Electronic Research Archive

ERA, 31(5): 2447–2471.
DOI: 10.3934/era.2023124
Received: 19 January 2023
Revised: 14 February 2023
Accepted: 16 February 2023
Published: 02 March 2023

http://www.aimspress.com/journal/era

Research article

Enterprise financialization and R&D innovation: A case study of listed companies in China

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Abstract: In financial asset allocation, enterprises adjust their investment in R&D innovation according to their motives and the external environment. Based on a review of the literature related to enterprise financialization and R&D innovation, this paper proposes research hypotheses through theoretical analysis first; then, taking China's A-share non-financial listed companies from 2010 to 2019 as research objects, this paper explores the relationship between enterprise financialization and R&D innovation with a quantile panel data model; further, the heterogeneous relationship between the two under different business cycle phases is empirically analyzed. The following conclusions are drawn. First, there is a dynamic relationship between enterprise financialization and R&D innovation, varying with different financing constraints. Second, the dynamic relationship between enterprise financialization and R&D innovation stems from the motivation difference in enterprise asset allocation. Third, there are significant differences in the dynamic relationship at different business cycle phases.

Keywords: enterprise financialization; R&D innovation; dynamic relationship; financing constraints; business cycle

1. Introduction

There are two kinds of motivation for enterprise financial asset allocation: "precautionary" motivation and "alternative" motivation. The precautionary motivation is based on the precautionary saving theory, which was put forward by Keynes in 1936. According to this theory, enterprises should hold cash and other monetary assets to prevent capital shortages from affecting their production and

operation [1]. Demands for cash flow of enterprises in various production cycle stages are different [2,3]. In the process of enterprise running, agents can flexibly allocate financial assets out of the precautionary motivation according to the production stage, the seasonality of products and the law of business activities. Alternative motivation refers to enterprises choosing to allocate assets to those with more profits to obtain more short-term benefits and maximize agents' short-term utility. This motivation arises due to the defects of the principal-agent mechanism proposed by Berle and Means [4]. Since the principal's goal is to maximize the profit and value, while the agent's goal is to improve his or her compensation, there is a conflict of interest between the two, especially between their medium- and long-term and short-term interests [4]. As a result, the principal-agent mechanism generates the problem of information asymmetry, and then the principal's supervision of the agent will fall into a dilemma. The agent is likely to damage the principal's interests for his or her benefit. The utility maximization pursued by the principal is based on the premise of the continuous operation of the enterprise and the maximization of profits in the medium and long term. At the same time, the principal will consider corporate social responsibility [5,6]. In order to maximize their utility, agents are more likely to pursue their short-term economic benefits. Therefore, agents are more likely to allocate assets to those with higher current profit margins. Under the current market conditions, financial assets have the characteristics of strong liquidity, strong speculation and relatively high returns, so agents tend to perform more financial asset allocation and thus have the typical features of financialization [7].

In the process of financial asset allocation, agents make dynamic adjustments according to the conditions, regardless of the motivation. For precautionary motivation, agents will consider all kinds of uncertainty risks in investment decision-making [8,9]. Suppose enterprises hold financial assets for preventive purposes to diversify risks and cope with economic uncertainty. In that case, generally, they will keep the asset portfolio that includes assets measured at fair value and monetary funds. The reason for this kind of asset allocation is that these assets can cushion the potential unexpected impact on investment and trading [10]. In addition, the financial asset allocation is also conducive to avoiding the high cost of external financing. In the case of asymmetric information, the cost of external financing is often higher, so enterprises are more willing to conduct internal financing [11]. When financing constraints are relatively tight, enterprises will carry out preventive savings so that they can invest when there are investment opportunities in the future.

Moreover, operational investments such as fixed and intangible assets generally have weak liquidity, long cycles and poor reversibility, whereas financial asset investments have stronger liquidity, shorter return periods, lower adjustment costs and higher investment returns [12]. When enterprises lack funds for R&D innovation activities, they can obtain liquidity by rapidly realizing short-term financial assets, thus easing the financial pressure [13]. Holding long-term financial assets can feed back R&D innovation activities through income. The allocation of financial assets by enterprises with a precautionary motivation is equivalent to increasing the internal monetary asset reserve of enterprises, thereby providing more funds to meet future capital needs. If an enterprise holds financial assets for the alternative motive, it will compare the profit difference of different asset categories during the agency period [14,15]. According to the principal-agent relationship, the agent will use the information asymmetry mechanism to select the asset category with strong liquidity and high profit during the agency period for asset allocation [16]. As financial assets have relatively high yields and high uncertainties as well, agents will compare even different types of financial assets according to the level of external returns, and they will also adjust the allocation of financial assets and types at any time according to the dynamic characteristics of financial assets [17]. It can be seen from the above analysis

that business operators (agents) will allocate financial assets according to the degree of uncertainty faced by the enterprise, different stages, the term of the agent contract and the dynamic nature of the financial asset returns, regardless of the allocation motivation.

What's more, agents will adjust the financial asset allocation according to the uncertainty of enterprise R&D innovation itself. Enterprise R&D innovation has experimental characteristics, and the possibility of R&D innovation realization can be predicted at different experimental stages [18]. The whole process of R&D innovation involves appropriate financial asset allocation. At the beginning stage of R&D innovation, investment in R&D innovation labor and experiments is required, and the allocated assets are mainly used for the daily expenses of the R&D department and corresponding equipment [19]. In the experimental stages of R&D innovation, assets are mainly allocated to increase the expenditure on experimental equipment and materials [20]. When R&D innovation is in the later stage, it is necessary to allocate associated financial assets, such as a series of cash flows, to invest in new product projects [21]. If the R&D innovation fails, losses need to be accrued. Therefore, the demand for preparatory financial assets for R&D innovation in the business process of enterprises has dynamic characteristics, and there are very strong unbalanced characteristics in different stages. Due to various constraints on external financing and relatively high financing costs, enterprises are more inclined to internal financing due to the dynamic and unbalanced capital demand of R&D and innovation. The internal financing of enterprises is allocated through the comparison of the returns of different types of assets. When the agent, as an enterprise operator, aims to maximize the benefits of his tenure, the agent will adjust the allocation of financial assets at any time.

It can be seen from the above analysis that enterprises make asset allocation decisions according to the internal and external environment, such as uncertainty. Furthermore, the uncertainty degrees of R&D innovation at different stages and the returns of financial assets in various stages are different. Hence, the relationship between enterprise financialization behavior and investment in R&D innovation is dynamic. Moreover, since agents make rational choices, accordingly, from the evolutionary perspective of the relationship between enterprise financialization behavior and R&D innovation, agents may be more inclined to the precautionary motivation at the initial stage, making relatively more allocation for the demand of R&D innovation. However, with the gradual shortening of the agent's term of office, together with the uncertainty of R&D innovation and the change in the external economic environment, the agent will gradually adjust the allocation of R&D innovation assets to the category of financial assets with higher profits, forming a financialization behavior.

The major contribution of this paper is that this paper illustrates the relationship between enterprise financialization behavior and R&D innovation. Different from existing literature which suggests that the relationship between the two presents a certain direction, i.e., positive or negative, this paper found through empirical research that the relationship between the two is not a fixed positive or negative effect, and the relationship is strongly correlated with the level of enterprise financial asset allocation.

The rest of this paper is structured as follows: The second section elaborates on the theoretical hypothesis of the study; the third section focuses on the econometric tests of the role of financialization behavior on corporate R&D innovation. Section four further studies the role of enterprise financialization on corporate R&D innovation in the context of economic cycles, considering that enterprises make discretionary decisions. The fifth section draws the conclusion and proposes the policy implications.

2. Research hypothesis

In the process of financial asset allocation, enterprises make decisions according to the impact of R&D innovation activities, so there is a dynamic relationship between the two [22]. Enterprise R&D innovation has the characteristics of long periodicity, positive spillover effect and considerable investment scale. Therefore, enterprises will face high risk and information asymmetry when carrying out R&D innovation activities. Especially in the context that China's financial system structure is not sound enough, enterprise R&D innovation faces severe financing constraints [23]. In addition, enterprise R&D innovation is subject to severe external financing constraints due to its long-term nature and uncertainty, which makes enterprises more inclined to internal financing for R&D innovation investment [24]. Suppose an enterprise wants to use its internal assets to carry out R&D innovation activities. In that case, it will generally encounter two problems: First, the internal finance may be unstable, and R&D innovation activities may be suspended due to the collapse of the capital chain. Second, the adjustment cost of R&D innovation activities is high [25]. The enterprise will suffer heavy losses if the R&D activities are suddenly interrupted. Unstable sources of funds and high adjustment costs restrict the R&D innovation activities of enterprises. Due to the market failure and the financing constraints of asymmetric information, the investment in R&D innovation of enterprises is seriously insufficient, resulting in discretionary decision-making of enterprises, so there is no consistent strategic arrangement in the investment in R&D innovation of enterprises [26]. Therefore, the role of enterprise financialization in R&D and innovation has both positive and negative effects.

In fact, whether enterprise financialization promotes or inhibits R&D innovation is highly related to the motivation of agents' decision-making. Because China's financial industry can generate excess returns, Chinese entity enterprises have two motivations for allocating financial assets: substitution (also known as speculative arbitrage) and precautionary reserve [12,27]. On the one hand, based on the alternative motivation, financialization is driven by excess returns, and the alternative motivation has three effects on the R&D innovation of enterprises [28]. First, the available capital of enterprises is limited by financing constraints, so the investment in financial assets may reduce the resources used for the R&D innovation investment. Second, the excess return of financial assets will weaken the motivation of enterprises' R&D innovation, further promoting enterprises to occupy the limited resources invested initially in R&D innovation. Third, excessive financialization may cause asset bubbles, leading enterprises to pay more attention to short-term interests and give up the motive of long-term R&D innovation.

On the other hand, from the perspective of the precautionary motivation of allocating financial assets, the main channels through which financialization affects enterprise R&D innovation are as follows. First, allocating financial assets to reserve funds has the capital cost effect, which is based on the advantages of financial assets over cash [14]. Through appropriate asset management, financial assets can generate returns and reduce the capital cost of external financing. Reserves in the form of financial assets can help smooth the investment in R&D innovation of enterprises. Second, excess income generated by financial assets investment can promote enterprise R&D innovation and improve business performance through the income effect [29,30]. Generally speaking, if the financialization behavior of an entity enterprise is driven by alternative motives, the enterprise will allocate more limited funds to financial assets to obtain greater economic benefits. If the investment in R&D innovation is reduced under resource constraints, the enterprise's R&D innovation capability will be weakened or even inhibited eventually, which is known as the "crowding-out effect." If an enterprise's

financialization is motivated by the desire to alleviate financing constraints through capital reserves, then when the external financing environment is good, or the degree of capital constraints is low, the enterprise can invest excess funds in financial assets with a certain excess rate of return through excess financing [31,32]. This can reduce the financing cost and ease the financial constraints on innovation investment when the external funding environment is poor, thus benefiting enterprise R&D innovation to a certain extent.

To analyze the dynamic relationship between enterprise financialization and R&D innovation, it is necessary to analyze further the degree of financing constraints enterprises face and the strength of the alternative motivation. This paper argues that the impact of enterprise financialization on R&D innovation cannot be simply summed up as a "positive" promoting effect or a "negative" crowding-out effect but as a dynamic change. In terms of statistics, the degree and direction of the impact of enterprise financialization on R&D innovation vary with the level of financial asset allocation. The driving force behind this dynamic change mainly comes from the external financing environment faced by enterprises and the internal motivation of enterprise financialization. Specifically, if the enterprise financialization is out of the capital-saving motivation to improve the sustainability of the enterprise's R&D investment, the intensity of this motivation is significantly different for enterprises with varying levels of financing constraints. The allocation of financial assets to enterprises with a relatively high degree of financing constraints will inevitably reduce current investment in R&D innovation. On the contrary, enterprises with low financing constraints can invest surplus funds in financial assets, which will not reduce the current investment in R&D innovation. Instead, it will help improve the level of enterprise R&D innovation in the future. If the above logic is true, then with changes in financing constraints and financialization motivation, enterprise financialization will have a dynamic impact on R&D innovation, which is not only manifested in the gradual change of the influence degree but even in the inflection point of direction. Accordingly, we propose the following competitive hypotheses to test the dynamic impact of enterprise financialization on R&D innovation.

H1: There is a negative relationship between enterprise financialization level and R&D innovation. This implies that financialization behavior squeezes out the R&D innovation investment due to an alternative motivation. Furthermore, the stronger the alternative motivation of an enterprise is, the more significant the negative relationship between financialization and R&D innovation.

H2: The dynamic relationship between enterprise financialization level and R&D innovation is heterogeneous among enterprises with different financing constraints. For enterprises with relatively high financing constraints, we expect a significant negative relationship between the two. In contrast, for enterprises with relatively light financing constraints, we expect that there is no significant relationship between the two.

3. The econometric tests of the dynamic relationship between enterprise financialization behavior and R&D innovation

3.1. Sample selection and model setting

To investigate the dynamic relationship between enterprise financialization and R&D innovation while considering data availability, this paper selects China's A-share non-financial listed companies in 2010–2019 as the research objects. To ensure sample data continuity, listed companies in the financial industry and ST (Special Treatment) and PT (Particular Transfer) listed companies were

excluded, and enterprises with more missing data were excluded, too. The reason for excluding financial listed companies is that their main business is investment and financing, so they are significantly different from non-financial listed companies in R&D innovation investment, inconsistent with the research objectives of this paper. ST and PT companies are continuous loss-making enterprises with insufficient sustainable operation ability and do not have the general characteristics of financial asset allocation, so they are eliminated. Therefore, under the constraints of time and type, the number of enterprises in China's A-share listed companies that meet the criteria for the study sample is 1221.

This research aims to analyze the dynamic relationship between enterprise financialization and R&D innovation, so the causal relationship is not discussed in detail. The models that describe the dynamic relationship include the variable parameter state space model and the DCC-GARCH model. The former model focuses on the change of the relationship between variables over time, and it is more suitable for the case of limited space units. Since the spatial units involved in this paper are 1221 samples, the variable parameter state space model is unsuitable in this case because such large-scale spatial samples will consume more degrees of freedom in the parameter estimation process and thus cannot obtain effective parameter estimation. Accordingly, the variable parameters of this type of model cannot capture the dynamic characteristics. A typical DCC-GARCH model mainly reflects the dynamic relationship between different time series, and its parameter estimation method is not suitable for data with spatial characteristics. From the perspective of the research objectives, it is necessary to study the change in R&D innovation level when the level of financialization changes, and the quantile regression model can examine the dynamic relationship between the two at different quantiles, so this paper adopts the quantile regression model to explore the dynamic relationship between the two, taking the level of enterprise financialization as the explained variable and the level of enterprise R&D innovation as the explanatory variable. Other control variables are included for modeling. The specific model setting is as follows:

$$Q_{Fin_{it}}(\tau|Rd_{it}, CFO_{it}, X_{it}) = \alpha + \beta_1(\tau)Rd_{it} + \beta_2(\tau)X_{it} \tag{1}$$

In Eq (1), the subscripts *i* and *t* denote the enterprise and the year, respectively; *Fin* represents the enterprise financialization level; *Rd* represents the enterprise R&D innovation level; *X* represents control variables. The specific variables are described in Table 1.

3.2. Variable selection and data sources

After setting the model, it is necessary to explain the measurement and data sources for each variable in the model.

There are many methods to measure the enterprise financialization indicator *Fin*. Based on the calculation and robustness analysis of various indicators, referring to the method of Demir (2009), the paper uses the ratio of financial assets to total assets at the end of the period to measure the enterprise financialization level [33]. Among them, financial assets include trading financial assets, investment real estate, long-term financial equity investment, entrusted financial management and trust products [34].

This paper uses the proportion of net intangible assets in total assets to measure the enterprise R&D innovation *Rd*. Unlike most research which employs R&D expenditure to measure enterprise R&D innovation, this paper adopts the proportion of net intangible assets in total assets for the

following reasons. First, intangible assets, as the result of enterprise R&D innovation investment, can comprehensively reflect enterprise R&D innovation activities. Second, the R&D and innovation activities of enterprises cover a wide range. The R&D expenditure only measures the costs of the enterprise R&D and innovation. Still, the patent rights, copyrights and trademark rights generated from the output of the enterprise's business process are not included, so the R&D expenditure cannot comprehensively reflect the R&D and innovation activities of enterprises. Third, from the perspective of data availability, there is little disclosure of the R&D expenditure in China's non-financial listed companies [35].

In addition, the paper also introduces relevant control variables to control the impact of other corporate characteristics on the level of financialization. As many factors affect the level of enterprise financialization, according to relevant theories and existing empirical studies [36–39], this paper considers adding other variables that affect the level of financialization in the modeling process. Since the model is to examine the dynamic relationship between different levels of financialization and R&D innovation, the explained variable is set as the level of financialization, and the relevant variables of the influencing factors of financialization are selected as the corresponding control variables, that is, it is necessary to assume that other factors affecting financialization remain unchanged while analyzing the dynamic relationship. Combined with the characteristics of listed companies in China and the influencing factors of the level of financialization, this paper introduces seven control variables: CFO (net cash flow of operation), Lnsize (company size), Fixed (enterprise capital intensity), Lnage (enterprise age), ROA (net profit rate of enterprise operation), Lev (enterprise capital structure) and Shrcr (equity concentration degree). The specific variable descriptions are shown in Table 1.

Table 1. Variable descriptions.

Variable type	Variable name	Variable	Measure
Explained variable	Enterprise financialization	Fin	The ratio of the financial assets to the total assets at the end of the period.
Explanatory variable	Enterprise R&D innovation	Inno	The proportion of net intangible assets in total assets.
Control variable	Net cash flow of operation	CFO	The ratio of net cash flow from operating activities to total assets at the end of the period.
	Enterprise size	Lnsize	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	Take the natural log of the current year minus the company's registration year plus 1.
	The net profit rate of enterprise operation	Roa	The ratio of the net profit to the total assets at the end of the period.
	Enterprise capital structure	Lev	The ratio of total liabilities to total assets at the end of the period.
	Equity concentration	Shrcr	The sum of the shareholding ratios of the top ten shareholders.

The distribution of each variable in the model has a significant impact on the results of the econometric test. Therefore, descriptive statistical analysis of each variable in the model is required beforehand. Considering that the level of enterprise financialization is strongly correlated with the enterprise financing constraints, the whole sample is divided into two sub-samples according to the strength of enterprise financing constraints when conducting the descriptive statistics of each variable involved in the model, and the related variables are further analyzed by descriptive analysis. Therefore, based on the variables in Table 1, the basic characteristics of the data from 2010 to 2019 of 1221 sample companies are calculated. The descriptive statistics are shown in Table 2.

Table 2. Descriptive statistics of variables.

Variable	Sample	Observed value	Mean	Standard deviation	Minimum	Maximum
Fin	Full sample	12,210	0.1036	0.1298	1.48E-06	0.9070
	High financing constraints	6105	0.1108	0.1367	2.55E-06	0.8997
	Low financing constraints	6105	0.0964	0.1221	1.48E-06	0.9070
Rd	Full sample	12,210	0.0481	0.0673	0	0.8153
	High financing constraints	6105	0.0452	0.0499	0	0.6827
	Low financing constraints	6105	0.0511	0.0809	0	0.8153
CFO	Full sample	12,210	0.0454	0.0721	-0.5655	0.5526
	High financing constraints	6105	0.0432	0.0734	-0.5655	0.5526
	Low financing constraints	6105	0.0477	0.0708	-0.4023	0.4886
Lnsize	Full sample	12,210	22.5514	1.3566	19.0251	28.6365
	High financing constraints	6105	21.4935	0.5977	19.0251	22.3735
	Low financing constraints	6105	23.6092	1.0418	22.3736	28.6365
Fixed	Full sample	12,210	0.2201	0.1737	0.0002	0.9709
	High financing constraints	6105	0.2039	0.1458	0.0002	0.9709
	Low financing constraints	6105	0.2363	0.1963	0.0002	0.9542
Lnage	Full sample	12,210	2.9163	0.3169	0	4.2485
	High financing constraints	6105	2.8668	0.3118	0	4.2047
	Low financing constraints	6105	2.9657	0.3143	1.0986	4.2485
Lev	Full sample	12,210	0.4634	0.2152	0.0071	5.6808
	High financing constraints	6105	0.3732	0.2117	0.0071	5.6808
	Low financing constraints	6105	0.5536	0.1776	0.0075	2.2901
Roa	Full sample	12,210	0.0364	0.1055	-7.7001	0.4690
	High financing constraints	6105	0.0354	0.1375	-7.7001	0.4690
	Low financing constraints	6105	0.0374	0.0581	-2.0710	0.38400
Shrcr	Full sample	12,210	56.1158	15.6887	11.1900	100.0100
	High financing constraints	6105	52.9209	14.7383	11.1900	100.0100
	Low financing constraints	6105	59.3106	15.9586	13.2800	98.5850

Note: The division of financing constraints: enterprise size is used as the proxy variable of financing constraints to measure the intensity of financing constraints. Small enterprise size indicates high financing constraints. Otherwise, the financing constraint is low. The full sample is divided according to the median of the enterprise size. After ranking the sample enterprise sizes from small to large, the top 50% of enterprises belong to the high financing constraint sub-sample, and the last 50% belong to the low financing constraint sub-sample.

As shown in Table 2, each variable has no singular value, and each variable has significant

differences in the sub-samples with different financing constraints. First, in the full sample, the minimum value of financialization is 0.0000, the maximum value is 0.9070, and the mean is 0.1298, indicating that the overall degree of financialization is not high. The minimum value of enterprise R&D innovation is 0.0000, the maximum value is 0.8153, and the mean is 0.0673, which shows that the level of enterprise R&D innovation is not high on average either. Second, there are differences in the level of financialization and R&D innovation among enterprises with different financing constraints. The mean value of the enterprise financialization level in the low financing constraints sub-sample is 0.0964, lower than that of the full sample, while the mean value of the enterprise financialization level of the high financing constraints sub-sample is 0.1108, higher than that of the full sample. The mean value of the enterprise R&D innovation of the low financing constraints sub-sample is 0.0511, higher than that of the full sample. In contrast, the mean value of the enterprise R&D innovation of the high financing constraints sub-sample is 0.0451, lower than that of the full sample.

3.3. The dynamic relationship between enterprise financialization and R&D innovation

To investigate the dynamic relationship between enterprise financialization level and enterprise R&D innovation, it is necessary to estimate each parameter of Model 1. Since this section focuses on the dynamic relationship between enterprise financialization level and enterprise R&D innovation as a whole, we choose the full sample data. As for the selection of the parameter estimation method, we use the least squares method, considering that it meets the good criteria of parameter estimation. The parameter estimation results can dynamically reflect the dynamic relationship between enterprise financialization level and enterprise R&D innovation, in which the dynamic results are sorted by quantile regression from 10% to 90%. The specific results are shown in Table 3.

Table 3 shows that the higher the enterprise financialization level is, the more significant the crowd-out effect of financialization on R&D output. From the perspective of significance, financialization has a negative impact on enterprise R&D innovation only after the level of financialization increases to a certain extent. Table 3 indicates that when the financialization level is low (at 10% to 40% quantile), the relationship between R&D innovation and financialization level is not significant; but when the financialization level is high (at the 50% quantile and above), the negative relationship between the two is very significant. From the perspective of the impact degree, no matter whether there is a significant correlation between the two, with the improvement of the financialization level, the negative impact gradually increases.

The conclusions drawn from Table 3 can be explained from the perspective of enterprise motivation for asset allocation. When the level of enterprise financialization is low, enterprises allocate relatively few financial assets, and the allocation motivation is more to deal with corporate liquidity. Accordingly, enterprises will allocate financial assets according to their strategic plans, so there is almost no crowding-out effect on enterprise R&D innovation funds. In this case, although there is no crowding-out effect on the investment in R&D innovation, whether an enterprise will invest in R&D and innovation depends on its planning and needs. Therefore, the level of financialization is not closely related to R&D and innovation at this stage. When the enterprise financialization level is high, the investment in financial asset increases, and the enterprise has the alternative motive demand, which will form a crowding-out effect on the enterprise R&D and innovation funds, thus restricting the implementation of enterprise strategic planning and reducing the motivation of enterprise R&D and innovation. Therefore, the level of financialization will have a crowding-out effect on enterprise R&D and innovation. Hypothesis 1 is verified.

Table 3. Quantile regression results of the dynamic relationship.

	10th Fin	20th Fin	30th Fin	40th Fin	50th Fin	60th Fin	70th Fin	80th Fin	90th Fin
Rd	-0.1060	-0.1250	-0.1400	-0.1570	-0.1780**	-0.2010***	-0.2270***	-0.2530***	-0.2850***
	(-0.76)	(-1.03)	(-1.32)	(-1.73)	(-2.38)	(-3.09)	(-3.37)	(-3.08)	(-2.59)
CFO	-0.0054	-0.0002	0.0039	0.0087	0.0146	0.0210	0.0281	0.0353	0.0442
	(-0.08)	(-0.00)	(0.08)	(0.21)	(0.42)	(0.7)	(0.9)	(0.93)	(0.87)
Lnsize	-0.0087	-0.0093	-0.0098	-0.0104	-0.0112	-0.0120**	-0.0129**	-0.0138**	-0.0149
	(-0.77)	(-0.97)	(-1.16)	(-1.44)	(-1.87)	(-2.30)	(-2.40)	(-2.10)	(-1.69)
Fixed	-0.0601	-0.0733	-0.0836*	-0.0956**	-0.1100***	-0.1270***	-0.1450***	-0.1630***	-0.1850***
	(-1.23)	(-1.74)	(-2.26)	(-3.02)	(-4.23)	(-5.57)	(-6.16)	(-5.69)	(-4.82)
Lnage	0.0778	0.0777	0.0777	0.0776**	0.0775**	0.0774***	0.0773***	0.0772**	0.0771
	(1.33)	(1.55)	(1.76)	(2.06)	(2.49)	(2.86)	(2.76)	(2.26)	(1.68)
Lev	-0.0394	-0.0474	-0.0536	-0.0609**	-0.0700***	-0.0799***	-0.0908***	-0.1020***	-0.1150***
	(-0.86)	(-1.20)	(-1.55)	(-2.05)	(-2.85)	(-3.75)	(-4.12)	(-3.79)	(-3.20)
Roa	-0.0233	-0.0278	-0.0314	-0.0355	-0.0405	-0.0461**	-0.0522**	-0.0585**	-0.0662
	(-0.46)	(-0.64)	(-0.82)	(-1.09)	(-1.51)	(-1.98)	(-2.17)	(-1.99)	(-1.68)
Shrcr	-0.0010	-0.0010**	-0.0010**	-0.0010***	-0.0010***	-0.0010***	-0.0010***	-0.0010***	-0.0010**
	(-1.95)	(-2.27)	(-2.57)	(-3.01)	(-3.63)	(-4.17)	(-4.02)	(-3.29)	(-2.44)
N	12210	12210	12210	12210	12210	12210	12210	12210	12210

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

In the process of asset allocation, enterprises will make decisions according to their financing constraints. Therefore, in order to further analyze the dynamic relationship between financialization level and R&D innovation in the context of financing constraints, the full sample is divided into two sub-samples with high and low financing constraints. The panel quantile model is used again, and the least squares method is also adopted in the parameter estimation. The obtained parameter estimation results are shown in Table 4.

Table 4. Panel quantile regression results of sub-samples under different financing constraints.

	Financing constraints	Rd	Control variable	Time fixed effect	N
10^{th} Fin	High	0.0000(-1.25)	yes	yes	6105
	Low	-0.2030(-0.91)			
20^{th} Fin	High	-0.1560(-1.72)	yes	yes	6105
	Low	-0.2170(-1.23)			
30^{th} Fin	High	-0.1660**(-2.08)	yes	yes	6105
	Low	-0.2280(-1.48)			
40^{th} Fin	High	-0.1770**(-2.26)	yes	yes	6105
	Low	-0.2410(-1.57)			
50^{th} Fin	High	-0.1910**(-2.07)	yes	yes	6105
	Low	-0.2570(-1.37)			
60^{th} Fin	High	-0.2070(-1.70)	yes	yes	6105
	Low	-0.2730(-1.11)			
70^{th} Fin	High	-0.2240(-1.40)	yes	yes	6105
	Low	-0.2900(-0.91)			
80^{th} Fin	High	-0.2390(-1.21)	yes	yes	6105
	Low	-0.3070(-0.77)			
90^{th} Fin	High	-0.2600(-1.04)	yes	yes	6105
	Low	-0.3280(-0.66)			

Note: t values are in parentheses; ** indicates the significance level of 5%.

Table 4 shows that under different financing constraints, the dynamic relationship between enterprise financialization level and R&D innovation varies greatly. Although there is a negative relationship between the two at different quantiles under different financing constraints, when enterprises face high financing constraints, the financialization level is around the 50% quantile, presenting a degree of inverted U-shaped state, and the negative significance degree between the two is the highest. When enterprises face low financing constraints, the negative relationship between the two is not significant.

The above conclusions are closely related to the capital adequacy of enterprises. For enterprises with a low degree of financing constraints, their funds are relatively abundant. When enterprises have different business needs for funds, agents can finance from internal or external sources relatively easily and at a fairly consistent cost to meet the needs of different businesses for funds. From the perspective of agent operation, when enterprises face low financing constraints, they can easily satisfy the capital demand. At this time, when agents conduct enterprise asset allocation, according to the law that market returns tend to be average, there is no significant difference in the returns obtained by various assets. That is, the alternative level between different asset categories is relatively high, and the agent's

alternative motivation is relatively weak. Accordingly, there is no significant negative relationship between enterprise financialization level and R&D innovation. The empirical results also show that the dynamic relationship between financialization and R&D innovation is not significant in enterprises with a financialization degree ranging from 10% to 90%.

For enterprises with a high degree of financing constraints, the financing cost is relatively high, and the demand for funds in strategic need depends more on the optimal allocation of their assets. When agents face significant differences in the returns of different types of assets, their alternative motivation in asset allocation is strong, leading to significant differences in decision-making mechanisms. When the financialization level is at the low quantile, the correlation between the financialization level and R&D innovation is not strong as the financial assets allocation is geared towards meeting the demand for working capital. When the financialization level is around the 50% quantile, the agents' alternative motivation is gradually strengthened when allocating assets due to financing constraints, leading to financial assets being relatively more profitable. With the gradual enhancement of substitution motivation in the process of asset allocation, the squeezed-out assets are more likely to be allocated to financial assets with strong liquidity and high yield, while the fund demand for R&D innovation belongs to the asset category with long-term and strong uncertainty. Therefore, the enterprise financialization level has a significant crowding-out effect on enterprise R&D innovation, presenting a significant negative relationship in parameter estimation results. In the process of asset allocation, enterprises have a certain proportion of R&D innovation assets. When external financing constraints are high, the returns of financial assets are relatively high. However, when the ratio of R&D innovation assets in the whole asset allocation is very low, the R&D innovation funds cannot be squeezed out in the asset allocation. Therefore, when the financialization level is at the high quantile, the parameter estimation results show no significant relationship between the enterprise financialization level and R&D innovation investment.

4. Dynamic relationship between enterprise financialization and R&D innovation at different business cycle phases

4.1. Theories of business cycle division and its impact on enterprise behavior

The business cycle is an inevitable phenomenon in economic operation, characterized by the recurrence of a particular state or phase after a certain period. Different scholars have different theoretical bases for the division of the phases, leading to no unified standard for the division of the business cycle. One division standard is the dichotomy, which regards economic activities as a regular expansion and contraction process. The repeated alternations of contraction and expansion of economic activities form a business cycle. Scholars who hold this view divide the business cycle into two phases: the expansion phase and the contraction phase. Another dividing standard is the quartering method, which divides the business cycle into four phases: expansion, recession, contraction and recovery. The above two divisions are essentially dependent on the actual business cycle theory. Burns & Mitchell define the business cycle as a form of macroeconomic fluctuation [40]. This kind of fluctuation shows that many economic variables enter the four phases in the alternate cycle at a similar pace, and any business cycle will not be a simple repetition of the previous cycle. Each business cycle shows differences in amplitude, scope and duration. In the quadrant, expansion and contraction can be regarded as the main stages of the business cycle, while recession and recovery are the transitional

phases of the business cycle. Therefore, in the process of dividing the business cycle, the recovery phase and the expansion phase can be regarded as the economic expansion phase divided by the dichotomy method; the recession and depression phases can be regarded as the economic contraction phase divided by the dichotomy method.

Since the economic system has the function of self-regulation, it is in a dynamic equilibrium state of expansion and contraction. The alternation of economic expansion and contraction mainly depends on the fluctuation of the aggregate social demand and the aggregate social supply in the overall economy [41–43]. In the short term, the fluctuation of the business cycle is mainly determined by the change in economic and social demand, including the shortage of goods supply and the aggregate demand greater than the aggregate supply. The aggregate social demand can also be divided into the investment demand and the consumption demand, and the two affect each other, leading to cyclical fluctuations. On the one hand, fluctuations in investment demand will lead to cyclical fluctuations. In the case of low consumption, the fluctuation of the investment demand determines the fluctuation of the aggregate social demand. In this case, local governments and enterprises tend to expand production by increasing investment, and the multiplier effect of investment can rapidly increase national income and push the economy into an expansion phase. In the case of insufficient or unbalanced resources, national income growth will slow down, and investment will also decline. Under the multiplier effect, national income will decrease rapidly. According to the acceleration principle, the investment will be further reduced, which is why the economy enters a contraction phase.

On the other hand, social demand also leads to cyclical business fluctuations. When investment is insufficient, the fluctuation of the aggregate social demand will depend on the fluctuation of the consumption demand. When the economy is in the growth stage, consumption can effectively promote economic growth, prolong economic prosperity and curb economic recession. Generally speaking, if consumption falls, economic growth tends to slow down. If consumption increases, economic growth will also increase, and changes in consumption and economic cycles have a certain degree of synchronicity. When the economy is in the contraction phase, economic development is insufficient. It is necessary to stimulate consumption, increase consumption demand and promote economic recovery. In addition, consumption can also influence the fluctuation characteristics of the business cycle through investment demand. In the long run, the fluctuation of the business cycle is mainly determined by the fluctuation of the aggregate social supply, because the aggregate social demand tends to be stable under certain conditions, and the aggregate supply affects the fluctuation of the economy.

Changes in the aggregate supply of the whole society are mainly due to technological progress. Technological progress is highly correlated with business cycle fluctuations and has a long-term impact on the evolution of the business cycle. As the business cycle changes from contraction to expansion, major inventions and major scientific and technological innovations increase productivity through three important factors affecting productivity, making them the driving force of economic growth. Therefore, technological progress is a vital accelerator in economic expansion. According to the above analysis, the theory of the real business cycle emphasizes that technology shock is a major factor of economic fluctuation and always affects the characteristics of business cycle changes.

There are differences in the financialization behavior of enterprises during different business cycle phases. In the phase of economic expansion, due to the financial accelerator effect mechanism, an increase of enterprise net value reduces the financing constraints so that enterprises can expand capital regeneration. At the same time, during the expansion phase, the aggregate social demand is strong. To meet the increase in product market demand, enterprises will use surplus funds for physical

investment to expand production and enterprise scale. In the process of continuous growth of enterprise income, the income of real enterprises is greater than that of financial earnings. At this time, economic uncertainty is small, and the business risks faced by enterprises are also low. Enterprises allocate financial assets out of precautionary financialization motives to prevent future risks instead of engaging in excessive financialization, because the investment in financial assets in this context will hinder the future development of the enterprise.

When the economy is in a state of contraction, the aggregate demand of the whole society shrinks sharply, the competition in the commodity market intensifies, and the operating returns of real enterprises continue to decline. Through financial allocation out of the alternative motive, enterprises' investment in financial assets with higher returns helps improve their operating performance and maximizes agents' short-term income. In addition, the financial accelerator theory suggests that the decrease in the net worth of enterprises in the phase of economic contraction will increase the financing constraints of enterprises, and the degree of financing constraints will be greater than that in the economic expansion so that enterprises will face the shortage of funds [44–46]. In this context, the business and market risks enterprises face will rise sharply. In order to diversify the risks, enterprises invest in financial assets with high liquidity out of the alternative motive to reduce adjustment costs. Through such asset allocation, enterprises can mitigate the adverse impact of the external environment to some extent.

The R&D innovation activities of enterprises are counter-cyclical. According to Schumpeter's innovation theory, the marginal cost of enterprise innovation is the lowest in the recession, so enterprises are more willing to implement R&D and innovation activities during the recession [47–50]. During the period of economic contraction, innovation activities can creatively destroy the depressed economy through the destructive innovation process, improve the efficiency of production factors, promote economic recovery and ensure the future profitability of enterprises. Based on the opportunity cost hypothesis, enterprise investment mainly depends on the selection of the proportion of productive investment and R&D innovation investment. With the continuous improvement of capital accumulation, the marginal opportunity cost of enterprise R&D innovation continues to decline. The relatively low opportunity cost will promote enterprises to carry out R&D innovation in the contraction phase, forming a cross-phase substitution for productive investment. Therefore, it is believed that enterprise R&D innovation presents the characteristics of the counter cycle.

According to the relative ratio of costs and benefits, the investment in R&D and innovation of enterprises is discontinuous. Because the relative ratio of marginal benefits between the productive investment and the R&D innovation investment will change, enterprises will weigh the benefits between the two types before investment, and the funds will be allocated to the side with higher benefits. In the initial stage, all funds are invested in general investment (capital accumulation). However, due to the law of diminishing marginal returns, the marginal returns of capital accumulation gradually decreased to a lower level than that of R&D innovation activities. Hence, the enterprise enters the second stage and uses all funds for R&D and innovation activities. New technology emerges with R&D and innovation activities, improving total factor productivity from a technical level and further improving the marginal income of general investment to a higher level. As a result, the enterprise enters the third stage, where all funds are used for general production investment under new technology.

It can be concluded that there is a reverse correlation between innovation activities and the business cycle. Enterprises will choose to carry out R&D innovation only when the personnel cost of R&D innovation is lower than the potential income, and this relative ratio change usually occurs in the

economic contraction phase. Therefore, enterprise R&D innovation activities are negatively correlated with the business cycle. From the perspective of the balance between short-term and long-term returns, in the three-overlapping-generation model [44], long-term returns are not affected by the current shocks, while short-term returns are significantly affected by the current fluctuations. Based on the rational man hypothesis, when facing the negative impact of the macro environment, enterprises will choose the long-term return, that is, investing in R&D innovation activities. Based on the above theoretical analysis, the R&D innovation activities of enterprises often undergo counter-cyclical adjustment with the business cycle.

Based on the above analysis, it can be found that there are significant differences in the characteristics of enterprise financialization behavior and R&D innovation activities in different phases of the business cycle. Therefore, the relationship between the two in different phases of the business cycle will show asymmetry.

4.2. Dynamic relationship model construction and data preprocessing considering cycle phases

When enterprises face different phases of the business cycle, agents have different allocation decisions. To further analyze the dynamic relationship between the level of enterprise financialization and R&D innovation, it is necessary to include the business cycle factors in the model. Considering that in the process of asset allocation, agents will make decisions according to the phase of the business cycle, enterprise financialization and the business cycle are not independent of each other. Accordingly, the interaction term of the enterprise financialization level and the business cycle is added to the model variables, and the dynamic changes of the parameters of the interaction term are investigated. Since the dynamic changes of the same phase (such as expansion or contraction) in the business cycle can be obtained from the previous section, this section focuses on the dynamic relationship between financialization and R&D innovation in the same business cycle but at different phases of the cycle. According to the research objectives, this paper takes R&D innovation as the explanatory variable in the set panel data model, adding the business cycle variable when studying the dynamic relationship between the level of financialization and enterprise R&D innovation. In order to describe the impact of financialization under the business cycle, the interaction term of the two is also added to the explanatory variable. We continue to use the panel data model to keep the time and space of the research samples consistent. The specific equation of the model is as follows:

$$Rd_{it} = \beta_0 + \beta_1 BC_{it} + \beta_2 BC \times Fin_{it} + \sum \alpha_i X_{it} + I_i + T_t + \varepsilon_{it} \tag{2}$$

In Eq (2), *BC* represents the business cycle, *I* represents the individual effect, and *T* represents the time effect. The meanings of other symbols are completely consistent with the connotations of the formulas mentioned above. In the model, the Hodrick Prescott filter method is used to extract the cyclical component of GDP to measure the business cycle. *BC* greater than 0 indicates the phase of economic expansion (DBC = 0), and *BC* less than 0 indicates the phase of economic contraction (DBC = 1).

According to the preceding econometric test, there is a dynamic relationship between the level of enterprise financialization and R&D innovation, which has nonlinear characteristics. In order to capture the nonlinear characteristics under the potential background of different cycle phases, the paper uses the panel smooth transition regression (PSTR) model to describe its nonlinear characteristics. The basic two-regime PSTR model is set as shown in Eq (3):

$$y_{it} = \mu_i + \beta_0^{'} x_{it} + \beta_1^{'} x_{it} \times G(q_{it}; \gamma, c) + \varepsilon_{it} \tag{3}$$

In Eq (3), i = 1, 2, ..., N, and t = 1, 2, ..., T. N and T represent the total number of individuals and periods, respectively. ($q_{it;}$ γ, c) represents a transition equation, which is a continuous value between 0 and 1, where q_{it} is the transition variable (BC). x_{it} represents k-dimensional exogenous variables, including the control variables in Eq (2); μ_i and ε_{it} represent the individual fixed effect and the random error, respectively.

Referring to Granger & Terasvirta [51] and Gonzalez & Dijk [52], we consider the logistic transition function:

$$G(q_{it}; \gamma, c) = \left(1 + exp\left(-\gamma \prod_{j=1}^{m} (q_{it} - c_j) \right) \right)^{-1} \tag{4}$$

In Eq (4), c= (c_1, …, c_m) ^{t} represents the m-dimensional position parameter vector of the transition equation, and the slope parameter γ represents the smoothness of the transition equation, that is, the conversion rate from one regime to another. The parameters c and γ strictly follow $c_1 \leq c_2 \leq \ldots \leq c_m$, $\gamma > 0$.

To realize the model, each variable is required to be stable. We use the Levin-Lin-Chu (LLC) and the Fisher-Augmented Dickey-Fuller (Fisher-ADF) methods to test the stationarity of variables. The test results are shown in Table 5.

Table 5. Unit root test results.

Variable	LLC	ADF
Rd	-0.5673***	80.0420***
Fin	-0.4103***	9.7556***
CFO	-0.9481***	60.2260***
Lnsize	-0.2512***	25.5542***
Fixed	-0.5482***	64.7842***
Lnage	-0.0398***	1002.2347***
Lev	-0.4325***	29.6382***
Roa	-0.5765***	22.4066***
shrcr	-0.5534***	28.9986***

Note: *** indicates the significance level of 1%.

Table 5 shows that all variables involved in the model are stable. Both LLC and ADF statistics have passed the significance test, indicating that all variables involved in the model are stable, and this stationarity is robust. The model set can be used to analyze the dynamic relationship between enterprise financialization behavior and R&D innovation at different cycle phases.

4.3. Empirical analysis of the dynamic relationship at different cycle phases

In this section, we estimate the parameters in Eqs (2)–(4) and analyze the dynamic relationship between financialization and R&D innovation at different business cycle phases. Nonlinear tests and

other results are not presented in this section since the research objective is focused on the dynamic relationship. The least squares method is also used to estimate model parameters, and the estimation results are shown in Table 6.

Table 6. Dynamic relationship at different business cycle phases.

	(1) Full sample	(2) DBC = 0	(3) DBC = 1
	Rd	Rd	Rd
BC	-0.1630**	0.5790*	-0.2320***
	(-2.33)	(1.94)	(-2.60)
BC*Fin	0.0027	-1.1360***	0.4030**
	(0.03)	(-3.80)	(2.57)
CFO	0.0152***	0.0136**	0.0094
	(3.4)	(2.06)	(1.41)
Lnsize	0.0034***	0.0040***	0.0040***
	(4.28)	(3.18)	(3.44)
Fixed	0.0177***	0.0091	0.0221***
	(4.51)	(1.58)	(3.74)
Lnage	0.0124**	0.0139	0.0143**
	(2.5)	(1.63)	(2.28)
Lev	0.0074**	-0.0006	0.0149***
	(2.34)	(-0.12)	(3.27)
Roa	-0.0018	-0.0005	0.0034
	(-0.52)	(-0.05)	(0.76)
Shrcr	-0.0001**	-0.0001	-0.0001***
	(-2.32)	(-1.61)	(-2.69)
Constant term	-0.0745***	-0.0860*	-0.0947***
	(-3.13)	(-2.21)	(-2.88)
Individual fixed effect	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes
N	12210	6105	6105

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

Table 6 reveals significant differences in the relationship between the financialization level of enterprises and R&D innovation at different phases of the business cycle. Column (1) in Table 6 shows that the coefficient regression result of *BC*Fin* in the full-sample is not significant after the interaction term between the financialization and the business cycle is included. Column (2) shows the regression results at the economic expansion phase. The coefficient of *BC*Fin* is significantly negative under the condition of 1%, indicating that when the business cycle is in the expansion stage, financialization has a negative regulating effect on enterprise R&D innovation. Column (3) presents the regression results at the economic contraction phase. The coefficient of *BC*Fin* is significantly positive under the condition of 5%, which indicates that financialization has a positive regulating effect on enterprise R&D innovation when the business cycle is in the contraction phase.

Based on the above analysis, we conclude that the financial asset allocation of enterprises is carried out in response to the business cycle, which has an opposite effect on the direction of R&D

innovation. We can analyze the result from the perspective of the asset allocation behavior of enterprises. In the economic expansion phase, financial assets have relatively high returns, and enterprises tend to allocate more financial assets. Meanwhile, during this phase, enterprises obtain relatively low returns from R&D and innovation investment. Under the principal-agent mechanism design, agents have stronger alternative asset allocation motivation, so they allocate more financial assets. As a result, enterprises have insufficient investments in R&D innovation, and enterprise financialization has a more significant crowding-out effect on R&D innovation. On the contrary, in the phase of economic contraction, enterprises have fewer financing and investment opportunities. In order to survive and develop, enterprises need to obtain sufficient market competitiveness through R&D and innovation. At the same time, the opportunity cost of R&D innovation is relatively low at this phase, so enterprises will allocate more assets to R&D innovation. Before the economic recession, the financial assets and earnings of enterprises with a high level of financialization provided a certain fund foundation for R&D innovation. Therefore, during this phase, financialization can promote the R&D innovation of enterprises.

Different phases of the business cycle also have opposite effects on the direction of R&D innovation, but the degree of significance varies. Business cycle expansion has a positive impact on R&D innovation, while business cycle contraction has a negative effect on R&D innovation. However, the above positive and negative interaction degrees are smaller than the interaction degree between the cycle and the financialization. Therefore, there is a significant difference in the relationship between the level of enterprise financialization and R&D innovation in different phases of the business cycle. The conclusion that the influence direction presents a reverse relationship is robust.

The action directions of control variables in different cycle phases are further compared. Among the seven control variables selected, except for the two control variables of net profit rate of enterprise operation (*ROA*) and enterprise capital structure (*Lev*), the direction of other indicators in different cycle phases is opposite. Although the estimated results of the two control variables of *ROA* and *Lev* have the opposite impact direction, only on one condition (at the contraction stage of the business cycle) can enterprise capital structure pass the significance test after the parameter estimation. Based on further analysis of the control variables, the interactive term of financialization and business cycle fully captures the dynamic behavior between enterprise financialization and R&D innovation at different phases of the business cycle.

In the process of asset allocation, enterprises consider not only the business cycle phases but also the financing constraints they face. Therefore, this paper adopts the sub-samples grouped according to the financing constraints degree and estimates parameters in Eqs (2)–(4). The parameter estimation results are shown in Table 7.

Table 7 shows significant differences in the dynamic relationship between enterprise financialization and R&D innovation when the cycle stages of the business cycle and financing constraints are different. It can be seen from Table 7 that in the economic expansion phase, the impact of financialization on enterprise R&D innovation is not heterogeneous between enterprises with high financing constraints and enterprises with low financing constraints, both of which have a negative regulating effect. However, in the economic contraction phase, enterprise financialization with low financing constraints has no significant relationship with enterprise R&D innovation, while the financialization of enterprises with high financing constraints has a positive relationship with enterprise R&D innovation.

Table 7. Dynamic relationships under different financing constraints in different business cycle phases.

	High financing constraints		Low financing constraints	
	(1) DBC = 0	(2) DBC = 1	(3) DBC = 0	(4) DBC = 1
	Rd	Rd	Rd	Rd
BC	0.9092	-0.0546	0.3352	-0.2222**
	(1.58)	(-0.28)	(0.87)	(-1.99)
BC*Fin	-0.9560**	0.1209	-1.3501***	0.5736***
	(-2.54)	(0.47)	(-2.83)	(2.67)
CFO	0.0004	0.0125	0.0205**	0.0042
	(0.04)	(1.03)	(2.25)	(0.55)
Lnsize	0.0074***	0.0017	0.0029	0.0026
	(2.73)	(0.62)	(1.38)	(1.47)
Fixed	0.0470***	0.0466***	-0.0065	0.0025
	(5.18)	(4.38)	(-0.75)	(0.33)
Lnage	0.0207	0.0080	0.0050	0.0143*
	(1.18)	(0.53)	(0.48)	(1.86)
Lev	0.0048	0.0181**	-0.0146*	-0.0035
	(0.65)	(2.38)	(-1.89)	(-0.55)
Roa	0.0352***	0.0110*	-0.0632***	-0.0274***
	(3.49)	(1.70)	(-4.10)	(-2.88)
Shrcr	-0.0002*	-0.0001	-0.0000	0.0001
	(-1.93)	(-0.53)	(-0.15)	(0.70)
Constant term	-0.1878**	-0.0326	-0.0232	-0.0599***
	(-2.44)	(-0.44)	(-0.39)	(-1.25)
Individual fixed effect	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
N	2590	2055	3515	4050

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

Similar to the above analysis, the impact of the business cycle on R&D innovation is examined separately. After the inclusion of financing constraints, when the economy is in the expansion stage of the business cycle, no matter under high or low financing constraints, the impact of the business cycle on R&D innovation is positive, but it cannot pass the significance test. When the economy is in the stage of economic contraction, the impact of the business cycle on R&D innovation is negative, but it passes the significance test when the financing constraint is low. Compared with the coefficient of the interaction term, its significance has changed, indicating financialization has an impact on R&D innovation when the agents allocate financial assets.

The above significant differences are explained as follows. In the phase of economic contraction, for enterprises with high financing constraints, the demand for funds is more intense, and the assets available for free disposal by the principal are very limited. No matter what the financialization level is, it is difficult for the agent to allocate funds for R&D innovation. Therefore, there is no significant correlation between the financialization level of enterprises and R&D innovation. For enterprises with low financing constraints, internal and external financing is relatively easy, and the reserved financial

assets can provide a certain financial basis for R&D and innovation. Therefore, during this phase, financialization can promote the R&D and innovation of enterprises.

5. Conclusions and policy implications

5.1. Main conclusions

This paper adopts a panel quantile model to study the dynamic relationship between enterprise financialization level and R&D innovation. At the same time, considering the impact of the business cycle, the dynamic relationship at different phases of the business cycle is analyzed by introducing the interaction term. The study yields the following conclusions.

First, the dynamic relationship between enterprise financialization and R&D innovation stems from the motivation difference in enterprise asset allocation. There are two kinds of motivation for financial asset allocation: the "precautionary" and the "alternative" motivation. Under the principal-agent mechanism, agents make decisions based on uncertainty and internal & external environments when allocating assets. However, the uncertainty degrees of enterprise R&D innovation and financial asset returns are different at various stages, resulting in the dynamic relationship between the level of financialization and R&D innovation input.

Second, the dynamic relationship between the level of enterprise financialization and R&D innovation varies with different financing constraints. Based on the data of China's A-share non-financial listed companies from 2010 to 2019, this paper sets a panel quantile model to study the significance and impact the degree of financialization crowding out R&D innovation with the improvement of financialization level. From the perspective of significance, the level of financialization has a negative effect on enterprise R&D and innovation only after the level of financialization increases to a certain extent. From the perspective of impact degree, whether there is a significant correlation between the two, the negative impact degree gradually increases with the improvement of financialization. Under different financing constraints, there are significant differences in the dynamic relationship between the two. When enterprises are faced with high financing constraints and when the level of enterprise financialization is about the 50% quantile, there is a certain degree of inverted U-shaped relationship between the two, and the negative significance between the two is the highest. When enterprises face low financing constraints, the negative relationship between the two is not significant.

Third, there are significant differences in the dynamic relationship between enterprise financialization level and R&D innovation at different business cycle phases. By introducing the product of the business cycle and financialization level into the panel data model as the explanatory variable, the paper empirically analyzes the dynamic relationship between the two at different business cycle phases. The results show significant differences in the relationship between the two at different phases of the business cycle. When the business cycle is in the expansion phase, financialization has a negative regulating effect on R&D innovation. When the business cycle is in the contraction phase, financialization has a positive regulating effect on enterprise R&D innovation. Considering the influence of financing constraints, in the economic expansion stage, the impact of financialization on the R&D innovation of enterprises with high financing constraints and low financing constraints shows no heterogeneity, and both are negative. However, in the economic contraction stage, the financialization of enterprises with low financing constraints has no significant relationship with R&D

innovation, while the financialization of enterprises with high financing constraints has a positive relationship with R&D innovation.

5.2. Policy implications

First, governments should rationally guide the financialization of enterprises and optimize policies to encourage enterprises to innovate. On the one hand, based on the main business, enterprises' effective use of financial activities is of great significance to the sustainable development of themselves and the real economy. While effective financial activities are significant for the sustainable development of enterprises and the real economy, this research found that a high degree of financialization negatively impacts R&D innovation. Considering that most enterprises have failed to effectively use financial resources to promote the transformation between financial capital and actual output, the research has found that there is an appropriate range of the impact of financialization behavior on enterprise R&D innovation. Therefore, the government should reasonably guide the financialization behavior of enterprises, urging enterprises to take their main business as the basis and reasonably use financial instruments to prevent "going from real to virtual." On the other hand, since R&D innovation plays an important driving role in the current economic growth, China should strengthen relevant policies such as tax incentives and government subsidies, optimize innovation incentive policies and give play to the guiding role of policies to promote enterprise innovation investment and R&D innovation, which can provide momentum for the new round of economic growth.

Second, governments should moderately relax and ease financing constraints and guide enterprises to effectively use financialization and promote innovation. One of the main reasons for enterprises' lack of innovation motives is that they face financing constraints. At present, many enterprises are facing the bottleneck of restricting their development due to the difficulty and high cost of financing. Although enterprise financialization has certain effects on alleviating financing constraints, based on this research, it is found that the financialization behavior of enterprises with high financing constraints has a more obvious inhibition effect on enterprise R&D innovation. In current China, the enterprises with high financing constraints are mainly private enterprises. Therefore, the government can appropriately relax the standards for private enterprises regarding access to financial institutions. On the one hand, it can effectively guide private enterprises to carry out financialization, reducing the negative effects of excessive financial means taken by entity enterprises, such as impeding the innovation of real enterprises and the real economy. On the other hand, private enterprises are the main body of China's R&D and innovation activities, so moderately relaxing and easing the financing constraints can effectively improve the investment and effectiveness of R&D innovation of private enterprises. At the same time, it is also conducive to inter-industry competition and promotes the development of the industry.

Third, governments should implement targeted and regulatory policies based on phases and industries. According to this research, the process of enterprise financialization is dynamic, and the level of enterprise financialization is closely related to asset allocation motivation and business cycle phases. Therefore, governments should implement differentiated policies to achieve accurate guidance by business cycle phases and industries.

Acknowledgments

This research was funded by the National Social Science Fund 22BTJ053, the 2022 Excellent Youth Project of Hunan Province Education Department 22B0857 and the Project of Hunan Provincial Social Science Achievement Evaluation Committee XSP22YBC139.

Conflict of interest

The authors declare there is no conflict of interest.

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