



Research on the Mechanism of Entrepreneurs' Age in Enterprises' Innovation Ecosystem: A Grouping Regression Verification Based on Gender

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Abstract

The construction of the innovation ecosystem plays an important role in the technology research and development activities of innovation-oriented enterprises. How to effectively promote the perfection of enterprise innovation ecology determines the quality of engineering technology activities of innovation-oriented enterprises. Entrepreneurs play a key role in enterprise innovation ecological construction, especially in resource allocation. Therefore, based on the Upper Echelon Theory, this paper investigates the “age” effect of enterprise innovation ecological construction under the influence of top managers and its economic consequences under the adjustment of various heterogeneous factors. Based on this, this paper selects the data of GEM listed companies from 2009 to 2017 as samples, uses STATA14.0 for an empirical test, constructs an OLS model with quadratic terms, and uses multiple grouping variables for a grouping regression test. The main results show that there is an inverted U-shaped relationship between the entrepreneurs' age and R&D investment, that is, due to the influence of entrepreneurs, there is a midlife crisis in R&D investment behaviors of enterprises; the test of gender grouping shows that female entrepreneurs alleviate this crisis. The conclusion of this paper reveals the influence of entrepreneur's age on enterprise innovation activities, and puts forward the important role that female managers may play in R&D activities, which provides managers with references for improving the technical level and engineering quality of innovation-oriented enterprises.

Keywords: *entrepreneurs' age; mid-life crisis; R&D investment; gender dividend*

1. Introduction

With economic development and intensifying global competition, science and technology are playing an increasingly important role. At present, enterprises in China are transforming from labor-intensive to technology-intensive. Innovation activities, which are key to driving enterprises, continue to give impetus to the improvement in the performance of enterprises; technological innovation creates new competitive advantages for the enterprises and promotes the recombination of production factors within the enterprises (Schumpeter, 1911) [1]. Therefore, to avoid a decline in competitiveness, enterprises must continuously invest in technological innovation activities to promote the reorganization of resources and the development of

new productive forces (Arrow, 1998) [2], which means that enterprises must continuously increase their investment in innovation.

According to the decisive role played by entrepreneurs in Schumpeter's innovation theory and the research on the theory of Upper Echelon Theory, entrepreneurs serve as the key managers and decision-makers of enterprises, and their characteristics influence the focus on investment of enterprises. In small and medium-sized enterprises, due to the absence of a complete governance structure, entrepreneurs often directly determine the direction of investment of enterprises to a large extent. Entrepreneurs' attitudes, perceptions, abilities, etc. will affect their decision-making and those factors are subjective, which will have an irrational impact on the corporate decision-making.

Based on this, many domestic and foreign scholars have adopted the entrepreneurs' characteristics to be exposed to quantifiable factors, such as age, education background, tenure, etc., which can be affected by the entrepreneur's personal experience, learning ability, cognitive level, and ultimately reflect their decision-making (Hao & Sun, 2015; Jiang et al., 2009) [3-4]. According to the conclusions of existing studies, age is an important demographic feature. As individuals age, they can be affected by a variety of factors, and meanwhile different cognitive patterns and different environments bring changes in individual decision-making methods, especially risk preferences. Some studies pointed out that owing to the influence of age, the operation of enterprises has shown a phenomenon of mid-age innovation bottleneck that middle-aged entrepreneurs often lack innovative spirit compared with young and elderly entrepreneurs, for they face a mid-life crisis in resources and power, which has an impact on the survival of enterprises (Zhang Yuming et al., 2013) [5]. Other scholars believed that there is a linear decline in risk appetite as entrepreneurs age, which affects R&D investment of enterprises. Based on the existing studies, there is insufficient research on the relationship between the age of entrepreneurs and R&D investment, and there is no consistent conclusion on the role of age. At the same time, it is also necessary to consider the effect of investment in innovation on samples.

In addition, with the increasing requirements for gender equality, there is much research on the impact of gender in management activities. By summarizing the characteristics of women's management, researchers believed that female managers have different characteristics from male managers in terms of management, such as delicate, soft, empathetic, and cautious, which improves the management of enterprises. In addition, some scholars proposed that gender equality allows women to participate in social activities, which leads to gender equality dividend referred to as gender dividend (Yang Juhua et al., 2021) [6]. This is based on the fact that as more women participate in social activities, the labor force is liberated, and their potential is released. Therefore, the participation of female managers exerts greater influence on companies, especially R&D activities that are strategically significant for companies.

Drawn on the above studies, this research starts with the GEM listed companies that have more investment in R&D and thus have a greater impact, and then presents the question: How does the age of entrepreneurs with core leadership affect the sample companies with a greater impact on innovation investment? Meanwhile, this research pays more attention to whether the adjustment function will be generated under the influence of heterogeneous factors, such as the adjustment function of the difference in entrepreneurs' gender, property rights, and external environmental uncertainties.

2. Related research and theoretical hypotheses

(1) Age of entrepreneurs and R&D investment

The influence of age on corporate decision-making comes from the accumulation of experience, changes in risk tolerance, and managers' exposure to other factors except themselves due to age. Younger entrepreneurs have greater risk appetites, and thus they dare to innovate, with willingness to take greater risks and paying attention to the improvement in the competitiveness of their companies in a long term. As the increase of age, entrepreneurs continue to accumulate personal experience and become more confident in making investment decisions based on their perceptions (Hambrick & Mason, 1984; Herrmann & Datta, 2005; Karami et al., 2006) [7-9], and are more daring to make innovative R&D investments. On the contrary, as for elderly entrepreneurs, due to deficiency in energy and physical limitations, they have a lower risk appetite, and are more inclined to follow the original business and production model, unwilling to carry out innovations.

In the research on the impact of the average age of entrepreneurial teams on corporate innovation, some scholars support the attenuation theory that as the average age of entrepreneurs increases, fewer measures will be taken for expenditure in innovation or R&D (Xu Jingchang et al., 2010; Kang Yanling et al., 2011) [10-11]. According to their analysis, as entrepreneurs age, their ability and driving force to change their cognition and thinking decline, and they tend to have path dependence on experience in making decisions. In addition, the older the entrepreneurs are, the less tolerant of new things they become, and the more skeptical of motivations they tend to be; elderly entrepreneurs, to a large extent, have lowered their recognition of the outside world, and do not need to prove their value through strategic reforms or innovative research and development of the enterprise. According to Zhu Jinwei et al. (2014) [12], as the investment return period of R&D investment is long, reputation cannot be achieved and wealth cannot be obtained from it immediately, which causes entrepreneurs who have path dependence not to make long-term investments and thus reduces innovative projects.

In addition, other scholars have put forward different views. They believed that there is not a simple linear relationship between the age of entrepreneurs and the decision-making mechanism of enterprises, but a non-linear, complex relationship (Grund & Nielsen, 2005) [13]. Wang Chuan et al. (2014) [14], by analyzing the age structure and entrepreneurial spirit as measured by innovation and entrepreneurship, pointed out that for entrepreneurs aged 20 to 29, their age has a negative impact on entrepreneurship; for those aged 30 to 39, their age exerts a positive influence but there is a significantly

negative correlation in the 60-69 age group. This reveals the multi-stage, complex influence of age on entrepreneurs' decision-making (Wang & Song, 2013) [15]. According to Cheng Hong et al. (2016) [16], who analyzed the age effect of entrepreneurs by using CEES data in 2016, pointed out that the age of entrepreneurs influences entrepreneurial innovation spirit, which is essentially reflected in the fact that the age of entrepreneurs has an impact on corporate decisions on innovative investment. The data analysis indicates that there is a U-shaped relationship between the age of entrepreneurs and their innovative spirit, which brings about the term "mid-age innovation bottleneck" of entrepreneurship in which the turning point is around 51 years old. The above-mentioned research proves that the relationship between the age of entrepreneurs and corporate innovation has shifted from linear to nonlinear.

Based on the above analysis, it can be found that scholars have remained divided over the impact of the age of entrepreneurs. Through the analysis of related research and entrepreneurs' personal experience, this research reveals that for innovative enterprises, entrepreneurs are the cultural leaders and decision-makers of enterprises. As most innovative enterprises are founded by scientific and technological personnel when they are young, although entrepreneurs aim to forge ahead at the beginning of the establishment, they need to accumulate resources for innovative activities due to the limitation of their resources. At the same time, entrepreneurs who work hard at the beginning of their career, face less pressure from their family, society, and power struggles in the enterprise, which allows them to dedicate themselves to making innovations. In addition, with entrepreneurs' increasing social experience, deeper understanding of innovative products, and more comprehensive strategies for competition, enterprises tend to increase investment in innovation. However, as entrepreneurs age, their ability declines, reluctant to analyze financial investment and to accept new things, and they face pressure from family life. Apart from this, enterprises plunge into mid-life crises as there are internal conflicts of control, which results in entrepreneurs' less attention to business practices and less willingness to invest in high-risk innovations. Meanwhile, entrepreneurs shift their focus from the innovation in the technique of production and operation to the struggle for power within the enterprise to maintain their position. Consequently, as entrepreneurs grow older, they face problems such as the aging of their knowledge structure, the further decline in their willingness to innovate, and the increase in risk awareness, which hinders the R&D investment of enterprises.

Therefore, based on the above analysis, the following hypothesis is proposed:

H1: There is a nonlinear inverted U-shaped relationship between the age of the entrepreneur and

the R&D investment of the enterprise.

(2) Analysis of the adjustment function of gender differences in entrepreneurs

Scholars have valued the influence of gender on the characteristics of managers. Due to the differences in personality, risk appetite, and strategic focus between men and women in the management process, different results are shown in terms of the relationship between the age of entrepreneurs and R&D investment for entrepreneurs of different genders. This paper analyzes the possible differences between female and male entrepreneurs and their impact on R&D investment based on the following aspects. First, in an era when women's awareness of equal rights is strengthened, men's wrong behaviors in married life may lead to more serious consequences, which causes male entrepreneurs to invest more time and energy in such problems but less time in management. Women's participation in management helps to release the gender dividend. Second, female entrepreneurs have higher risk awareness and are more discreet about the investment than male managers. Compared with the male entrepreneurs' overconfidence, female counterparts are less overconfident. Female entrepreneurs are more risk-averse than male entrepreneurs: for example, during the financial crisis, investment of companies held by female entrepreneurs declined (Zhu Jigao et al., 2012) [17], which does not mean their unwillingness of taking risks, but their prudence in financial decision-making and the long-term perspective of investment (Francis, 2009) [18]. The long-term perspective of strategy is often conducive to companies' long-term investment in R&D activities. Third, the flexible management of female entrepreneurs and the maternal role they play in the team will improve the overall decision-making of the team. For example, Maniero (1994) [19] proposed that women entrepreneurs are more tolerant towards change, and are more willing to solve problems through innovations to promote the development of enterprises. At the same time, they endeavor to promote change by adopting flexible and brainstorming management methods to allow enterprises to better adapt to changes in the external environment, which drives the development of the enterprise and helps them to get promoted. Robert (2003) [20] pointed out that as women are born with a strong affinity, they are inclined to make decisions through democracy and communication with employees, attach importance to interpersonal relationships within the team and the unity with the management, which makes it easy to reach a consensus in discussions, improve employee satisfaction, and thereby raise employees' expectations of the enterprise and propel the development of the company. In addition, according to the scholars' research, the participation of female directors can improve corporate governance (Adams, 2009) [21], information disclosure, and audit quality, which proves the role of female entrepreneurs or managers in improving the corporate

management.

It can be considered that from the perspective of innovation investment of technology companies, female entrepreneurs are more strategically stable than male counterparts, and have better risk awareness, which helps enterprises to ensure control over the high-risk strategic business activity of R&D investment.

Therefore, based on the above analyses, the following hypothesis is proposed:

H2: The entrepreneurs' difference in gender adjusts the relationship between the age of entrepreneurs and R&D investment.

3. Study Design

(1) Source of Sample Data

Given the influence brought by enterprise R&D investment and its scale, this paper selected GEM listed enterprises as the research sample, and obtained the main data from CSMAR and Wind, while some data were manually acquired. Excluding ST companies, financial companies, and repeated data, the final sample covers the data of 739 GEM enterprises from 2009 to 2017. All the data were winsorized.

(2) Variable Selection and Definition

(a) Explained variable: R&D investment (*RDsum*)

In view of the demand of resources for innovation activities, enterprises of different sizes are trying to gain competitive advantages by investing resources; it is therefore difficult to judge the authentic technological advantages formed by enterprises' R&D by virtue of relativized indicators. Accordingly, this paper directly adopted R&D investment as a proxy variable to measure enterprises' innovation expenditures with natural logarithm treatment.

(b) Explanatory variable: Age of the entrepreneur (*Age*)

GEM companies are mostly entrepreneurial, so the influence of the most senior entrepreneurs and their mastery of decision-making is much higher than that of the management team. Technology R&D, as a strategic corporate investment, notwithstanding its higher risks,

$$RDsum = \alpha + \beta_1 Age + \beta_2 Gov + \beta_3 Gear + \beta_4 SharePer + \beta_5 Share3 + \beta_6 Cash + \beta_7 Scale + \beta_8 Roe + \varepsilon \quad (1)$$

$$RDsum = \alpha + \beta_1 Age + \beta_2 Age^2 + \beta_3 Gov + \beta_4 Gear + \beta_5 SharePer + \beta_6 Share3 + \beta_7 Cash + \beta_8 Scale + \beta_9 Roe + \varepsilon \quad (2)$$

In the above model, *RDsum* represents the R&D input, *Age* and *Age*² refer to the entrepreneur's age and its squared term. According to Hypothesis 1, the primary term of the entrepreneur's age was tested first, and later the squared term was introduced to test whether there was a curvilinear relation between the entrepreneur's age and

especially represents a critical strategic decision-making act for companies to be able to maintain long-term competitive advantage. Therefore, it is more likely to be influenced by the founders or senior managers. Accordingly, this paper collected the "age" of CEOs as the sample data source of entrepreneurs, and logarithmically processed it.

(c) Control variables

Numerous studies have shown that due to the greater consumption of resources and higher uncertainty in innovation activities, the factors affecting enterprises' R&D investment will mainly exert an influence by affecting enterprises' resource acquisition ability and the adequacy of resources to be allocated. Therefore, drawing on the available research results, given that government subsidies increase the disposable funds, more adequate resources can stimulate the growth of enterprises' R&D investment. Enterprises borrow appropriately to expand the scale of enterprises, thus continuously enhancing the vitality of enterprises and providing more innovation support resources for enterprises. From the perspective of resource support, government subsidy (*Gov*) and asset-liability ratio (*Gear*) were selected as control variables. Considering the speed and efficiency of decision making embodied in equity concentration, it has been argued that equity concentration can positively influence corporate innovation investment, so the first majority shareholder was therefore selected. Besides, the possible influence of power group in the governance structure was also considered; from the perspective of governance structure, the share of the largest shareholder (*SharePer*) and the equity ratio of the top three shareholders (*Share3*) were selected as control variables. Insomuch as the most direct means of solving the financing constraint of the enterprise, i.e., the support of innovation activities by the cash resources held by the enterprise, and the possible resource enrichment effect of the overall size of the enterprise, the cash holdings (*Cash*), enterprise scale (*Scale*), and enterprise profitability (*Roe*) were selected as control variables. Besides, dummy variables of industry and time were also set to control that impact.

(3) Modeling

This paper built the following model to carry out the empirical test of each hypothesis.

the R&D input.

4. Empirical Results and Explanations

(1) Descriptive Statistics

Table 1 Descriptive Statistics of the Main Variables

Variables	Mean value	Standard deviation	Min	Max
Age	48.358	6.341	28	71
Roe	0.078	0.089	-1.533	0.553
RDsum	17.256	0.934	11.878	21.344
Gov	15.811	1.194	7.824	19.914
Gear	0.269	0.163	0.011	1.037
SharePer	32.167	13.009	4.15	89.85
SharePer3	50.068	13.677	8.77	98.9
Cash	4.85e+08	6.17e+08	3840000	1.22e+10
Scale	21.068	0.803	18.679	24.616
Ind	41.365	16.289	1	87
Year	2014.267	2.236	2009	2017

Table 1 showed the descriptive statistics of the main variables, through which it could be found that the minimum value of the entrepreneur's age was 28, the maximum was 71, and the mean was about 48 years old; the span of the entrepreneur's age was large, and the average level was in the middle age stage. From the data of R&D investment, the processed data of the minimum and maximum values and standard deviation of R&D investment showed that most GEM enterprises had R&D investment behavior, where the difference was relatively small.

(2) Analysis of Regression Results of the Main Hypothesis Test

According to the regression results in Table 2, the results in Model (1) were not significant when regressing the primary term corresponding to the entrepreneur's age, indicating that there was no significant linear relationship between the entrepreneur's age and the R&D investment activities of the enterprise. In Model (2), the regression result was significant after the inclusion of the secondary term of Age^2 corresponding to the entrepreneur's age, and the R^2 is 0.526, which was also a good fit. It indicated that according to the regression results of Model (2), there was a relatively significant non-linear relationship between entrepreneurial age and enterprise R&D investment. Besides, according to the coefficients fitted

by the model, it could be seen that there was an inverted U-shaped relationship between entrepreneurial age and R&D investment. On the grounds of the estimation, the peak point of entrepreneur's age was 46–47 years old, which meant that before the peak point, the accumulation of experience allowed entrepreneurs to make more R&D investment decisions, but with the advent of middle age, R&D investment started to decline, and entrepreneurs fell into the “mid-life crisis” in R&D investment decisions.

A comparative analysis of the two empirical results showed that the relationship between entrepreneurial age and R&D investment was better illustrated by including the quadratic term of the variable corresponding to entrepreneurial age. The relationship between entrepreneur's age and R&D investment presented an inverted U-shaped curve, that is, there was a peak point, before which, as the entrepreneur's age grew, R&D investment kept rising, and the entrepreneur's investment in innovation activities also kept elevating; after which, as the entrepreneur's age grew, R&D investment kept falling, and the entrepreneur's investment in innovation activities also kept declining. Therefore, the relationship of the main hypothesis was verified and there was an inverted U-shaped nonlinear relationship between the age of entrepreneurs and the R&D investment of enterprises.

Table 2 Regression Test Results of the Relationship Between the Age of Entrepreneurs and R&D Investment

	Model (1)	Model (2)
Age	0.019 (0.18)	7.935** (1.97)
Age ²		-1.031** (-1.98)
Gov	0.182*** (14.81)	0.182*** (14.83)
Gear	-0.058 (-0.60)	-0.047 (-0.49)
SharePer	-0.047 (-1.13)	-0.048 (-1.15)
Share3	-0.055 (-0.83)	-0.048 (-0.72)
Cash	0.111*** (5.31)	0.110*** (5.32)
Scale	0.483*** (16.25)	0.484*** (16.33)
Roe	0.986*** (5.32)	0.976*** (5.23)
Cons	1.702*** (2.66)	-13.511* (-1.73)
Year	Control	Control
Ind	Control	Control
N	3189	3189
R ²	0.525	0.526
F	172.637	163.140
p	0.000	0.000

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(3) The Moderating Effect of Gender Differences in Entrepreneurs

In view of the gender differences of entrepreneurs, the relationship between age and R&D investment was tested empirically using Model (1) and Model (2) for male and female entrepreneurs, respectively. According to the empirical results in Table 2, within the group of female entrepreneurs, the R^2 for Model (1) was 0.479 and the R^2 for Model (2) was 0.536, i.e., after the inclusion of the squared term, the model had a stronger explanation and a better fit. Thus, compared to the linear relationship, the inverted U-shaped nonlinear relationship had a higher fit and was better able to explain the relationship between age and R&D investment of female entrepreneurs. According to the results, the age point corresponding to the peak of R&D investment of female entrepreneurs occurred between 52-53 years old, delayed by four years compared to the overall sample, extending the time of

high quality investment in R&D. Based on the previous theoretical analysis, it could be concluded that in the process of strategy formulation and implementation, female entrepreneurs have more stable development ability of high-risk investment due to their stable personality, introversion, gentleness and stimulating effect on the team, thus showing stronger R&D stamina.

The results of testing Model (1) as well as Model (2) within the subgroup of male entrepreneurs showed that the primary term of entrepreneurial age was significant, while the inclusion of the secondary term did not show significant results. Thus, for male entrepreneurs, there was a negative linear relationship between entrepreneurial age and R&D investment. This indicated that the aging phenomenon shown by male entrepreneurs in terms of the growth of R&D investment was obvious, that is, in the group of male entrepreneurs, the elder they were, the weaker their sense of risk-taking and the

stronger the path dependence of enterprise investment in production will be, coupled with the possible mid-life crisis, which made male entrepreneurs tired of coping with various problems and reduce the intensity of enterprise R&D investment even more. Overall, it indicated the negative impact of age on entrepreneurs.

In summary, the results of the regression between female and male entrepreneurs showed that the relationship between age and R&D investment was different for the two types of entrepreneurs, indicating that gender differences play an essential moderating role in the relationship, and Hypothesis 2 was thus tested.

Table 3 Regression Test Results Discussing the Relationship Between the Age of Entrepreneurs and R&D Investment by Gender

	Female Entrepreneurs		Male Entrepreneurs	
	Model (1)	Models (2)	Model (1)	Models (2)
Age	2.414*** (3.72)	76.345** (2.53)	-0.206** (-2.35)	2.036 (0.66)
Age ²		-9.644** (-2.48)		-0.292 (-0.72)
Gov	0.235*** (3.40)	0.213*** (3.53)	0.175*** (14.98)	0.175*** (14.97)
Gear	0.672 (1.57)	0.702* (1.66)	-0.120 (-1.23)	-0.116 (-1.20)
SharePer	-0.070 (-0.33)	-0.134 (-0.65)	-0.054 (-1.26)	-0.054 (-1.26)
Share3	-0.006 (-0.02)	0.036 (0.11)	-0.053 (-0.79)	-0.051 (-0.76)
Cash	0.204 (1.57)	0.178 (1.54)	0.098*** (4.93)	0.098*** (4.93)
Scale	0.211* (1.69)	0.230* (1.88)	0.514*** (17.38)	0.514*** (17.38)
Roe	0.819 (1.25)	0.824 (1.48)	1.054*** (5.12)	1.051*** (5.09)
Cons	-4.913 (-1.34)	-145.996** (-2.51)	2.291*** (3.87)	-2.019 (-0.34)
Year	Control	Control	Control	Control
Ind	Control	Control	Control	Control
N	196	196	2993	2993
r ²	0.479	0.536	0.547	0.547
F	14.335	17.579	170.639	161.706
p	0.000	0.000	0.000	0.000

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(4) Test for the Moderating Effect of Other Heterogeneous Factors

(a) Heterogeneous influence of the nature of property rights

The paper further discussed the comparison of the relationship between the two in enterprises with different property rights nature, divided into two types of enterprises, state-owned enterprises as well as non-state-owned enterprises, with certain policy implications. From the regression results in Table 4, it could be seen that for SOEs, the results of both Model (1) and Model (2) were not significant, probably since that SOEs had stronger

administrative overtones, entrepreneurs had a more obvious agency role in SOEs and lacked strategic initiative for R&D investment, and that SOEs face less resource constraints. Coupled with the fact that poor performance of entrepreneurs would be subject to accountability and turnover, the relationship between the age of entrepreneurs and R & D investment was not significant. For non-SOEs, the results of Model (2) significantly demonstrated that the peak of the non-linear relationship was between 46-47 years old, and that non-SOEs had stronger motivation for R&D and innovation, but were more dependent on entrepreneurs due to their corporate nature.

Table 4 Regression Test Results of the Relationship Between the Age of Entrepreneurs and R&D Investment Discussed by Enterprises with Different Property Rights Nature

	State-Owned Enterprises		Non-State-Owned Enterprises	
	Model (1)	Model (2)	Model (1)	Model (2)
Age	0.205 (0.84)	-5.074 (-0.52)	0.010 (0.11)	9.251*** (2.78)
Age ²		0.681 (0.54)		-1.205*** (-2.78)
Gov	0.143*** (3.86)	0.143*** (3.84)	0.188*** (16.03)	0.188*** (16.03)
Gear	-0.578** (-2.18)	-0.583** (-2.19)	0.004 (0.04)	0.018 (0.19)
SharePer	0.022 (0.17)	0.019 (0.15)	-0.059 (-1.23)	-0.060 (-1.27)
Share3	0.146 (0.69)	0.144 (0.68)	-0.072 (-1.00)	-0.062 (-0.86)
Cash	0.008 (0.13)	0.006 (0.09)	0.128*** (6.10)	0.126*** (6.04)
Scale	0.660*** (8.08)	0.663*** (8.09)	0.465*** (16.20)	0.467*** (16.28)
Roe	3.240*** (5.46)	3.259*** (5.48)	0.886*** (6.43)	0.875*** (6.35)
Cons	-1.160 (-0.72)	9.068 (0.47)	1.797*** (3.09)	-15.938** (-2.49)
Year	Control	Control	Control	Control
Ind	Control	Control	Control	Control
N	355	355	2834	2834
r ²	0.556	0.557	0.529	0.531
F	24.862	23.447	186.277	176.779
p	0.000	0.000	0.000	0.000

t statistics in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

(b) The Impact of Economic Policy Uncertainty

Due to the demand for resources for enterprises' innovation activities, the function of entrepreneurial age on enterprises' R&D investment often changes due to enterprises' external resource acquisition. This study considered the effect of the level of uncertainty in the external environment on the ease of access to resources from the perspective of the external economic uncertainty factor. This paper used data from the paper "Measuring Economic Policy Uncertainty in China" written by Lu Shangqin and Huang Yun. Ten representative newspapers in China (Baker & Bloom, 2016) [22] were selected and the keywords related to economic policy uncertainty in the newspaper articles were searched to compile coefficients that reflect the level of economic policy

uncertainty according to the magnitude of the coefficients. This study argued that in years with high economic policy uncertainty, enterprises had limited access to external resources, and entrepreneurs faced greater constraints. Entrepreneurs, when allocating limited resources within the enterprise, would be instead more cautious with considering external constraints, thus exhibiting the alleviation of the midlife crisis phenomenon, when the impact of entrepreneurial age on enterprises' innovation inputs showed a non-significant effect. In years of low economic uncertainty, due to the increased availability of external economic resources, the restrictive resource factor of entrepreneurs decreased and the age of entrepreneurs re-expressed a stronger influence, still showing the mid-life crisis phenomenon as in the main hypothesis with the same inflection point of 48 years old.

Table 5 Regression Test Results of the Relationship Between Economic Policy Uncertainty Affecting the Age of Entrepreneurs and R&D Investment

	Low EPU Group		High EPU group	
	Model (1)	Model (2)	Model (1)	Model (2)
Age	0.002 (0.02)	12.368** (3.25)	0.149 (1.18)	-3.484 (-0.76)
Age ²		-1.611** (-3.25)		0.473 (0.79)
Gov	0.187*** (13.83)	0.186*** (13.81)	0.124*** (7.33)	0.124*** (7.32)
Gear	-0.010 (-0.10)	0.008 (0.08)	0.070 (0.49)	0.064 (0.45)
SharePer	-0.019 (-0.36)	-0.019 (-0.36)	-0.056 (-0.81)	-0.055 (-0.79)
Share3	-0.044 (-0.55)	-0.038 (-0.47)	0.001 (0.01)	-0.004 (-0.04)
Cash	0.120*** (5.40)	0.120*** (5.39)	0.039 (1.16)	0.039 (1.17)
Scale	0.510*** (16.60)	0.510*** (16.64)	0.630*** (13.44)	0.629*** (13.41)
Roe	1.032*** (6.12)	1.024*** (6.08)	0.856*** (4.48)	0.865*** (4.52)
Cons	0.324 (0.50)	-23.384** (-3.19)	-0.008 (-0.01)	6.995 (0.78)
Year	Control	Control	Control	Control
Ind	Control	Control	Control	Control
N	1955	1955	1234	1234
r ²	0.603	0.605	0.528	0.528
F	154.670	148.189	75.531	71.566
p	0.000	0.000	0.000	0.000

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(5) Robustness Test

In order to check the robustness of the findings, this paper chose the method of replacing the main independent variable for robustness testing, i.e., R&D investment. Given that most studies had adopted R&D intensity, i.e., the proportion of R&D investment to sales revenue of the enterprise in the current year, as a proxy variable for the enterprise's R&D investment. This paper also adopted the R&D intensity indicator as a proxy variable in the robustness test, and the above hypotheses were retested. It was found that all the results remained the same, and not all the test results were listed due to the limited space.

5. Conclusions and Implications

Using data from GEM listed companies, this study empirically tested the entrepreneurial age effect of enterprise R&D investment, and focused on examining and analyzing the effect brought by entrepreneurial gender. The study obtained the following conclusions:

(1) There was an inverted U-shaped relationship between the age of entrepreneurs and R&D investment. In other words, there was a peak of the relationship between entrepreneur's age and R&D investment, and the empirical test results showed that the peak was around 48 years old. (2) The gender of entrepreneurs could influence the relationship between the age of entrepreneurs and R&D investment, which was reflected in the negative relationship between the age of male entrepreneurs and R&D investment; whereas, there was a significant inverted U-shaped relationship between the age of female entrepreneurs and R & D investment, and the turning point of mid-life crisis was significantly lagged compared with the total sample. (3) For enterprises with different property rights, the empirical regression results showed a significant relationship between the two in non-state-owned enterprises, specifically a non-linear inverted U-shaped relationship. The relationship between entrepreneurial age and R&D investment in SOEs was not significant; economic policy uncertainty had a heterogeneous effect on the relationship between entrepreneurial age and R&D investment, and the relationship between entrepreneurial age and R&D investment was not significant in years with high economic policy uncertainty, showing the mitigating effect of resource access constraints on the mid-life crisis phenomenon.

Based on the above findings, the following insights were obtained from this study:

The age effect can significantly affect the investment decisions of enterprises, so the aging of the management team, especially the top managers, will lead to a decrease in the competitive vitality of enterprises, which requires enterprises to pay attention to maintain the age composition of the management team and try to prevent

the phenomenon of excessive aging of the decision-making hierarchy to improve the innovation vitality of enterprises. In addition, from the perspective of population policy, aging does have an impact on the improvement of innovation dynamics of enterprises. Therefore, at the policy level, corresponding measures shall be put forward to promote the rationalization of the age of the working population.

Besides, the percentage of female managers was still small, but they had already demonstrated their advantages in corporate management, governance, and decision-making, which was closely related to the increase of women's education and participation in social affairs in recent years. Several scholars have suggested that after the demographic dividend, the "gender dividend" released by liberating women's labor force and increasing women's participation in society would exert a great impact on society. Therefore, it is necessary to reasonably guide women's participation in business operation, management, and decision-making, and to improve the gender ratio of enterprise management teams, giving full play to the positive role of women in enterprise high-risk investment decision-making and long-term formulation of development station strategy.

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