



Does financialization of non-financial corporations promote the persistence of innovation: evidence from A-share listed manufacturing corporations in China

Zhengjuan Xie¹ · Jiang Du¹ · Yongchao Wu² 

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Abstract

Financialization of non-financial corporations is an important factor affecting innovation activities. This paper calculates the optimal financialization of enterprises and the deviation of optimal financialization, divides amplex into moderate and excessive financialization, then investigates the relationship between financialization and sustainable innovation in different research samples using the data of A-share manufacturing enterprises in China from 2012 to 2018. The results indicate that the deviation of optimal financialization is negatively related to the persistent innovation of enterprises. However, financialization had significantly different effects on persistent innovation in different research sample. More specifically, excessive financialization could crowd out the persistent innovation, but moderate financialization may promote the persistent innovation. This study provides a new perspective for understanding the relationship between financialization and innovation, and helps finance better serve the real economy.

Keywords Financialization · Persistent innovation · Invalid financialization · Excessive financialization · Moderate financialization

✉ Yongchao Wu
wuyc@scu.edu.cn

Zhengjuan Xie
xiezhengjuan@stu.scu.edu.cn

Jiang Du
dujiang_1@scu.edu.cn

¹ School of Economics, Sichuan University, Chengdu 610065, China

² School of Marxism, Sichuan University, Chengdu 610065, China

1 Introduction

According to the theory of economic development, innovation is an engine for persistent development in corporations and is seen as an important determinant of their growth (Aghion & Howitt, 1992; Ganter & Hecker, 2013; Shumpeter, 2017). Corporation can obtain a long-term competitive advantage through persistent innovation; however, innovation in a period can bring only temporary excess profits (Tavassoli & Karlsson, 2015). The fact is that corporations' persistence in innovation has attracted increasing interest from scholars in recent years. Every corporation would like to make great progress through persistent innovation. It is of great significance to understand the dynamics of corporations' innovation behavior to build dynamic competitive advantage and understand the driving process of innovation (Latham & Le Bas, 2006; Malerba et al., 1997).

Persistent innovation refers to the sustainable relationship between current innovation and previous innovation, which is seen as the degree of intertemporal continuity in innovative behavior (Guarascio & Tamagni, 2019; Suárez, 2014; Zhongyi & Lin, 2019). The accumulation of feedback that arises from innovations and puts corporations in a better position to seek new innovations is the process of persistent innovation (Antonelli, 1997; Geroski et al., 1997). Persistent innovation is a long-term process and requires continuous investment in research and development (R&D) funds, but submergence, irreversibility, output uncertainty and long cycles are the properties of innovation input, which means that corporations must face high R&D and financing costs to persistently pursue innovation (Seo et al., 2012; Zhongyi & Lin, 2019). In fact, the resources of every corporation are limited, and the lack of R&D investment of Chinese corporations in the innovation process is a rather serious issue.

In reality, the Chinese economy appears the phenomenon of “transforming the economy from substantial to fictitious”, and growing investment capital is flowing to the virtual sector, which has led to a slump in the real economy in recent years. Meanwhile, Non-Financial Corporations (NFCs) gradually reduce investment in the main business and increase financial asset allocation because of the decline in the profit rate of the main business and the high investment income of the finance industry. Meanwhile, under the essential demand of capital pursuing profit, NFCs begin to change their financial behavior and governance structure, increasingly focusing on financial income and pursuing the maximization of shareholder value via financial payments; that is, top managers' objectives have shifted from investing in tangible assets and R&D projects to short-term profits, known as “the financialization of NFCs” (Orhangazi, 2008; Seo et al., 2012; Zhongyi & Lin, 2019).

Therefore, the financialization of NFCs could affect the investment structure of corporations, which leads to a growing amount of funds flowing to the financial sector that should be used for R&D investment. The dynamic behavior of innovation at the corporation level could be seriously affected by the financialization of NFCs. Meanwhile, there are different degrees of financialization in different industries because of the main business, and the manufacturing industry is the

cornerstone of the real economy in China. Under such situations, this paper discusses the relationship between the financialization of NFCs and the persistence of innovation. To take into account the heterogeneity of industry, the paper used data from A-share manufacturing enterprises in China to obtain the empirical specifications.

To address the research objectives, this paper is organized as follows: Sect. 2 presents a literature review on the relationship between the financialization of NFCs and persistent innovation. Section 3 provides the theoretical mechanism and hypotheses. Section 4 presents the empirical model and describes the data used to test the model. Section 5 is the empirical analysis, and Sect. 6 is the discussion and conclusions.

2 Literature review

2.1 The research on persistent innovation

A large number of scholars have studied persistent innovation from different perspectives since the publication of a paper by Geroski et al. (1997), but these papers mainly researched the existence and degree of persistent innovation at the corporation level, motivation and the factors related to persistent innovation. Recent empirical studies show that current innovation depends on previous innovation. The transition probability matrix in the first- and second-order Markov chain (Cefis, 2003; Cefis & Orsenigo, 2001; Tavassoli & Karlsson, 2015) and the dynamic random effects probability model with the Wooldridge (2005) method (Clausen et al., 2012; Ganter & Hecker, 2013; Haned et al., 2014; Raymond et al., 2010) are two main empirical methods that are used to measure the persistence of innovation. Additionally, Smith (2005) posited that in conducting persistent innovation activities, enterprises should pay more attention to human capital development and new technology introduction, digestion and absorption. According to Ditillo (1998) and Sung (2019), the proportion of intangible assets to total assets is used to measure persistent innovation. In terms of the drivers of persistent innovation, there are three crucial mechanisms: the knowledge accumulation approach, the success-breeds-success hypothesis and the sunk costs in R&D activities. The knowledge accumulation hypothesis refers to experience in innovation, which is the dynamically increasing returns from the learning-by-doing effect (Antonelli et al., 2013; Latham & Le Bas, 2006). The success-breeds-success hypothesis suggests that previous innovation aids in accumulating resources to create further innovation; that is, resources from previous innovation increase the profitability of current innovation (Le Bas & Scellato, 2014; Tavassoli & Karlsson, 2015). The sunk cost in R&D activities is another explanatory factor relating to persistent innovation. Corporations will continue to invest in R&D activities because innovative activities have long-term characteristics, and there will be a sunk cost if corporations abandon investment in innovative projects (Antonelli et al., 2013; Le Bas & Scellato, 2014; Tavassoli & Karlsson, 2015).

2.2 The relationship between financialization and investment behavior

It is very important to recognize and discuss the definition of financialization before studying the effect of financialization on investment. According to previous studies, we summarize three main approaches to define and measure financialization. The first type emphasizes the asset side, including the holding of financial assets (Davis, 2018; Kliman & Williams, 2015) and financial income from financial activities in NFCs (Demir, 2007, 2009; Krippner, 2005; Stockhammer, 2004). The second type focuses on the liability side, referring to the increasing financial payment in NFCs (Kliman & Williams, 2015; Orhangazi, 2008). The third type highlights shareholder value ideology, and pursuing shareholder value induces NFCs to make more financial payments and income, changing the structure of corporate governance (Lazonick, 2007; Seo et al., 2016).

According to the different understandings of financialization, scholars began to study the relationship between financialization and investment; however, there remains a lack of consistent conclusions because of different characteristics of NFCs (Lee et al., 2020) and the heterogeneity in different countries (Stockhammer, 2004). Jibril et al. (2018) referred to three main channels, namely, crowding-out, debt trapping and shareholder value ideology, in which financialization could affect real investment. The majority of researches indicate that there is a negative effect of financialization on real investment, believing that the increasing importance of a shareholder value ideology could encourage managers to consider short-term investment plans that could reduce investment in real projects (Barane & Hake, 2018; Davis, 2018; Seo et al., 2012; Tori & Onaran, 2018). Conversely, Seo et al. (2016) indicate that a negative effect of financialization on real investment is lack of robust evidence; other researches find a positive correlation between financialization and real investment (Davis, 2017, 2018; Jibril et al., 2018; Kliman & Williams, 2015; Lee et al., 2020). Some financial assets in NFCs might actually reflect other activities, not financial accumulation (Rabinovich, 2019). Additionally, some scholars believe that there is no obvious crowding-out effect because of the various financial markets in different countries (Hsu et al., 2014).

2.3 The relationship between excessive financialization and innovation

With the deepening of financialization, a growing number of scholars have begun to pay attention to the impact of excessive financialization and have noted that excessive financialization is an important factor inhibiting long-term economic development, hindering innovation and aggravating financial risks (Arcand et al., 2015; French et al., 2009; Pariboni et al., 2020; Wu, 2021). The financialization of NFCs may be capital arbitrage to obtain an excess rate of return or to reserve more funds to alleviate the pressure of capital demand of enterprises. Different motivations for financialization play different roles in innovation, and financialization based on speculative motives easily breeds excessive financialization, which has a crowding-out effect on innovation investment (Zheng et al., 2017, 2019). Wang et al. (2021) note that the impact of

financialization on enterprise innovation is an inverted U-shape; that is, the financialization of NFCs will inhibit innovation when the level of financialization is too high. To pursue short-term interests, NFCs invest much funds in the financial sector, which easily deviates from the main business and leads to excessive financialization, crowding out innovation investment funds and seriously hindering the innovation activity of NFCs (Wen et al., 2018). In conclusion, previous papers have mainly explored the effect and channel of financialization on investment behavior. However, the findings of current studies are inconclusive. Based on the understanding of financialization of Kliman and Williams (2015), this paper defines the financialization of NFCs as holding total financial assets by NFCs in portfolio investment and resource allocation, emphasizing the change in financial asset holding due to the increasing participation of NFCs in financial activities. A review of the literature shows that few papers have examined the relationship between financialization and persistent innovation in China. This study thus attempts to examine the effects of financialization on Chinese NFCs' persistent innovation, which could address the gap in the existing literature.

The contributions of this study are as follows. First, the financialization of NFCs is a very common phenomenon that could induce a negative and positive effect on real investment behavior in the existing literature. We believe that there is an optimal level of financialization in different corporations due to the heterogeneity among them (Wen et al., 2018), and there is a deviation between the actual financialization and the optimal financialization of some NFCs. This paper expands the model of Richardson (2006) to calculate the deviation of financialization, which can be used to judge whether the degree of financialization matches the existing resources of the enterprise.

The second contribution is the measurement of persistent innovation. Most of the existing literature regards the effect of previous innovation on current innovation as the probability of persistent innovation (Ganter & Hecker, 2013; Haned et al., 2014), using patent application and a binary variable for innovation input to measure innovation activities. Few papers distinguish the behavior of innovation when measuring persistent innovation (Ganter & Hecker, 2013; Haned et al., 2014; Tavassoli & Karlsson, 2015). This paper regards innovation as an independent research variable and uses innovation input and innovation output to investigate innovation activities. The comparison between the former and the latter innovation activities is used to reflect the degree of persistent innovation.

For the third contribution, based on optimal financialization, this paper divides the research objects into moderate and excessive financialization of NFCs, examines the effect of various degrees of financialization on persistent innovation, and distinguishes the effect of moderate and excessive financialization on sustainable innovation.

3 Theoretical mechanism and hypotheses

A long cycle, high risk and strong demand for funds are the most important characteristics of persistent innovation, which means that enterprises need continuous capital investment to encourage them to persist in innovation. The financialization

of NFCs is a very common phenomenon and itself should be regarded as a kind of market-oriented behavior of pursuing "rational" interests, which could solve the problem of capital demand for the persistence of innovation. However, there are great differences in the effect of financialization on persistent innovation because of the motivation for financialization. Precautionary motivation and speculative motivation are two main motives for nonfinancial enterprises to hold financial assets (Lee et al., 2020). For precautionary motivation, NFCs could ease financing constraints and avoid risks by holding more liquid financial assets. In terms of speculative motivation, NFCs could obtain excess returns by holding more financial assets, which could more easily cause over-financialization. In fact, it is very difficult to distinguish the real investment motivation of enterprises. Under different resource conditions, there is an optimal level of financialization that matches the existing resources of NFCs. Excessive financialization occurs if the actual financialization is greater than the optimal financialization; otherwise, moderate financialization occurs. Thus, based on the optimal level of financialization, this paper divides financialization into moderate financialization and excessive financialization and discusses the effect of different degrees of financialization on the persistent innovation of NFCs. The deviation of optimal financialization is defined as the degree of deviation from actual financialization to optimal financialization, which could induce the phenomenon of resource mismatch and reduce the available funds of enterprises. That is, regardless of whether the actual financialization is greater or less than the optimal level, the available funds of enterprises may be reduced because of resource mismatch. Hypothesis H1 is thus proposed.

Hypothesis 1 (H1): Deviations in optimal financialization could inhibit the persistent innovation of NFCs. Namely, due to the influence of the deviation in optimal financialization in the regression model, the coefficient of the optimal financialization deviation is significant and negative.

Moderate financialization is consistent with the financial behavior of precautionary motivation. Moderate financialization refers to the scale of financial assets held by enterprises, enhancing the liquidity of the enterprises and maintaining the adequacy of internal funds, which could reduce dependence on external financing for persistent innovation (Bonfiglioli, 2008; Gehringer, 2013; Khan et al., 2020; Tori & Onaran, 2018; Tran, 2020). With the assumption of moderate financialization, first, NFCs may reduce the cost of external financing because of the benefit of capital costs and then ease financing constraints. Second, financial investment could increase the available funds of NFCs so that the increased funds could be allocated to the real economy, which could augment investment in innovation and promote the persistent innovation of NFCs (Arizala et al., 2013; Davis, 2018; Khan et al., 2020; Stulz, 1996). Therefore, hypothesis H2 is proposed.

Hypothesis 2 (H2): Under moderate financialization, the financialization of NFCs could promote the persistence of innovation.

Excessive financialization refers to the degree of financialization exceeding the optimal level and overholding of financial assets by enterprises, which causes a large amount of enterprise funds to flow to the financial market and induces a shortage of internal funds (Orhangazi, 2008; Richardson, 2006). In fact, NFCs are more likely to lead to over-financialization when enterprises hold a large number of financial assets

to obtain excess returns based on speculative motivation. Excessive financialization may affect the persistent innovation of NFCs as follows. First, under financing constraints, the proportion of financial assets in the enterprise portfolio will increase, which may crowd out real investment and affect the demand for innovative capital with the deepening of financialization (Davis, 2017, 2018; Tran, 2020). Second, excessive financialization may make NFCs face greater financial risks, which will lead to unstable profits and thus cannot guarantee continuous investment in innovation. Third, under the pressure of maximizing shareholder value, managers of NFCs will focus on financial investment returns by increasing holdings of financial assets and reducing long-term investment projects such as innovation (Jibril et al., 2018; Sen & Dasgupta, 2018). Thus, this study proposes hypothesis H3.

Hypothesis 3 (H3): Under excessive financialization, the financialization of NFCs could inhibit the persistence of innovation.

4 Data, variables and model specification

4.1 Data sources and processing

The research object in this paper is A-share manufacturing enterprises in China from 2012 to 2018. The main reasons are as follows: First, manufacturing is the cornerstone of China's real economy and a main part of persistent innovation activities. Second, the R & D and patent data of most A-share listed manufacturing enterprises are continuous from 2012 to 2018, which ensures the reliability of the estimation results. Besides, all data used in this study were obtained from authoritative Chinese databases to ensure reliability and authenticity, such as the CSMAR database¹ and WIND database.²

We also preprocessed the data according to the following criteria: (1) removing enterprises with incomplete indicators and data; (2) excluding enterprises that have undergone IPOs in that year to eliminate the impact of the enterprises' listing on financial data; (3) deleting the loss-making enterprises for two consecutive years (ST) and loss-making enterprises for three consecutive years (*ST), because they have delisting risk and their financial data have no reference value. (4) The main variables are tailed of at a 1% level to exclude the influence of outliers. Finally, this study selected 394 enterprises and 2758 observations as the research object.

4.2 Dependent variable

In this study, the dependent variable is persistent innovation, which is defined as the comparison between current innovation and previous innovation. Most of the literature uses the dynamic random effects probability model with the Wooldridge

¹ CSMAR database: <http://www.gtarsc.com/>.

² WIND databases: <https://www.wind.com.cn/>.

(2005) method to measure persistent innovation and judges the probability of enterprises maintaining innovation from the regression results. However, the result of the calculation of persistent innovation is a concept of mean value, and this method ignores the difference between the persistence of innovation input and innovation output. In addition, Triguero and Córcoles (2013) show that both innovation input and innovation output are highly persistent, and the persistence of innovation input is higher than that of innovation output. Therefore, this paper uses the cycle development speed of the average value for innovation activities in two adjacent periods multiplied by the current innovation average value to measure the degree of persistent innovation from innovation input and innovation output. The main reasons are as follows: First, the cycle development speed could reflect persistence. Second, using the average value for innovation activities of two adjacent periods makes the data more stable and eliminates the impact of data fluctuations. Specifically, the persistent innovation in year t is expressed by multiplying the cycle development speed of the sum of innovation input (or innovation output) in years t and $t-1$ by the sum of innovation input (or innovation output) in years t and $t-1$, as follows:

$$pin_rd_{it} = \ln\left(\frac{rd_{it} + rd_{it-1}}{rd_{it-1} + rd_{it-2}} \times (rd_{it} + rd_{it-1})\right) \quad (1)$$

$$pin_pat_{it} = \ln\left(\frac{patent_{it} + patent_{it-1}}{patent_{it-1} + patent_{it-2}} \times (patent_{it} + patent_{it-1})\right) \quad (2)$$

where i represents the respective research enterprises (from the total 394 enterprises); t refers the year of analysis (from the 2012–2018 time period); pin_rd in Eq. (1) indicates the persistent innovation input, and rd in Eq. (1) represents the R&D input of enterprises; and pin_patent in Eq. (2) is the persistent innovation output, and $patent$ in Eq. (2) is the patent applications of enterprise, not patent grant, because it takes a period of time from patent application to grant.

4.3 Independent variable

4.3.1 Model for judging the excessive and moderate financialization

The independent variable is financialization (fin), which is defined as the ratio of financial assets of NFCs to total assets. In this study, financial assets include monetary capital, trading financial assets, derivative financial assets, financial assets available for sale, held-to-maturity investment, investment real estate and net long-term equity investment.

Meanwhile, the deviation of optimal financialization ($deviation_fin$) is another independent variable in this study. According to the residual measurement model of Richardson (2006), this paper selects the control variable of financialization and constructs a model to distinguish the deviation of optimal financialization. First, the optimal level of financialization for NFCs is measured. Second, the deviation of actual financialization from the optimal financialization for NFCs is calculated as

Table 1 The comparative descriptive statistics

Variable	Excessive financialization (1393)				Moderate financialization (971)			
	Mean	S.D	Min	Max	Mean	S.D	Min	Max
<i>fin</i>	0.323	0.136	0.026	0.845	0.133	0.054	0.011	0.370
<i>size</i>	21.438	0.819	19.209	24.530	21.822	0.844	19.009	25.511
<i>age</i>	13.315	5.231	3.000	35.000	13.954	4.944	4.000	37.000
<i>tbq</i>	2.574	1.629	0.871	15.098	2.479	1.495	0.953	11.570
<i>roa</i>	0.346	0.077	-0.959	0.964	0.051	0.066	-0.462	0.313
<i>cash</i>	0.108	0.051	0.002	0.300	0.271	0.145	0.017	0.845
<i>lev</i>	0.382	0.185	0.027	2.800	0.274	0.159	0.008	0.846
<i>cap</i>	0.255	0.119	0.004	0.619	0.183	0.097	0.004	0.556

the deviation of optimal financialization (*deviation_fin*). Third, moderate financialization or excessive financialization for NFCs is judged, NFCs have excessive financialization if the actual financialization is higher than the optimal financialization; otherwise, financialization is moderate. The detailed calculation model is as shown in Eq. (3).

$$\begin{aligned}
 fin_{it} = & \lambda_0 + \lambda_1 fin_{it-1} + \lambda_2 \ln size_{it} + \lambda_3 age_{it} \\
 & + \lambda_4 tbq_{it} + \lambda_5 roa_{it} + \lambda_6 cash_{it} + \lambda_7 lev_{it} + \lambda_8 cap_{it} + \epsilon_{it}
 \end{aligned}
 \tag{3}$$

where enterprise size(*size*) and enterprise age(*age*) are measured as the natural logarithm of business income and the number of years from registration, respectively, which represent the inherent characteristics of enterprises; Tobin’s Q value (*tbq*) and return on assets (*roa*) are defined as the ratio of market value to total assets and the proportion of net profit to total assets, respectively, which can control the profitability of enterprises; the cash stock (*cash*) and the asset liability ratio (*lev*) are calculated as the ratio of monetary capital to total assets and the rate of total liabilities to total assets in order to control the influence of the financing channel; and the capital intensity (*cap*) is the ratio of fixed assets to total assets, which represents the substitution effect of real investment on financial investment. ϵ in Eq. (3) is the residual error, which is defined as the value of radical financialization minus the optimal financialization, and it indicates excessive financialization if $\epsilon > 0$; otherwise, an NFC exhibits moderate financialization. Namely, the absolute value of ϵ is represented as the deviation of optimal financialization (*deviation_fin*).

4.3.2 Comparative descriptive statistics for the evaluation results

The evaluation results of Eq. (3) show that a total of 41.07% (971 corporations) had excessive financialization, and 58.93% (1393 corporations) had moderate financialization, which indicates that manufacturing enterprises showed a tendency for excessive financialization in China. The comparative descriptive statistics for the basic characteristics and operations in the excessively financialized enterprises and moderately

financialized enterprises are described in Table 1. For the enterprises with excessive financialization, their *size* and *age* are smaller than those of the enterprises with moderate financialization, which indicates as enterprise size and age increase, the internal governance level of enterprises is constantly improving, and enterprises are more likely to pursue long-term development rather than holding too many financial assets for short-term benefits, which leads to excessive financialization. Their *tbq* and *roa* are higher, which indicates that improvements in profitability will increase the holding of financial assets; *cash* is smaller, which indicates that when the internal financing of enterprises is insufficient, enterprises will obtain more cash flow by investing in financial assets; and *lev* is higher because enterprises improve the level of financialization by increasing leverage lending. Thus, the inherent characteristics and operations of NFCs are important factors that affect the holding of financial assets and determine the optimal financialization of NFCs to some extent.

4.3.3 Robustness test of the measurement results

To test whether the measurement results for the excessive financialization and moderate financialization are robust in Eq. 3, this paper recalculates the financialization of NFCs based on the financial channel profit. Specifically, the proxy variable of financialization is that investment income, profit and loss from changes in fair value and other comprehensive income, deducting the investment income from associates and joint ventures. Then, the new financialization of NFCs is entered into Eq. 3 for regression, and the results remain basically unchanged, which shows that the measurement results for excessive financialization and moderate financialization are highly robust.

4.4 Control variables

To eliminate the impacts of other factors on persistent innovation, this study also controls for the characteristics of enterprises. More specifically, this paper controls for the variables enterprise size (*size*), enterprise age (*age*), return on assets (*roa*), asset liability ratio (*lev*), operating cash flow (*cfo*), enterprise growth ability (*grow*), capital intensity (*cap*), R&D input intensity (*rds*), and share concentration (*share*). The definitions of *size*, *age*, *roa*, *lev*, and *cap* are the same as before. The variable *cfo* is defined as the share of cash flow from operating activities to total assets, which represents the cash flow constraints; *grow* is the growth rate of main business income, which reflects the growth ability of enterprises; *rds* is the proportion of R&D input to business income; and *share* is defined as the shareholding ratio of the top ten shareholders of the enterprise. In addition, these definitions of the model variables are described in Table 2.

4.5 Model specification

Based on the theoretical analysis, this paper sets the following panel regression model to study the impacts of the deviation of optimal financialization on persistent innovation. Meanwhile, the persistent innovation of NFCs may induce a change in the allocation of financial assets when enterprises face resource constraints, thus

Table 2 The definition of the main variables in the model

Variable	Symbol	Definition
Persistent innovation	<i>pin_rd</i>	Relationship between current R&D and previous R&D
	<i>pin_patent</i>	Relationship between current patent and previous patent
Financialization	<i>fin</i>	Ratio of financial assets to total assets
	<i>deviation_fin</i>	Deviation of actual financialization from optimal level
Enterprise size	<i>size</i>	Natural logarithm of total assets
Enterprise age	<i>age</i>	Number of years from registration
Return on assets	<i>roa</i>	Proportion of net profit to total assets
Liability ratio	<i>lev</i>	Rate of total liabilities to total assets
Cash flow	<i>cfo</i>	Share of cash flow from operating activities to total assets
Growth ability	<i>grow</i>	Growth rate of main business income
Capital intensity	<i>cap</i>	Ratio of fixed assets to total assets
R&D intensity	<i>rds</i>	Proportion of R&D input to business income
Share concentration	<i>share</i>	Shareholding ratio of the top ten shareholders

Table 3 Descriptive data for the main variables in the model

Variable	Obs	Mean	S.D	Min	Max
<i>pin_rd</i>	2758	18.756	1.150	14.050	23.962
<i>pin_patent</i>	2758	3.883	1.404	0.652	9.467
<i>fin</i>	2758	0.227	0.140	0.011	0.845
<i>deviation_fin</i>	2364	0.073	0.063	0.000	0.557
<i>size</i>	2758	21.002	1.168	16.077	25.916
<i>age</i>	2758	13.716	5.294	3.000	51.000
<i>roa</i>	2758	0.042	0.071	− 0.9596	0.964
<i>lev</i>	2758	0.336	0.182	0.008	2.800
<i>cfo</i>	2758	0.042	0.064	− 0.355	0.488
<i>grow</i>	2758	0.220	1.240	− 0.982	55.044
<i>cap</i>	2758	0.222	0.119	0.004	0.674
<i>rds</i>	2758	5.440	5.230	0.023	76.350
<i>share</i>	2758	59.749	13.407	9.164	101.16

affecting the level of financialization (Table 3). Therefore, to reduce the influence of endogens, this paper deals with the independent variable with a one-period lag.

$$pin_rd_{it} = \beta_0 + \beta_1 deviation_fin_{it-1} + \gamma X_{it} + \mu_i + \varepsilon_{it} \quad (4)$$

$$pin_patent_{it} = \beta'_0 + \beta'_1 deviation_fin_{it-1} + \gamma' X_{it} + \mu'_i + \varepsilon'_{it} \quad (5)$$

To test the heterogeneous impacts of financialization on persistent innovation, this paper divides the research objects into moderate and excessive financialization of NFCs based on the optimal financialization and studies the effect of various

degrees of financialization on persistent innovation. This paper uses the following model.

$$pin_rd_{it} = \beta_0^* + \beta_1^* fin_{it-1} + \gamma^* X_{it} + \mu_i^* + \varepsilon_{it}^* \quad (6)$$

$$pin_patent_{it} = \beta_0'' + \beta_1'' fin_{it-1} + \gamma'' X_{it} + \mu_i'' + \varepsilon_{it}'' \quad (7)$$

Equations (4) and (5) are used to estimate the effect of invalid financialization on persistent innovation input and persistent innovation output, respectively; Eqs. (6) and (7) are used to estimate the effect of financialization on persistent innovation input and persistent innovation output, respectively. i represents the respective research enterprises (from the total of 394 enterprises); t refers the year of analysis (from the 2012–2018 time period); X represents a (9×1) vector of control variables that includes *size*, *age*, *roa*, *lev*, *cfo*, *grow*, *cap*, *rds*, and *share*; u , u' , u^* and u'' are the unobservable firm-specific effects; and ε , ε' , ε^* and ε'' are the random errors.

5 Results

5.1 Descriptive statistics

The descriptive statistics for the main variables in the model are presented in Table 2. The results show that the standard deviations of persistent innovation input (*pin_rd*) and persistent innovation output (*pin_patent*) were 1.150 and 1.404 respectively, indicating that persistent innovation input and persistent innovation output vary widely across the different NFCs. The mean value of financialization (*fin*) was 0.227, the maximum value was 0.011, and the minimum value was 0.845, which shows that the financialization in NFCs were quite different. In addition, the actual financialization level of 86% (2364 corporations) of the research sample deviates from their optimal financialization. Therefore, it is necessary to determine whether the financialization of NFCs is excessive financialization and to study the relationship between excessive or moderate financialization and persistent innovation.

5.2 Discussion of the relationship between financialization and persistent innovation

Estimation of a fixed effect model in OLS was used to test the hypotheses. Table 4 reports the coefficients and significance levels of the variables in all research objects. In Table 4, the independent variable of Models (1) and (2) is financialization; the dependent variable is persistent innovation input in Model (1) and persistent innovation output in Model (2); the independent variable of Models (3) and (4) is the deviation of optimal financialization; and the dependent variable is persistent innovation input in Model (3) and persistent innovation output in Model (4).

The value of *fin* ($\beta_1^* = -0.329$, $p < 0.05$) in Model (1) had a significantly negative sign, which indicates that financialization could reduce the persistent innovation

Table 4 The impacts of financialization on persistent innovation in all samples

Model	(1)	(2)	(3)	(4)
Dependent variable	<i>pin_rd</i>	<i>pin_patent</i>	<i>pin_rd</i>	<i>pin_patent</i>
<i>fin</i>	− 0.329** (0.133)	− 0.193 (0.175)		
<i>deviation_fin</i>			− 0.008* (0.206)	− 0.067* (0.277)
<i>size</i>	0.110*** (0.021)	0.013 (0.028)	0.111*** (0.021)	0.013 (0.028)
<i>age</i>	0.152*** (0.008)	0.055*** (0.011)	0.153*** (0.000)	0.055*** (0.011)
<i>roa</i>	0.582*** (0.194)	0.856*** (0.255)	0.579*** (0.194)	0.857*** (0.255)
<i>lev</i>	0.816*** (0.135)	0.462** (0.178)	0.855*** (0.135)	0.486*** (0.177)
<i>cfo</i>	0.357* (0.211)	0.006 (0.278)	0.230 (0.210)	0.016 (0.276)
<i>grow</i>	0.092*** (0.008)	0.017* (0.010)	0.093*** (0.008)	0.017* (0.010)
<i>cap</i>	− 0.859*** (− 0.199)	− 0.237 (0.261)	− 0.792*** (0.194)	− 0.265 (0.255)
<i>rds</i>	0.035*** (0.004)	0.033*** (0.005)	0.035*** (0.004)	0.033*** (0.005)
<i>share</i>	0.006** (0.002)	0.005* (0.003)	0.005** (0.002)	0.005* (0.003)
Time Effect	Yes	Yes	Yes	Yes
Constant	13.60*** (0.485)	2.752*** (0.638)	13.481*** (0.483)	2.675*** (0.635)
R ²	0.402	0.504	0.459	0.652
Obs	2758	2758	2364	2364

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

input. The coefficients of *fin* ($\beta_1'' = -0.193$, $p > 0.10$) in Model (2) had a negative sign but was not significant. Thus, the results could not verify the relationship between financialization and persistent innovation. Further study of the relationship in different samples is necessary.

The value of *deviation_fin* in Model (3) ($\beta_1 = -0.008$, $p < 0.10$) and Model (4) ($\beta_1' = -0.067$, $p < 0.10$) had a significantly negative relationship with *pin_rd* and *pin_patent* respectively, showing that *deviation_fin* could significantly adversely affect persistent innovation. That is, persistent innovation will be reduced if financialization deviates from the optimal level for enterprises. To promote persistent innovation, financialization should be controlled within an appropriate range. Hence, *deviation_fin* could inhibit the persistent innovation of NFCs, which provides empirical evidence for Hypothesis 1(H1).

Additionally, the coefficients of *size*, *age*, *roa*, *lev*, *cfo*, *grow*, *rds* and *share* are positive and significant at the 5% level in Model (1), and this research result is

Table 5 The impacts of financialization on persistent innovation in different samples

Model	(5)	(6)	(7)	(8)
Sample	Excessive financialization		Moderate financialization	
Dependent variable	<i>pin_rd</i>	<i>pin_patent</i>	<i>pin_rd</i>	<i>pin_patent</i>
<i>fin</i>	− 0.381*** (0.237)	− 0.252** (0.325)	0.506** (0.439)	1.237** (0.588)
<i>size</i>	0.092** (0.038)	0.034** (0.052)	0.112*** (0.031)	0.009** (0.039)
<i>age</i>	0.141*** (0.016)	0.050** (0.021)	0.160*** (0.012)	0.049*** (0.015)
<i>roa</i>	0.550 (0.336)	0.117 (0.460)	0.281* (0.257)	1.015*** (0.359)
<i>lev</i>	1.355*** (0.265)	0.443*** (0.359)	0.213*** (0.188)	0.870*** (0.252)
<i>cfo</i>	− 0.989** (0.395)	− 0.194 (0.564)	0.560** (0.256)	− 0.372 (0.390)
<i>grow</i>	0.055*** (0.052)	0.063*** (0.016)	0.153*** (0.024)	0.034** (0.032)
<i>cap</i>	− 0.977** (0.390)	− 0.368* (0.506)	− 0.651** (0.261)	− 0.176* (0.365)
<i>rds</i>	0.023*** (0.006)	0.008 (0.009)	0.046*** (0.006)	0.048*** (0.007)
<i>share</i>	0.009* (0.005)	0.001 (0.006)	0.004 (0.003)	0.007 (0.004)
Time Effect	Yes	Yes	Yes	Yes
<i>Constant</i>	13.848*** (0.880)	2.616** (1.201)	14.134*** (0.672)	2.142** (0.900)
<i>R</i> ²	0.534	0.572	0.658	0.697
<i>Obs</i>	1393	1393	971	971

Standard errors in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

consistent with previous research. Meanwhile, *cap* and *pin_rd* had a significantly negative relationship, showing that different investment projects will crowd each other out. The control variables in Model (2), (3), (4) are consistent with Model (1) except for *size* and *cfo*.

This paper divides the research samples into moderate and excessive financialization to further study the relationship between financialization and persistent innovation of NFCs. Table 5 reports the empirical results. The sample in Model (5), (6) contains the enterprises with excessive financialization, and the sample in Model (7), (8) consists of the enterprises with moderate financialization. In Model (5), *fin* ($\beta_1^* = -0.381$, $p < 0.01$) had a significantly negative relationship with *pin_rd*. In Model (6), *fin* and *pin_patent* ($\beta_1'' = -0.252$, $p < 0.01$) had a significantly negative relationship. This result is consistent with the argument of Davis (2018) and Tori and Onaran (2018) that the financialization of NFCs arises from changes in corporate government structure, making them attribute more importance to short-term

investment plans and reducing investment in innovation projects. The research result suggests that excessive financialization has a negative impact on persistent innovation, providing empirical evidence for Hypothesis 3 (H3). Hypothesis 3 (H3) was accepted.

Meanwhile, the research sample shows moderate financialization in Model (7), (8). As shown in Table 5, the coefficients of *fin* in Model (7) ($\beta_1^* = 0.506$, $p < 0.05$) and Model (8) ($\beta_1^{**} = 1.237$, $p < 0.01$) are negative and significant at the 5% level. This result is similar to the findings of Jibril et al. (2018) and Lee et al. (2020), showing a positive relationship between financialization and persistent innovation under moderate financialization. Thus, the research result provides empirical evidence for Hypothesis 2 (H2). Hypothesis 2 (H2) was accepted.

5.3 Endogeneity test

The above results may be affected by endogeneity because NFCs need a great deal of money to be persistent in innovation activities, which would lead them to make financial investments and obtain short-term benefits and then alleviate the capital demand of persistent innovation (Rabinovich, 2019). Therefore, the paper uses the investment income of NFCs (*income*) as an instrumental variable that is measured by the ratio of investment income to total assets. On the one hand, the investment income of NFCs is not only one of the main sources of nonoperating profits but also an important embodiment of enterprise financialization. On the other hand, investment income cannot be the main source of funds to maintain the persistent innovation of NFCs (Cai and Chen, 2019). In other words, investment income meets the basic conditions as an instrumental variable for financialization. Then, a two-stage least squares (2SLS) regression analysis is used to avoid endogeneity. The detailed endogeneity test results are shown in Table 6.

The first and fifth columns of Table 6 show the results of the first stage, showing that in both the samples of excessive financialization and moderate financialization, the coefficients of the instrumental variable (*income*) are positive and significant at the 5% level. Meanwhile, the F statistic of the instrumental variable is significantly greater than 10, which indicates that there is no weak instrumental variable problem. Additionally, in columns (3) and (4) of Table 6, the coefficients of financialization are negative and significant at the 5% level for the excessive financialization of NFCs; columns (6) and (7) of Table 6 show that the coefficients of financialization are positive and significant at the 10% level for the moderate financialization of NFCs. Columns (3), (4), (6), and (7) of Table 6 show the results of the second stage, which is consistent with the conclusion in Table 5. Thus, there is no endogeneity problem in the above results.

5.4 Discussion of the Nature of the NFCs

The investment structure is quite different between state-owned enterprises and private enterprises, which could affect innovation activities. Therefore, it is necessary to classify the research samples into state-owned enterprises and non-state-owned

Table 6 The 2SLS results

Sample	Excessive financialization			Moderate financialization		
	First	Second	Second	First	Second	Second
Model	<i>fin</i>	<i>pin_rd</i>	<i>pin_patent</i>	<i>fin</i>	<i>pin_rd</i>	<i>pin_patent</i>
<i>fin</i>		– 0.401*** (0.130)	– 0.286** (0.211)		0.654** (0.465)	1.045* (0.127)
<i>income</i>	0.024** (0.063)			0.052** (0.038)		
Control Variable		Yes	Yes		Yes	Yes
Time Effect		Yes	Yes		Yes	Yes
<i>Constant</i>		10.405*** (0.560)	2.544** (1.603)		11.970*** (0.675)	2.561*** (0.899)
F statistic	48.15***			53.37***		
Wald test		327.67***	138.32***		98.64***	78.60***
<i>R</i> ²	0.678	0.552	0.578	0.713	0.664	0.697
<i>Obs</i>	1393	1393	1393	971	971	971

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7 The empirical results for different nature enterprises

Nature	State-owned enterprises				Non-state-owned enterprises			
	Excessive financialization		Moderate financialization		Excessive financialization		Moderate financialization	
Sample	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Model								
Dependent Variable	<i>pin_rd</i>	<i>pin_patent</i>	<i>pin_rd</i>	<i>pin_patent</i>	<i>pin_rd</i>	<i>pin_patent</i>	<i>pin_rd</i>	<i>pin_patent</i>
<i>fin</i>	– 1.280*** (0.834)	– 0.572*** (0.769)	0.424*** (0.980)	0.248* (0.772)	– 0.334* (0.252)	– 0.313 (0.333)	0.038* (0.413)	0.221* (0.551)
Control Variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Constant</i>	15.683*** (2.067)	2.243*** (2.080)	14.712*** (2.439)	3.035** (0.647)	13.560*** (0.047)	2.58* (1.347)	13.677*** (0.747)	1.503** (0.948)
<i>R</i> ²	0.506	0.438	0.466	0.441	0.440	0.473	0.400	0.418
<i>Obs</i>	170	170	145	145	1195	1195	1248	1248

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

enterprises to investigate the impact of financialization on persistent innovation. In Table 7, the research samples in Model (9), (10) consist of state-owned enterprises with excessive financialization; the samples in Model (11) and Model (12) consist of state-owned enterprises with moderate financialization; the samples in Model (13),

Table 8 The estimated results of the robustness test

Sample	All samples		Excessive financialization		Moderate financialization	
	(17)	(18)	(19)	(20)	(21)	(22)
Model						
Dependent variable	<i>pin_rd</i>	<i>pin_patent</i>	<i>pin_rd</i>	<i>pin_patent</i>	<i>pin_rd</i>	<i>pin_patent</i>
<i>fin</i>	– 0.104* (0.251)	– 0.075 (0.239)	– 0.362*** (0.290)	– 0.209** (0.382)	0.428** (0.396)	0.857* (0.532)
Control Variable	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes
<i>Constant</i>	12.901*** (0.361)	2.357*** (0.619)	13.004*** (0.076)	2.852* (0.605)	13.288*** (0.503)	2.900** (0.482)
<i>R</i> ²	0.432	0.513	0.503	0.544	0.580	0.515
<i>Obs</i>	2758	2758	971	971	1393	1393

(14) include non-state-owned enterprises with excessive financialization; and the samples in Model (15) and Model (16) include non-state-owned enterprises with moderate financialization.

As shown in Table 7, *fin* and *pin_rd*, *fin* and *pin_patent* had significantly negative relationship in Model (9), (10), respectively, showing that both the significance and the absolute value of the estimated coefficient are larger than those in Model (13), (14). The empirical results demonstrate that the restraining effect of excessive financialization on persistent innovation in state-owned enterprises is greater than that in non-state-owned enterprises. Meanwhile, *fin* and *pin_rd*, *fin* and *pin_patent* had significantly positive relationship in Model (11) and Model (12), respectively, and the significance and the absolute value of the estimated coefficient are also larger than those in Model (15), Model (16). In other words, the effect of moderate financialization on persistent innovation in state-owned enterprises is greater than that in non-state-owned enterprises.

5.5 Robustness test

According to previous research, the definition of financialization is still vague, and the measurement indicators have not achieved consensus; different measurement indicators of financialization may impact the conclusions of the study. Thus, to test the robustness of the relationship between financialization and persistent innovation in NFCs, this paper employed another method to measure the agent variable of financialization. We replaced the ratio of the financial assets of NFCs to total assets with the total financial assets of NFCs based on Seo et al. (2016) and then discussed the impacts of financialization on the persistence of innovation. The empirical results are shown in Table 8. As shown in Model (17), (18), *fin* had a significant and negative impact on *pin_rd*, and *fin* and *pin_patent* had an insignificantly negative sign. In Model (19), (20), excessive financialization had significantly negative relationship with persistent innovation input and output. In Model (21) and (22), moderate financialization had significantly positive relationship with persistent innovation

input and output. The empirical results of the robustness test are consistent with the results in Tables 4 and 5. In summary, whether using different measurement methods for the independent variable, financialization has a significant and negative impact on persistent innovation under excessive financialization and a significant and positive impact on persistent innovation under moderate financialization, which further provides empirical evidence for H2 and H3.

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

6 Discussions and conclusions

Using data from 2,758 observations of 394 A-share manufacturing enterprises in China based on the CSMAR and WIND databases, this study explored the effects of financialization on the persistent innovation of NFCs. To avoid false regression and ensure the validity of the estimation results, we conducted unit-root tests to confirm the stationarity of the series. The Hausman method was used to select a suitable estimation model, and the results showed that the fixed effect model was most reliable and valid. Thus, we used the fixed effect model to investigate the relationship between the financialization and persistent innovation of NFCs. The empirical results indicate that financialization with a one-period lag significantly decreases persistent innovation input in all research samples but insignificantly decreases persistent innovation output, showing that the relationship between financialization and persistent innovation is not significant. This result is consistent with the argument that the negative effect of financialization on real investment lacks robust evidence (Davis, 2018; Hsu et al., 2014; Kliman & Williams, 2015). Thus, it is necessary to further study the relationship between financialization and persistent innovation. Then, this study measured the deviation of optimal financialization according to Richardson's residual measurement model, exploring the relationship between the deviation of optimal financialization and persistent innovation. Meanwhile, this study also investigated the impact of moderate and excessive financialization on persistent innovation. Based on the empirical analyses of this study, the main results and conclusions can be drawn as follows.

One of the empirical results shows significant evidence of crowding out between the deviation of optimal financialization and persistent innovation. This result is consistent with past findings (Epstein & Crotty, 2013; Jordà et al., 2017) examining the size of the financial system and discussing how much is too much in terms of the financialization of NFCs. More specifically, Jordà et al. (2017) posited that financial flows between financialization and persistent innovation are increasingly important and that financialization can be excessive. In other words, there is an optimal level of financialization that matches the existing resources of NFCs. Regardless of whether the actual financial level is greater or less than the optimal level, it is the deviation of optimal financialization that may reduce the available funds of enterprises because of resource mismatch. Meanwhile, the results of this study provide empirical evidence that the effect of financialization on persistent innovation input and persistent innovation output differs; hence, it is necessary to distinguish

persistent innovation input and persistent innovation output when measuring the persistence of innovation.

The second result verifies that the relationship between financialization and persistent innovation differs significantly depending on whether financialization is excessive or moderate. This finding is of great significance for understanding financialization. More specifically, excessive financialization could crowd out the persistence of innovation, but moderate financialization may promote the persistence of innovation. In other words, the optimal level of financialization is very important for understanding the relationship between financialization and persistent innovation.

The third result demonstrates that the nature of enterprises could also affect investment behavior; thus, financialization has significantly different impacts on persistent innovation depending on whether an enterprise is state-owned or not. More concretely, excessive financialization has a greater negative effect on the persistence of innovation in state-owned enterprises than in non-state-owned enterprises, and moderate financialization has a greater positive effect on persistent innovation for state-owned enterprises. Thus, we need to focus on the nature of enterprises to help us to understand the effect of financialization on persistent innovation.

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