, this article examines the mediation effects of variables by establishing stepwise regression models. When the mediation effects are not significant, further examination is conducted by adding interaction terms to the base regression to test for moderating effects. The model construction is as follows:

$$Rd_{it} = \alpha_1 + \beta_1 Fin_{it} + \sum_{j=1}^{n} \beta_j X_{ijt} + \varepsilon_{it}, \tag{9}$$

$$CEO\_share_{it} = \alpha_2 + \beta_{11} Fin_{it} + \sum_{j=1}^{n} \beta_j X_{ijt} + \varepsilon_{it}, \tag{10}$$

$$Rd_{it} = \alpha_3 + \beta_{12} Fin_{it} + \beta_{13} CEO\_share_{it} + \sum_{j=1}^{n} \beta_j X_{ijt} + \varepsilon_{it}, \tag{11}$$

$$Rd_{it} = \alpha_4 + \beta_{21} Fin_{it} + \beta_{22} CEO\_share_{it} + \beta_{23} Fin_{it} \times CEO\_share_{it} + \sum_{j=1}^{n} \beta_j X_{ijt} + \varepsilon_{it}, \tag{12}$$

Equations (9)–(11) represent the models for testing the mediating effects, while Eq (12) pertains to the model for testing the moderating effects, where, CEO_share denotes CEO stock ownership percentage, and other symbols hold the same meaning as previously described.

The hypotheses of regression coefficients need sequential testing, presenting multiple challenges. If $H0: \beta_{11} = 0$ and $H0: \beta_{13} = 0$ are rejected, the mediating effect is considered significant; otherwise, it is deemed insignificant. Complete mediation also necessitates testing $H0: \beta_{21} = 0$. The Type I error rate for this test is notably low, not surpassing the significance level and sometimes significantly lower than it. Analyzing moderating effects primarily involves estimation and testing β_{23}. If β_{23} is significant (i.e., rejecting the hypothesis of $H0: \beta_{23} = 0$), it implies that the moderating effect CEO_share is significant.

Descriptive statistics for CEO_share are detailed in Table 5. The numerical values across various percentiles illustrate that, in the majority of companies, most CEOs do not hold shares, and for those who do, the majority hold a percentage below 20%. However, there are instances where CEOs hold shares as high as 63.71%, indicating distinct truncation characteristics.

Table 5. Descriptive statistics of the CEO stock ownership percentage.

CEO_share	Observations	Mean	Standard Deviation	Minimum	Maximum
	12,210	0.0472	0.1069	0.0000	0.6371
Percentiles	10%	25%	50%	75%	90%
	0	0	0	0.0076	0.2127

4.2. Empirical parameter results of the moderate range impact mechanism

This section examines the impact mechanism based on the moderate range using models (9)–(12). When there are differences in corporate financialization levels, the impact mechanism may also vary. Based on the previously measured moderate range, this study divides the entire sample into three groups: below the lower limit of the moderate range, above the upper limit of the moderate range, and within the moderate range. Through multiple experiments, it is evident that the mechanisms across different samples exhibit significant differences. Among the samples within the moderate range, financialization directly influences R&D innovation positively without any mediating or moderating effects. In the other two samples, the CEO's shareholding ratio significantly affects the mechanism. Only empirical results with significant effects of the mechanism are presented here. Consequently, regression analyses were performed separately on the two samples outside the moderate range. In the stepwise regression analysis, the mediation effect of the CEO's shareholding ratio was introduced, or the interaction term between the CEO's shareholding ratio and the level of financialization was added to analyze the moderating effect. The Ordinary Least Squares (OLS) method was used for parameter estimation. The specific results are shown in Table 6.

Table 6. Regression results of mediation and moderation effects.

Mediation Effect			
Fin < 0.1329	(1) Rd	(2) CEO_share	(3) Rd
Fin	0.0356***(3.00)	-0.1574***(-8.72)	0.0108(0.86)
CEO_share			-0.0469***(-6.10)
Control Variables	Yes	Yes	Yes
Constant Term	0.0020(0.14)	0.3625***(16.66)	0.0290(1.26)
N	9,065	9,065	9,065
Moderation Effect			
Fin > 0.1403	(4) Rd	Fin > 0.1403	(5) Rd
Fin	-0.0357***(-5.37)	C_Fin	-0.0441***(-7.35)
CEO_share	-0.0225(-0.88)	C_CEO_share	-0.0125(-0.63)
Fin*CEO_share	0.1064*(1.71)	C_Fin*C-CEO_share	0.1271**(2.01)
Control Variables	Yes	Control Variables	No
Constant Term	-0.0374(-1.14)	Constant Term	0.0373***(85.85)
N	3005	N	3005

Note: t values are in parentheses; *, **, and *** indicate a significance level of 10%, 5%, and 1%, respectively.

From Table 6, it is evident that different sample mechanisms exist at various levels of financialization. When $Fin < 0.1329$, within the mechanism of financialization's impact on R&D innovation, there is a significant negative mediating effect on CEO shareholding. Conversely, when $Fin > 0.1403$, within the mechanism of financialization's impact on R&D innovation, CEO

shareholding exhibits a positive moderating effect.

The upper part of Table 6 presents the results of the mediating effect test. Using Eqs (9)–(11) to perform stepwise regressions on samples below the lower limit of the moderate financialization range, column (1) confirms the direct impact of financialization on R&D innovation, with a regression coefficient of 0.0356 significant at the 1% level. Column (2) validates the impact of financialization on CEO shareholding, exhibiting a regression coefficient of -0.1574, also significant at the 1% level, indicating a decrease in CEO shareholding due to financialization. In column (3), the impact coefficient of financialization on R&D innovation is not significant, while the impact coefficient of CEO shareholding on innovation is significantly negative. This implies that within the effect of financialization on R&D innovation, CEO shareholding acts as a complete mediating factor. Subsequent Sobel tests revealed an indirect effect coefficient of 0.0146 with a Z-value of 5.11, indicating a significant mediating effect. These regression results indicate that when financialization falls below the lower limit of the moderate range, CEO shareholding acts as a complete mediating factor.

The lower part of Table 6 presents the results of the moderating effect test. Based on Eq (12), regressions are conducted on samples above the upper limit of the moderate financialization range. Column (4) demonstrates the original CEO shareholding's moderating effect test, with an interaction term coefficient of 0.1064, significant at the 10% level. Column (5) presents the regression results after centralizing the independent variable financialization and the moderating variable CEO shareholding (i.e., subtracting the mean value of the data set from the original data, making the dataset mean zero). This regression did not include control variables, revealing an interaction term coefficient of 0.1271, significant at the 5% level, indicating a stronger significance than the coefficient before centralization. These regression results indicate that when financialization exceeds the upper limit of the moderate range, CEO shareholding acts as a moderating factor.

4.3. Discussion on empirical results of impact mechanisms

The empirical results of the mechanism of financialization levels on R&D innovation indicate significant differences in the effects of variables among samples within different intervals, even under the same standards. Consequently, this section analyzes the reasons behind the samples generated from the lower and upper limits of the moderate range to explore the operational mechanisms underlying the impact mechanisms.

According to the conclusions drawn from the upper half of Table 6, when $Fin < 0.1329$, CEO shareholding exhibits a significant negative mediating effect. This implies that when a company's financialization level falls below the lower limit of the moderate range, it stimulates R&D innovation by reducing CEO shareholding. On one hand, while directly investigating the impact of corporate financialization level on R&D innovation, there is a significantly positive promotion effect of financialization on R&D innovation. Since the company's financialization level is below the lower limit of the moderate range, theoretically, the company still needs to allocate more financial assets to prevent insufficient liquidity. In terms of R&D innovation investment, more financial support is required, especially as the R&D process progresses, necessitating greater liquidity. However, when executive shareholding is excessively high, it exerts greater influence on the allocation of financial assets, resulting in the misallocation of assets originally intended to meet liquidity needs for other financial asset investments. This leads to a misalignment of assets and, to a certain extent, inhibits the level of R&D innovation through the CEO shareholding mechanism. According to the principal-agent

theory, executives have decision-making authority over the allocation of corporate assets, while shareholders determine executive compensation. Therefore, as the level of financialization increases, companies gradually weaken incentives for executives to meet corporate development goals, which manifests as a reduction in CEO shareholding. Consequently, this diminishes the desire to invest in financial assets and encourages a shift towards R&D innovation. In this process, CEO shareholding acts as an intermediary.

From the bottom section of Table 6, it is deduced that when $Fin > 0.1403$, the CEO's shareholding proportion exhibits a positive moderating effect. Specifically, when the financialization level exceeds the upper limit of the appropriate range, an increase in the CEO's shareholding proportion intensifies the crowding-out effect of financialization on R&D innovation. Principal-agent theory suggests that executives whose income strongly correlates with the company's operational performance often pursue short-term tangible gains and are less inclined to take the risks associated with R&D innovation, conflicting with the goals of shareholders concerned about the company's long-term growth. Excessive speculation commonly exists when corporate financialization levels are excessively high, wherein the motivation for alternative allocation of financial assets predominates.

Although the relationship between financialization levels and R&D innovation varies due to differing financialization levels, the profit-seeking behavior and risk preferences of corporate managers remain consistent. CEOs, driven by liquidity preferences and self-maximization of interests, continue to choose financially lucrative assets among multiple asset allocation options in the external environment, leading to their reluctance to invest adequate funds into R&D innovation as their shareholding proportion increases. Moreover, the direct effect of financialization on R&D innovation itself acts as a suppressant. As top-level executives strengthen their own interests, they can only achieve this through the interaction with financialization levels. Thus, as the CEO's shareholding proportion increases, the crowding-out effect of financialization on R&D innovation is further amplified, demonstrating the moderating effect of the CEO's shareholding proportion in this process.

5. Industry variances in the appropriate range of financialization and R&D innovation

5.1. Industry classification and theoretical analysis of industry variances in the appropriate range

In different industries, varying degrees of factor intensity lead to diverse motivations for companies to engage in financialization, consequently resulting in differences in the impact of financialization on enterprise R&D innovation within an appropriate range. The disparities in factor intensity exert an influence on companies' capital requirements. The industry's inherent characteristics contribute to differences in the degree of financialization among enterprises across sectors. When non-financial firms in an industry exhibit higher primary business revenue, their inclination toward developing core businesses increases, thereby reducing investments in finance. The level of productive earnings in the industry influences the preference of companies for production and financial investments. For labor-intensive industries, enterprises place a higher percentage of living labor value in product value, primarily relying on enhanced labor efficiency for increased business value. Consequently, these companies lack robust profit-making capabilities, making them more susceptible to the allure of high-yielding financial markets. Therefore, enterprises in labor-intensive industries tend to engage more in financialization. However, as these entities have lower demands for R&D innovation, the higher returns from financialization may predominantly improve labor productivity rather than

positively impacting R&D innovation. In contrast, for capital-intensive industries, the substantial need for capital results in larger returns upon increased capital investments. These businesses allocate relatively less to labor input but significantly to machinery, which substantially consumes labor in the production process. Consequently, depreciation costs of fixed assets represent a significant portion of the product's cost. To reduce per-unit production costs, enterprises must engage in R&D innovation, improve production processes, and enhance machinery utilization. Therefore, while broadening financing channels, financialization among capital-intensive industries mitigates the high expenditure on R&D innovation, thereby further enhancing the inclination toward R&D innovation. As for technology-intensive industries, their core competitiveness hinges on highly technical machinery, often necessitating substantial capital investment in R&D innovation. Investing in finance at this stage not only displaces investment in R&D innovation, but also impacts the enterprise's long-term development. Thus, considering the high opportunity cost, companies in technology-intensive industries are less likely to allocate funds to financial markets. In summary, the varying industry characteristics directly influence the extent to which financialization either stifles or promotes R&D innovation activities, resulting in alterations in the appropriate range of financialization's impact on enterprise R&D innovation.

Table 7. Classification of industries in the moderate interval.

Factor intensity type	Sub-sector industries
Labor-intensive	A (Agriculture, Forestry, Animal Husbandry, Fishing), B (Mining), C0 (Food, Beverage), C1 (Textile, Apparel, Fur), C2 (Wood, Furniture), C9 (Other Manufacturing), E (Construction), F (Wholesale and Retail), H (Accommodation and Food Services), L (Rental and Business Services), N (Water Conservancy, Environmental and Public Facilities Management), P (Education), Q (Health and Social Work), R (Culture, Sports, and Entertainment), S (Comprehensive)
Capital-intensive	C3 (Paper, Printing, Cultural, Educational), C4 (Petroleum, Chemicals, Plastics), C6 (Non-Metallic, Metal), D (Electricity, Heat, Gas, and Water Production and Supply), G (Transportation, Warehousing, and Postal Services)
Technology-intensive	C5 (Electronics), C7 (Machinery, Equipment, Instruments), C8 (Pharmaceuticals, Biological Products), M (Scientific Research and Technical Services), I (Information Transmission, Software, and Information Technology)

Hence, in this section, this paper differentiates industries based on the intensity of factors, as factor intensity is linked to the allocation of financial assets. For instance, in labor-intensive industries, financial asset allocation largely revolves around labor remuneration and other financial needs. Industries that are capital-intensive exhibit a more diverse and flexible allocation of financial assets. On the other hand, technology-intensive industries' allocation of financial assets is characterized by longer cycles and greater uncertainty. Nevertheless, even among industries with similar factor

intensities, there may be variations in the moderate interval across different sub-sectors. These differences may stem from inherent distinctions among sub-sectors; for instance, while both food and beverage and construction fall into the labor-intensive category, their levels of financialization in the moderate interval are not entirely similar. Additionally, variations might arise due to different phases in a company's production cycle, such as differences between startup phases and normal operational stages. Due to the limitations of this project's research objectives, sub-sector analysis is not undertaken in this study. The significant differences in the allocation of financial assets across various industries contribute to disparities in the moderate intervals of financialization levels among industries with different factor intensities. Academically, there is not a standardized criterion for classifying industries based on factor intensity. Some scholars employ empirical observations for classification, while others use clustering analysis methods. A higher proportion of fixed assets signifies greater capital importance, categorizing it as capital-intensive. A higher ratio of R&D expenditure indicates greater technological importance over labor, designating it as technology-intensive, leaving the rest categorized as labor-intensive. Combined with the classification of labor-intensive and capital-intensive manufacturing industries, the classification of labor-intensive products in the Standard International Trade Classification (SITC), and the Listed Company Industry Classification Guidelines (revised in 2012), this subsection divides the 25 industries in the full sample into three sub-samples, labor-intensive, capital-intensive, and technology-intensive, as outlined in Table 7, illustrating the different sub-industry types corresponding to each sub-sample.

5.2. Empirical analysis of industry differences

In order to explore the appropriate threshold of financialization levels concerning research and development (R&D) innovation across various industries, maintaining consistency with the aforementioned process, the initial step is to conduct threshold effect tests on samples from different industries. Table 8 presents the test results of threshold effects conducted using the Bootstrap method for repeated sampling.

Table 8. Threshold effect test results by industry.

Industry Category	Threshold Model	F-value	P-value	Threshold Type	Estimate	Confidence Interval
Labor-Intensive	Single Threshold	21.53	0.0967	-	-	-
	Dual Threshold	17.67	0.2000			
Capital-Intensive	Single Threshold	46.16	0.0000	Threshold 1	0.1485	(0.1445,0.1497)
	Dual Threshold	36.40	0.0033	Threshold 2	0.3951	(0.3721,0.4146)
Technology-Intensive	Single Threshold	11.85	0.3767	-	-	-
	Dual Threshold	8.62	0.5200			

From Table 8, it is evident that there are significant differences in the number of appropriate threshold points among industries with varying factor intensities. For companies in labor-intensive and technology-intensive industries, there was no significant validation through the threshold model tests, indicating the absence of threshold effects in financialization behavior. Conversely, companies in capital-intensive industries passed the significance tests for both single and dual threshold models, indicating the presence of dual threshold effects in financialization behavior.

Based on the threshold effect tests, the threshold values for financialization behavior in capital-intensive industries were determined. As per Table 8, the estimated threshold points for financialization behavior in capital-intensive industries were 0.1485 and 0.3951, with the interval estimates at a 95% confidence level being (0.1445, 0.1497) and (0.3721, 0.4146), respectively.

Further investigation into the influence of financialization behavior on R&D innovation in capital-intensive industries within the intervals formed by different thresholds was conducted. Simultaneously, for comparative purposes between sub-samples and the entire sample, an analysis was performed on the overall impact of financialization behavior on R&D innovation in labor-intensive and technology-intensive industries. The parameter estimation results are presented in Table 9.

Table 9. Regression results of financialization and R&D innovation by industry.

	Labor-Intensive Industry	Capital-Intensive Industry		Technology-Intensive
Variables	Rd	Rd		Rd
Fin	-0.0405***	Fin ≤ 0.1485	0.1056***	-0.0243***
	(-5.95)	0.1485 < Fin ≤0.3951	(4.84)	(-4.76)
			-0.0053	
		Fin > 0.3951	(-0.46)	
			-0.0757***	
			(-6.73)	
CFO	0.0212***	0.0329***		0.0006
	(3.19)	(3.11)		(0.08)
Lnsize	0.0042***	0.0047***		0.0001
	(3.72)	(2.88)		(0.12)
Lev	-0.0107**	-0.0112		0.0183***
	(-1.98)	(-0.107)		(4.76)
Lnage	0.0004	-0.0015		0.0025
	(0.12)	(-0.34)		(0.92)
Fixed	0.0453***	-0.0142**		0.0364***
	(6.00)	(-2.21)		(6.48)
Roa	-0.0171**	-0.0296***		0.0089**
	(-2.36)	(-2.68)		(2.37)
Shrcr	-0.0000	-0.0002**		-0.0002***
	(-0.26)	(-2.21)		(-4.15)
Constant	-0.0445**	-0.0256		0.0312***
	(-2.24)	(-0.91)		(2.13)
Observations	4580	3060		4460
Number of	458	306		446

Note: t values are in parentheses; ** and *** indicate a significance level of 5%, and 1%, respectively.

From Table 9, it is evident that industries with varying factor intensities exhibit not only disparities within the moderate range, but also significant variations in the extent of financialization's influence on R&D innovation. In industries with different factor intensities, the moderate range of financialization's impact on corporate R&D innovation varies. While there are no threshold effects of financialization on the relationship between financialization and corporate R&D innovation in labor-intensive and technology-intensive industries, a dual-threshold effect exists in capital-intensive industries. For labor-intensive and technology-intensive industries, financialization levels predominantly exhibit a crowding-out effect on corporate R&D innovation, aligning the moderate range of financialization with the entire sample. Conversely, for capital-intensive industries, when the financialization level *Fin* is ≤ 0.1485, it significantly promotes corporate R&D innovation. When the financialization level ranges between $0.1485 < Fin \leq 0.3951$, there is no significant correlation between financialization and corporate R&D innovation. However, when the financialization level exceeds $Fin > 0.3951$, it significantly suppresses corporate R&D innovation, with the moderate range identified as (0.1445, 0.4146).

In the theoretical analysis, we mentioned that companies in labor-intensive industries tend to engage in financialization behavior with relatively lower demand for R&D innovation, thus not significantly benefiting R&D innovation. Conversely, technology-intensive industries emphasize greater investment in technological innovation, requiring substantial funds for R&D innovation, potentially leading to lower willingness to engage in financialization behavior. For these two industries, as revealed by regression results, regardless of high or low financialization levels, there exists an inverse correlation between financialization and corporate R&D innovation.

However, the scenario differs for capital-intensive industries. In such industries, significant capital is essential, and higher capital investment yields greater returns. At lower financialization levels, capital-intensive industries require investments in financial assets to obtain support for equipment updates, maintain regular business operations, and also create reserves for R&D innovation. Therefore, at this stage, a positive correlation exists between financialization levels and corporate R&D innovation. Subsequently, when a company's financialization level falls within the moderate range, there is no mutual impact between financialization and R&D innovation, allowing companies to freely allocate funds between financial assets and R&D innovation. Under these circumstances, companies can accumulate more funds, yet whether these funds are directed towards R&D innovation depends on the company's individual planning and needs, thus presenting a loose connection between financialization and R&D innovation during this stage. Finally, when a company's financialization level reaches higher levels, despite the heightened need for capital due to being in a capital-intensive industry, excessive investments in financial assets significantly crowd out the funds required for R&D innovation, resulting in a negative correlation between financialization levels and corporate R&D innovation.

6. Main findings and policy implications

6.1. Main findings

This study utilizes threshold regression models to examine the moderate range that maintains a positive relationship between financialization and corporate R&D innovation. Furthermore, it investigates the impact mechanisms within different intervals. Considering the varying factor intensity

across industries, this chapter also examines the diversity of the moderate range across different industries. The conclusions obtained are as follows:

First, the financialization level initially positively influences corporate R&D innovation. However, after reaching a certain threshold, financialization behavior negatively impacts corporate R&D innovation. According to calculations, the moderate range for financialization levels is identified as (0.1329, 0.1403). However, during this interval, the relationship between corporate financialization level and R&D innovation is not entirely positive.

Second, different sample mechanisms show variations across various financialization levels. When $Fin < 0.1329$, in the mechanism of the financialization level's impact on corporate R&D innovation, CEO shareholding has a significant negative mediating effect. Conversely, when $Fin > 0.1403$, in the mechanism of the financialization level's impact on corporate R&D innovation, CEO shareholding exhibits a positive moderating effect.

Third, industries with different factor intensities not only exhibit differences in the moderate range but also significant variations in the degree of financialization's impact on innovation. For labor-intensive and technology-intensive industries, overall, financialization exerts a crowding-out effect on corporate R&D innovation. The moderate range for financialization levels remains consistent with the entire sample. In contrast, for capital-intensive industries, when the financialization level is $Fin \leq 0.1485$, it significantly promotes corporate R&D innovation. When the financialization level is between $0.1485 < Fin \leq 0.3951$, there is no significant correlation between financialization level and corporate R&D innovation. However, when the financialization level is $Fin > 0.3951$, it significantly inhibits corporate R&D innovation, and the moderate range is identified as (0.1445, 0.4146).

6.2. Policy implications

Based on these conclusions, there are some issues that need to be noted in policies related to enterprise asset allocation. First, the allocation of financial assets in enterprises needs to be dynamically adjusted according to various situations. According to research findings, maintaining a moderate range of financialization for enterprises is beneficial for their R&D innovation, and this moderate range varies according to changes in various conditions, such as economic and financial cyclical changes. In other words, enterprises need to maintain a moderate level of financialization in their business operations according to economic and financial cycles. Second, enterprises need to adjust their executive shareholding based on the financialization level. From the empirical results, it can be found that the mechanism of the effect of executive shareholding on R&D innovation is reversed at different levels of financialization. Third, enterprises should adjust their financialization levels according to the industries they are in. Different industries have different levels of financial assets that maintain liquidity, so there are also differences in the level of financial assets that tend to be driven by savings. Enterprises need to find an appropriate range of financialization levels suitable for their respective industries based on their industry attributes, in order to more effectively promote the improvement of R&D innovation and avoid crowding out R&D innovation funds.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

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Conflict of interest

The authors declare there is no conflict of interest.

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