Will the New Ceos Stick to the Rules or Show Their Ambitions?--from the Perspective of Enterprise Innovation Investment

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Abstract: The decision-making of the new CEO plays a vital role in the development of the enterprise in the next few years. The new CEO's attitude towards innovation investment, conservative or risk-taking, will determine the future core competitiveness of the enterprise to a certain extent. Based on the prospect theory and model derivation, this paper finds that whether the new CEO will invest in innovation depends on the growth of reputation and salary of the new CEO when the innovation is successful, the degree of aversion to losses, and the relative probability of successful innovation both objectively and subjectively.   Using a dataset of the listed companies in China from 2009 to 2019, this paper makes an empirical test on the relationship between new CEOs and enterprise innovation investment, and the results show that there is a significant negative correlation between new CEOs and enterprise innovation investment.   Further research shows that the degree of new CEO's reluctance to invest in innovation will be affected by personal characteristics such as age or external environment, the preferential policies of the state to encourage innovation. The conclusion of theoretical model derivation and empirical test results show the enterprises how to encourage their new CEOs to actively invest in innovation, which is of great significance to the promotion of enterprise's sustainable innovation ability.

1. Introduction

Innovation refers to the process of continuously making progress in corporate products, production process and marketing by introducing new production technology, materials, talents and other elements. Innovation investment plays an important role in maintaining the enterprises, improving long-term profitability and increasing the market value of enterprises (Gerosk et al.,1993; Sheikh,2012). Only through continuous innovation can enterprises improve the core competitiveness of their products and expand their market share. Therefore, it is of great significance to explore what factors affect the level of enterprise innovation investment.

However, innovation has high risks. The cost of innovation is quite high and the short-term benefits are not obvious, which means the success of innovation is uncertain (Holmstrom,1989). Therefore, due to different risk preferences, different CEOs in different enterprises have different attitudes towards innovation investment. The CEO's age, education level, professional background and narcissistic tendency will have a significant impact on the amount of innovation investment (Chen Linde et al., 2011;Tuwe & Ngeno,2019). Besides, CEOs will also take different decisions according to the internal and external environment (Pfeffer & Salancik,1978). Some researches discussed the impact of external environment and internal R&D status on innovation investment, such as the relationship between competition and innovation investment of small and medium-sized enterprises (Moen et al.,2018), the impact of technology introduction on independent innovation investment of enterprises (Xinjian & Shanshan,2010), and the relationship between external environment and internationalization degree and innovation investment of enterprises (Huse et al.,2005).

The decision-making of the new CEO is crucial for the company to turn into a safe place and to go from decay to prosperity. A range of measures taken by the new CEO can have a positive impact

on the overall value of the business. For example, the new CEO can take corrective measures to improve some of the adverse measures affecting the development of the enterprise (Pan & Wang,2011).However, The psychology of a new CEO is often special, and it requires adaptation to a new competent role (Porter, 2004). For example, the new CEO is not familiar with the specific R&D capabilities of the enterprise and can not control the specific research process of the R&D team, which may make the new CEO consider innovation investment more carefully.

Therefore, this paper constructs a decision-making model of CEO innovation investment based on prospect theory, and deduces that whether the new CEO will make innovation investment depends on the growth of reputation and salary of the new CEO when the innovation is successful, the degree of aversion to losses, and the relative probability of successful innovation both objectively and subjectively. In order to verify the conclusion of the model, this paper takes the data of Listed Companies in Shanghai and Shenzhen stock markets from 2009 to 2019 as samples to empirically test the relationship between new CEOs and enterprise innovation investment. The empirical results show that there is a significant negative correlation between new CEOs and innovation investment. In addition, the new CEOs show differences when deciding whether to make innovation investment, affected by different external environment or their own different characteristics.

The main contributions of this paper are as follows: i) The main research object of this paper is the 'new' CEO. The newly appointed CEO is the CEO of the enterprise after the change. The business decisions the new CEO chooses to make often reflect the current internal and external environment of the enterprise and have a great impact on the future development of the enterprise. ii) It extends the application of behavioral economics in the field of innovation management and constructs a theoretical model of innovation investment of new CEO based on prospect theory. iii) It provides empirical evidence for the future development of Chinese enterprises. The empirical test shows that there is a significant negative correlation between new CEO and enterprise innovation investment, which shows that in China, new CEO has a high degree of risk aversion.

2. Theoretical Analysis and Research Hypothesis

2.1 Theoretical Model

Kahneman and Tversky put forward the prospect theory (Kahneman & Tversky, 1979) in 1979. The theory holds that bounded rational people tend to be more conservative and unwilling to take risks when facing positive prospects because of risk aversion. On the other hand, in the face of loss, they will prefer risk and dare to take risks. According to prospect theory, this paper establishes a model of the relationship between new CEO and innovation investment. Firstly, the form of value function is set as follows:

$$v(x) = \begin{cases} 1 - e^{-\gamma x} & x \geq 0 \\ -\lambda\left(1 - e^{\gamma x}\right) & x < 0 \end{cases} \tag{1}$$

We have $x^+ = I - C + F$ and $x^- = -C + F$. In particular, when the CEO does not invest in innovation, there are $I = 0, F = 0$ and $C = 0$. I indicates the change of CEO's salary while F is the change of CEO's reputation. C is the cost of enterprise innovation, and D shows whether he is a new CEO. $\gamma > 0$ indicates the risk aversion coefficient of CEO to innovation success and innovation failure while $\lambda > 0$ shows the aversion coefficient of CEO to innovation failure.

The change of CEO's salary(I) and the change of CEO's reputation (F) will be affected by whether the CEO is new or not(D)and the company's profit(P). New CEOs are expected to take corrective measures to increase the value of the company. When the company's performance is poor due to major mistakes and uncontrollable factors, CEOs will be fired (J Dirk & K Fadi,2006;Pan & Wang,2011), so we have:

$$I = I(D, P, ...); F = F(D, P, ...) \tag{2}$$

$$\frac{\partial I}{\partial D} > 0 \tag{3}$$

$$\frac{\partial F}{\partial D} > 0 \quad (F \geq 0); \frac{\partial F}{\partial D} < 0 \quad (F < 0) \tag{4}$$

γ and λ will be affected by whether the CEO is new or not(D).When the positive prospect of salary and reputation of new CEOs is the same as that of non-new CEOs, their total value will be higher. On the other hand, When innovation fails, its perceived total value will be lower. At the same time, if the new CEO's performance is bad, his reputation will decline quickly. As a result, new CEOs are more risk averse. So we have:

$$\gamma = \gamma(D,...); \lambda = \lambda(D,...) \tag{5}$$

$$\frac{\partial \gamma}{\partial D} > 0; \frac{\partial \lambda}{\partial D} > 0 \tag{6}$$

Then we introduce φ, the objective probability of innovation success and set the weight function of innovation success:

$$\pi = \pi[\varphi(D)] \tag{7}$$

Then, the weight function of innovation failure is:

$$\pi = \pi[\eta(D)], \quad \eta = 1 - \varphi \tag{8}$$

According to Porter (2004), new CEOs tends to need a certain amount of time to adapt to his new job and can not learn perfect information in this complex new field, so the probability of innovation success of new CEOs is generally smaller than that of non-new CEOs. On the contrary, the probability of innovation failure, objectively speaking, is generally higher than that of non-new CEOs. Then we have:

$$\frac{\partial \varphi}{\partial D} < 0; \frac{\partial \eta}{\partial D} > 0 \tag{9}$$

According to the weight function, the objective probability of the new CEO's innovation success is generally small while the bounded rational person will overestimate the probability of innovation success. In this case, the probability of the weight function and the objective probability of innovation success change in the opposite direction. The objective probability of innovation failure is generally large, so the probability of the weight function and the objective probability of innovation success change in the same direction. So there is

$$\frac{\partial \pi}{\partial \varphi} < 0; \frac{\partial \pi}{\partial \eta} > 0 \tag{10}$$

According to prospect theory, the utility of new CEO's innovation investment is

$$E(U) = v(x^+)\pi(\varphi) + v(x^-)\pi(\eta) \tag{11}$$

By substituting $(1),(7)$ and (8) into (11), we get

$$E(U) = \left(1 - e^{-\gamma(I-C+F)}\right)\pi[\varphi(D)] + \left[-\lambda\left(1 - e^{\gamma(-C+F)}\right)\right]\pi[\eta(D)] \tag{12}$$

calculate derivative of function $E(U)$ with respect to D, the outcome is

$$\frac{\partial E(U)}{\partial D} = a + b + c \tag{13}$$

where

$$a = -e^{-\gamma(I-C+F)}\left[-\frac{\partial \gamma}{\partial D}(I-C+F) + (-\gamma)\left(\frac{\partial I}{\partial D} + \frac{\partial F}{\partial D}\right)\right]\pi[\varphi(D)] + \left[1 - e^{-\gamma(I-C+F)}\right]\left[\frac{\partial \pi}{\partial \varphi}\frac{\partial \varphi}{\partial D}\right]$$

$$b = (-\lambda)\left[-e^{\gamma(-C+F)}\right]\left[\frac{\partial \gamma}{\partial D} + \gamma \frac{\partial F}{\partial D}\right]\pi\left[\eta(D)\right]$$

$$c = \left(-\frac{\partial \lambda}{\partial D}\right)\left(1 - e^{-\gamma(I-C+F)}\right)\pi\left[\eta(D)\right] + (-\lambda)\left[\frac{\partial \pi}{\partial \eta}\frac{\partial \eta}{\partial D}\right],$$

It can be seen that $a > 0, c < 0$ and the sign of b is uncertain according to $(3)(4)(6)(9)(10)$. So the sign of $\frac{\partial E(U)}{\partial D}$ depends on the relative size of the absolute value of a, b and c.

If $\left|\gamma \frac{\partial F}{\partial D}\right| > \frac{\partial \gamma}{\partial D}$, we have $B < 0$. In this case, if $|A| < |B| + |C|$, then we have $\frac{\partial E(U)}{\partial D} < 0$. On the contrary, $\frac{\partial E(U)}{\partial D} > 0$. When $\left|\gamma \frac{\partial F}{\partial D}\right| < \frac{\partial \gamma}{\partial D}$, we have $B > 0$. In this case, if $|A| + |B| < |C|$, then we have $\frac{\partial E(U)}{\partial D} < 0$. On the contrary, $\frac{\partial E(U)}{\partial D} > 0$.

The new CEO is willing to invest in innovation with $\frac{\partial E(U)}{\partial D} > 0$ while the new CEO is reluctant to invest in innovation with $\frac{\partial E(U)}{\partial D} \leq 0$.

2.2 Hypothesis

2.2.1 New Ceo and Innovation Investment

From the theoretical model derivation process and results, it can be seen that, objectively speaking, new CEOs have a higher probability of innovation success and the salary and reputation of new CEOs increase a lot when they succeed in innovation. Also, in the view of the new CEO's subjective psychology, if the new CEO overestimate the probability of innovation success and has a lower degree of loss aversion, the new CEO is more willing to carry out their grand plans. On the contrary, the CEO chooses to stick to the rules and is unwilling to invest in innovation.

Thus we posit:

h1a: There is a significant positive correlation between new CEO and innovation investment.

h1b: There is a significant negative correlation between new CEO and innovation investment.

2.2.2 The Different Influence of the Age of New Ceo on the Relationship between New Ceo and Innovation Investment

The age of CEO is one of the important aspects of CEO's personality. Hemanus(2015) found that young CEOs are more willing to engage in M & A transactions because the personal salary income of young CEOs are greater than those of older CEOs. Similarly, when younger CEOs invest in innovation and succeed, the increment of salary and reputation is more than that of older CEOs. An older new CEO has lower risk preference(Serfling & Matthew,2014),and his overestimation of innovation success probability is lower. On the other hand, according to wiebel(1995) and B Holmstrom(1989), young new CEOs do not have high-quality reputation. Therefore, young CEOs may be punished more severely for their poor performance, that is, after innovation failure, reputation will be reduced more than that of older CEOs, which will also make younger new CEOs have a higher degree of loss aversion. Thus, the following hypotheses are proposed:

h2a: Compared with older CEOs, younger new CEOs are more willing to invest in innovation.

h2b: Compared with younger CEOs, older new CEOs are more willing to invest in innovation.

2.2.3 The Impact of National Innovation Policies on the Relationship between New Ceos and Innovation Investment

The fiscal and tax policies implemented in China on January 1, 2016. further relaxed the scope of R & D activities of enterprises, clarifiing the negative list system and expanding the scope of R & D expenses that can be deducted. This policy reduces the innovation cost of enterprises so that enterprises can improve the quality of innovation at the same cost of innovation and ultimately increase the probability of innovation success. However, this will reduce the level of the growth of new CEO's salary and reputation when there is an innovation success. On the contrary, with the support of national innovation preferential policies, an innovation failure will increase the level of the decrease of new CEO's salary and reputation. According to Gu Jinhui and Ma Baichao (2020), though government subsidies will make up for some losses caused by innovation failure, they will make managers more averse to losses. Therefore, new CEOs will be more reluctant to invest in innovation with the implementation of the national preferential policies to encourage innovation.

h3: China's policies to encourage innovation in 2016 will increase the propensity of new CEOs to be unwilling to invest in innovation.

3. Research Design and Data

3.1 Sample and Data Sources

This paper selects Shanghai and Shenzhen listed companies from 2009 to 2019 as samples. The samples were screened according to the following rules: (1) Exclude ST and * ST companies. (2) Exclude financial and insurance companies. (3) Remove the companies with missing data, such as those with missing CEO departure date or incomplete disclosure information of R&D expenditure. (4) In order to eliminate the influence of extreme values, narrow the extreme values of all continuous variables at the levels of 1% and 99%. In the end, a total of 5948 samples of 1381 listed companies were obtained.

3.2 Variables and Models

3.2.1 Dependent Variable

The dependent variable is innovation investment intensity. Referring to Chen(2013), Wen Fang and Hu Yuming (2009), the innovation investment intensity is measured by the ratio of total R&D expenditure to business income.

3.2.2 Independent Variable

According to Xu Yan et al. (2017), if a CEO takes office before June 30 of year t, the first year of the CEO's tenure is year t. If he takes office after June 30 of year t, year t+1 is defined as the first year of the CEO's term. If a CEO will be re-elected multiple times within the same company, the multiple terms of the CEO will be added together and treated as one term. Based on the practice of Ali & Weining (2015), this paper takes half of the median CEO tenure (3 years) as the criterion for whether the CEO is new or not, and sets the independent variable as the dummy variable early years. The value is 1 if the annual observation value of a company is within half of the sample median of the CEO's tenure.

3.2.3 Control Variable

The R&D expenditure is not only affected by whether the CEO is in the early stage of his tenure but also affeted by other factors. According to the existing literature, such as Liu Yunguo and Liu Wen (2007), Wen Fang and Hu Yuming (2009), Yan ruoshen and Zhou ran (2021), etc., this paper selects the following factors as the control variables: asset-liability ratio (lev), return on assets (roa), enterprise size (size), average pay of executives (pay), proportion of fixed assets (ppe), Shareholding ratio of the top five shareholders (top5hold), the industry (industry) and the year (year).

All variables used in our estimates are described in Table 1.

Table 1 Variable Description

Type	Variable	symbol	Description
Dependent variable	Innovation investment	rd	total R&D expenditure/business income
Independent variable	New CEO	earlyyears	Dummy equal to 1 if the CEO's tenure is in the period mentioned above, 0 otherwise
Control variable	asset-liability ratio	lev	total liabilities/total assets at the end of the period
	return on assets	roa	Net profit/total assets at the end of the period
	enterprise size	size	total assets at the end of the period(natural logarithm)
	average pay of executives	pay	average pay of executives at the end of the period(natural logarithm)
	proportion of fixed assets	ppe	Fixed asset value/total assets
	Shareholding ratio of the top five shareholders	top5hold	shares held by the top five shareholders/total share capital of the company×100
	year	year	dummy year variable
	industry	industry	dummy industry variable

3.3 Models

In order to test hypothesis 1a and 1b, this paper constructs the following model to test the impact of new CEO on innovation investment.

$$rd_{i,t} = \beta_0 + \beta_1 earlyyears_{i,t} + \beta_2 control\ variables_{i,t} + year_i + industry_i + \varepsilon_{i,t}\ (14)$$

In this model, i denotes individual listed company and t represents year. The independent variable $rd_{i,t}$ represents the innovation investment of listed company i in year t, that is, the ratio of the total R&D expenditure to the business income of the company i in year t.

4. Empirical Results and Analysis

4.1 The Regression Results of New Ceo and Enterprise Innovation Investment

This paper performs regression on the model constructed above, and the regression results are shown in Table 2. Column (1) shows that when no control variable is added, the regression coefficient of innovation investment to new CEO is -0.791. Although it is significant at the 1% level. The R2 is only 0.89%, which indicates that the regression line fits the observed value to a low degree.In column (2) where control variables such as the asset-liability ratio and the return on assets are added (all of which are variables with a lag of one period), the regression coefficient between new CEO and enterprise innovation investment is - 0.715(p<0.01) and all the selected control variables are significant at 1% level. At the same time, the R2 rises to 18.84%, which shows that the interpretation of the regression has been greatly improved. Column (3) shows that when time and industry are further controlled on the basis of column (2), the regression coefficient between new CEO and enterprise innovation investment is -0.358(p<0.01), and other control variables are significant. The R2 increases again to 27.92%. We find support for hypothesis 1b that the relationship between new CEO and enterprise innovation investment is negatively correlated, which indicates that CEO in the early stage of taking office is not willing to make innovation investment generally.

Table 2 New Ceo And Enterprise Innovation Investment

Variable	rd		
	(1)	(2)	(3)
earlyyears	-0.791*** (-6.03)	-0.715*** (-6.13)	-0.358*** (-2.72)
lev		-5.097*** (-7.93)	-4.260*** (-6.66)
roa		-5.983***	-5.396**

		(-2.62)	(-2.46)
size		-0.553***	-0.417***
		(-6.67)	(-5.08)
pay		2.170e-06***	1.62e-06***
		(4.79)	(3.77)
ppe		-4.490***	-4.129***
		(-8.07)	(-7.12)
top5hold		-1.514***	-1.033***
		(-2.63)	(-1.85)
year			yes
industry			yes
N obs	5948	5948	5948
R^2	0.89%	18.84%	27.92%

T value in brackets

5. The Heterogeneity Test of the New Ceo's Investment in Innovation

5.1 Group Regression Results and Analysis of the Age of the New Ceo

Taking the age in the first year of the new appointment as the criterion, the dummy variable method is used to test the structure of the sample to test whether the CEO's age will actually cause structural changes and at which age node will cause major structural changes. After many trials, it was found that the CEO will undergo structural changes at the 64-year-old node. Generate dummy variable d1 ($d_1 = 1$ if the age is greater than or equal to 64 years old and $d_1 = 0$ if the age is less than 64 years old) and introduce both d1 and the interaction term earlyyears*d1 for OLS regression on the basis of model (14). The p value of the test is 0.0326, so the original hypothesis of 'no structural change' can be rejected at 5% level, which means that the relationship between the new CEO and enterprise innovation investment changes when the CEO is 64 years old.

The CEOs in the sample were classified according to the classification point (age of 64). The regression model was the same as the model controlling the year and industry.

Column (1) represents the regression results of CEOs aged 64 or above, with a regression coefficient of -1,539(p<0.05). Column (2) represents the regression results of CEOs younger than 64 with the regression coefficient is -0.333(p<0.05). We find that the hypothesis 2a holds. It shows that although the reputation of younger CEOs will decline more when they fail in innovation, they will gain more reputation and salary when they succeed in innovation than older CEOs. In addition, younger CEOs have higher risk preference and dare to take risks, so younger CEOs are more active than older CEOs.

5.2 An Analysis of the Impact of National Innovation Policies on the Relationship between New Ceos and Innovation Investment

Generate the dummy variable encouragement ($encouragement = 1$ indicates that the year is 2016 or later while $encouragement = 0$ indicates that the year is before 2016). The regression model is as follows:

$$rd_{i,t} = \beta_0 + \beta_1 earlyyears_{i,t} + \beta_2 encouragement_{i,t} + \beta_3 encouragement_{i,t} earlyyears_{i,t}$$
$$+ year_i + industry_i + \varepsilon_{i,t} \qquad (15)$$

$$rd_{i,t} = \beta_0 + \beta_1 earlyyears_{i,t} + \beta_2 encouragement_{i,t} + \beta_3 encouragement_{i,t} earlyyears_{i,t}$$
$$+ \beta_4 control\ variables_{i,t} + year_i + industry_i + \varepsilon_{i,t} \qquad (16)$$

The regression results are shown in Table 3. In the case of uncontrolled and controlled the year and industry dummy variables, the variable encouragement is significantly positive(p<0.01), which indicates that the implementation of national innovation incentive policy (lowering the threshold for enterprises to enjoy preferential treatment) can significantly improve the innovation investment of enterprises. However, the regression coefficient of the earlyyears*encouragement is significantly

negative(p<0.01) whether the year and industry are controlled or not. Therefore, the implementation of the policy of encouraging innovation will make the new CEO more reluctant to invest in innovation. This may be because CEOs feel that there will not be a lot of salary and reputation increases under the implementation of the national preferential policies for innovation even if they succeed in the innovation.If they fail, their reputation will decline more, so they are more averse to the loss. New CEOs are more reluctant to invest in innovation under the preferential policies to encourage innovation.

Table 3 the Impact Of Age and the Country's Policies on New Ceos and Innovation Investment

variables	rd			
	(1)	(2)	(3)	(4)
earlyyears	-1.539** (-2.22)	-0.333** (-2.50)	-0.524*** (-4.05)	-0.208* (-1.89)
encouragement			0.525*** (3.65)	2.233*** (5.15)
earlyyears* encouragement			-0.405* (-1.65)	-0.568** (-2.22)
control variables	yes	yes	yes	yes
year	yes	yes	no	yes
industry	yes	yes	no	yes
N obs	135	5813	5948	5948
R^2	44.36%	28.08%	19.14%	27.99%

6. Conclusion and Enlightmentnment

If the new CEO actively invests in innovation, he may succeed or fail. Based on the prospect theory of behavioral economics along with theoretical model derivation and empirical test, it is concluded that there is a significant negative correlation between the new CEO and enterprise innovation investment. Younger new CEOs are more willing to invest in innovation. The government's policy of encouraging enterprise innovation through the reform of deduction of R&D expenses makes the experienced CEOs willing to increase innovation investment, while the new CEO is not willing to increase innovation investment for the new CEO is afraid of being accused of wasting public resources if the innovation fails.

This gives the following enlightenment: (1) Provide more training for new CEOs so that they can adapt to the role of CEO as soon as possible. At the same time, enterprises should constantly improve their strength of R&D, so as to improve the objective probability of innovation success and the subjective probability of innovation success of new CEOs, which makes new CEOs   invest in innovation more willingly.(2) According to the prospect theory, if enterprises want to increase innovation when CEO changes, they should employ younger CEOs after CEO changes. The state's policy of encouraging innovation can eventually make CEOs increase innovation investment but it is not the same thing when they are new CEOs, which requires enterprises to formulate some effective incentive measures to encourage new CEOs to be more willing to invest in innovation.

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