Research on the Relationship between Innovation Capability and Corporate Performance: The Moderating Effect of Value Cognition Complexity and R&D Leap

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Abstract: Based on the theories of value cognition and punctuated equilibrium, this paper takes the panel data of 73 listed companies of AI concept stocks in China from 2011 to 2021 as samples. It analyses and tests the impact of innovation capability on corporate performance, the moderating effect of value cognition complexity during this process, and the activating effect of R&D leap on such effect. The research shows that corporate innovation capability of makes a positive impact on corporate performance; value cognition complexity negatively regulates the positive relationship between innovation capability and corporate performance and the relationship between innovation capability and corporate performance is jointly regulated by the R&D leap and value cognition complexity. This research is of important theoretical and practical significance for exploring the improvement in corporate innovation capability and the remodelling of the cognitive framework.

Keywords: Innovation Capability, Value Cognition, R&D Leap.

1 INTRODUCTION

With the rapid development and application of emerging technologies, such as artificial intelligence (AI) and big data, these technologies not only inject new momentum into the global economy but also bring about a disruptive revolution to the development of enterprises [13, 16]. Its strong autonomy and deeper learning and decision-making capabilities help enterprises to design intelligent products, novel services and invent new business models and organizational models, thus creating value. However, due to the rapid updating of emerging technologies, in the face of the transformation of emerging technologies involving AI, enterprises need to have a strong innovation capability and innovation output to survive and develop amid fierce competition. So, how the enterprises in the wave of AI technology choose an appropriate way for improving their innovation capability based on the value cognition structure becomes the key to gaining a competitive edge. In fact, there remains a research gap in the existing literature.

In recent years, scholars focusing on strategic management have started to emphasize the role of managers' cognitive factors in the establishment of dynamic capabilities to explain the path creation or punctuation in the dynamic development of organizational capabilities [25]. However,

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capability research and management cognition research in the strategic management field has been developing on two parallel tracks [6]. Essentially, the improvement in innovation capability is an organizational learning process that contains knowledge search and selection, which is affected by the cognitive framework of enterprises [20]. On the one hand, the information processing theory holds that an enterprise with a complex, decentralized cognitive framework has more complete sources of knowledge so that it can more accurately identify and select opportunities in the environment and improve the quality of risk decision-making [2, 5, 20]. On the other hand, the social classification theory believes that an enterprise with a complex, decentralized cognitive framework will see a longer psychological distance in the decision-making process, increasing the cost of making risky decisions [10]. Thus, there is a controversy on the role of value cognition in the improvement of innovation capability and the growth of corporate performance.

Also, the R&D mode is important for the continuous improvement of enter-prises' innovation output and competitiveness. Some studies believe that it is not necessary for enterprises to match the level of high value cognition in the case of a small R&D leap due to the small risk of innovation [24]. But, some studies argue that enterprises need to match higher value cognition in the case of a small R&D leap to achieve the potential capabilities necessary for improving their innovation capability [1]. Thus, the impact of R&D leap and value cognition on corporate innovation under different matching scenarios is still controversial.

Overall, Based on the theories of value cognition and punctuated equilibrium, this paper takes the panel data of 73 listed companies of AI concept stocks in China from 2011 to 2021 as samples. It analyses and tests the impact of innovation capability on corporate performance, the moderating effect of value cognition complexity during this process, and the activating effect of R&D leap on such effect.

2 RESEARCH HYPOTHESES

2.1 Innovation Capability and Corporate Performance

According to the resource-based theory, the outstanding innovation capability of an enterprise, as the main driving force for its advantage in market competition, will also directly act on the enterprise's innovation performance [7]. First, a strong innovation capability of an enterprise can help it effectively digest and absorb knowledge related to scientific and technological production and convert the scientific value and technological value into economic value, thus improving its innovation performance [31]. Second, the innovation capability of an enterprise can make it favored by external investors as these investors believe that innovative products can bring more benefits; and investors' confidence in the enterprise's innovation capability has con-tributed to the increase in their capital investment in the enterprise and provided some financial guarantee for the improvement in the enterprise's innovation performance [17]. Based on the above, this paper holds that there exists a positive correlation between the innovation capability of an enterprise and corporate performance and puts forward Hypothesis 1 as follows:

H1: Corporate innovation capability makes a positive impact on corporate performance.

2.2 The Impact of Value Cognition Complexity on the Relationship between Innovation Capability and Corporate Performance

Complexity refers to the breadth of knowledge contained in the knowledge structure of managers. It combines the links of value chain creation, i.e. the number of value creation links that managers pay attention to [3]. An enterprise with a complex, de-centralized cognitive framework will have a longer psychological distance in the decision-making process, thus increasing the cost of risk decision-making [10]. Moreover, emerging technologies are complex and highly uncertain, which increases the difficulty of enterprises' technology R&D [8]. As a result, enterprises are forced to pay attention to more external stimuli and react to them. At this point, a complex, decentralized cognitive framework will make it more difficult to achieve recognition among decision-making sub-groups [10, 18]. The lack of identity will result in prejudice and the stereotype effect among different decision-making sub-groups, and increase task and relationship conflicts among teams [12]. Based on the above, Hypothesis 2 is proposed as follows:

H2: Value cognition complexity negatively regulates the positive relationship between innovation capability and corporate performance. This means the positive relationship between corporate innovation capability and corporate performance will be weakened in the case of higher value cognition complexity.

2.3 Joint Interaction of R&D Leap and Value Cognition Complexity on the Relationship between Innovation Capability and Corporate Performance

Scholars Mudambi et al. (2011) used for the first time in 2014 the concept of "R&D leap" to describe the dynamic alternating process for exploratory innovation and utilization innovation. The transformation of innovation is a dramatic change that requires all elements in the enterprise to change their practices [19]. A higher degree of complexity forces more enterprises to pay attention to and respond to external stimuli [11, 26]. If too much attention is paid to the value link, high sunk costs will be incurred in the reallocation of resources [3], thus increasing the risk and costs of technological innovation. Conversely, in the case of low complexity, managers pay less attention to the value link. During the transformation, enterprises need to change less inertia such as systems, so they are highly flexible and spend less sunk costs [3], which is conducive to their technological innovation. Based on the above, Hypothesis 3 is proposed as follows:

H3: The relationship between innovation capability and corporate performance is jointly regulated by R&D leap and value cognition complexity. In the case of small R&D leap and low value cognition complexity, this relationship is positive.

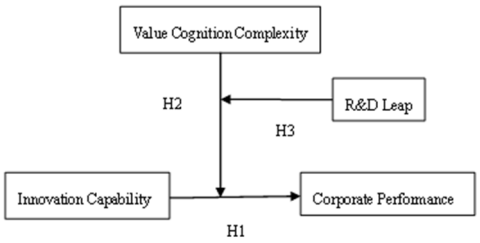

Figure 1: Conceptual framework

3 METHODS AND MATERIALS

3.1 Samples and Data Sources

This paper studies the listed companies of Flush AI concept stocks from 2011 to 2021 as a case. The reason for such a choice is as follows: (1) Highly reliable data. (2) Highly matched research problems. AI is the frontier field of emerging technologies. This field features intensive R&D activities of AI enterprises and a strong R&D foundation of enterprise teams. Meanwhile, for more accurate measurement, we performed an initial screening of data by taking the following measures:

First, excluding companies with poor performance and with the marks of ST, ST* and PT, etc. Second excluding companies with missing or incomplete data;

Meanwhile, considering the lagging effect of innovation capability on corporate performance, this paper takes the three-year average of corporate performance. Finally, a total of 73 enterprise samples were obtained. The annual reports and social responsibility reports were downloaded from CNINFO to manually encode data and obtain value cognition data. Patent data, R&D data, the proportion of independent directors, shareholding percentage of institutional investors, the proportion of state-owned shares, dual roles of the CEO, enterprise age, enterprise size, and other indicator data of sample enterprises were downloaded from the CSMAR Database. Also, the above data were supplemented and verified in combination with the annual reports of sample enterprises.

3.2 Variable Measurement

3.2.1 Dependent Variable: Corporate Performance

Based on Mudambi et al. (2014) Tobin's Q value is selected as the proxy variable of corporate performance in this paper. That the value is larger than 1 indicates the enterprise can sell at a price higher than its asset cost or the enterprise is creating value.

3.2.2 Independent Variable: Innovation Capability (INN)

Compared with other data, corporate patent data is not easy to be manipulated and represents a good way to measure innovation capability [29]. So, the number of patents of listed companies is selected in this paper as the proxy variable of innovation capability. With reference to Hottenrott et al.(2012), the number of patents is measured by the number of enterprises' applications for patents of invention. Also, the data are processed by referring to the calculation method of Chen et al.(2020):

(1) Number of corporate patents=1+the natural logarithm of the total number of pa-tent applications for the enterprise in the current year

3.2.3 Moderator Variable: Value Cognition Complexity (Nc)

By reference to the coding research design by Nadkarni, et al. (2007), and Wu (2011), the content analysis method is used in this research to describe the complexity of value cognition in the R&D process of Chinese enterprises. The steps are shown as follows:

Step 1: Statement recognition stage. The annual reports and social responsibility reports of enterprises are studied. Then, according to the coded vocabulary summarized by Wu (2011) in his research, identify and record the statements that enterprises take into account when they plan innovation strategies, as shown in each annual report.

Step 2: From the selected statements, identify the number of links in the value creation chain (such as R&D, production, market, manpower, and operation) that the enterprises consider and count it as the value of value cognition complexity. The greater the complexity value, the more value creation links are considered in the process of corporate decision-making and cognition.

The specific vocabulary is shown in Table 1

3.2.4 Moderator Variable: R&D Leap (RDL)

This paper refers to Mudambi et al. (2014) and Swift (2016), particularly their methods of measurement of R&D leap. The specific steps are shown as follows:

Step 1: Calculate the autoregressive model residual u_{itn} of the ith enterprise in year t and then proceed to the modeling of the next step;

Step 2: Calculate the GARCH model residual of the ith enterprise in year t, which measures the degree to which the enterprise's R&D expenditure in the year deviates from the predicted value that shows its historical trend;

Step 3: Then, calculate the studentized residual $e_{itn}(stud)$ for the R&D expenditure GARCH model of the ith enterprise in year t for subsequent comparative research. The specific calculating formula is shown as follows:

(1) $e_{itn}(stud) = \frac{e_{itn}}{s_i\sqrt{(1-h_{int})}}$, where s_i is the standard deviation of e_{itn} and h_{int} is the impact of $u_{itn}$of the ith enterprise in year t on the entire estimation.

Step 4: Compare the absolute value of studentized residuals of each enterprise during the ten years from 2011 to 2020 and find the maximum value $e_i(\max)$ during the observation, which is the R&D leap of the ith enterprise.

3.2.5 Control VARIABLES

In this paper, control variables based on research on innovation capability and corporate performance are selected. First, the strategic deployment of an enterprise will affect its innovation decisions. Thus, the proportion of independent directors, the shareholding percentage of institutional investors, the proportion of state-owned shares, and the dual roles of the CEO are adopted as control variables in this paper. Second, due to the impact of corporate innovation output by corporate resources [28], enterprise age, enterprise scale, and asset-liability ratio are also controlled in this paper. Finally, given the impact of the difference in the industry and the year, the innovation output on the enterprise (Chen, et al., 2018; Chen, et al., 2021), the industry and the year are also con-trolled here.

4 DATA RESULTS

4.1 Descriptive Statistics

In this paper, stata17.0 is used to make descriptive statistics on the data to obtain the mean and variance, and Pearson correlation coefficient is used to describe and test the correlation between variable data. The relevant results are shown in Table 2. Furthermore, all the variance expansion factors are tested. It is found that all VIF values are smaller than 3 and the mean value is 1.37, indicating that the model in this paper is free of the serious multicollinearity problem.

4.2 Hypothesis Test

In order to avoid the problems of heteroscedasticity, sequence correlation, and cross-section correlation, the Driscoll-Kraay (D-K for short) standard error is used for estimation with the aid of stata16.0. Meanwhile, the original hypotheses are rejected by the Hausman test results, so the fixed effect model is adopted. Additionally, the interaction term variable in the model is centralized to avoid multicollinearity.

(1) Testing the effect of innovation capability on corporate performance

This paper conducts a multiple regression analysis on the relationship between core variables, with the results shown in Table 3. According to Model 2, the regression coefficient of innovation capability is 0.056 ($p<0.05$), indicating a significant positive correlation between innovation capability and corporate performance. Thus, Hypothesis 1 is verified.

Table 1. Coding vocabulary of value creation link

Value creation links		Key words
Main links	R&D	Research, R&D, scientific research, manufacture, development, etc.
	Design	Design, planning, etc.
	Production	Processing, OEM, smelting, rough refining, refining, fabrication, assembly, synthesis, production, etc.
	Marketing	Publicity, development, expansion, promotion, market, marketing, advertising, brand, image, underwriting, etc.
	Supply	Exploration, mining, mining and beneficiation, procurement, purchase, transportation, logistics, freight, etc.
	Service	Maintenance, repair, installation, debugging, representative, technical service, technical support, etc.
Support links	Information management	Information collection, collection, research, investigation, understanding, opportunities, risks, analysis, feedback, briefing, reporting, mastery, etc.
	Relationship management	Contact, communication, coordination, relationship, organization, communication, cooperation, alliance, investment promotion, etc.
	Operation management	Supervision, supervisor, control, finance, operation, project management, etc.
	Manpower	Raising, recruitment, talents, education, training, exchange, assignment, labor, personnel, etc.

Table 2. Descriptive statistics of variables and Pearson correlation analysis

	Mean	SD	Perform	INN	Nc	RDL	Age	Size	debt	Inst	Indep	Stat	Dual
Perform	3.275	1.889	1										
INN	2.875	1.893	-0.137***	1									
Nc	4.730	1.859	-0.125***	0.231***	1								
RDL	2.428	4.305	-0.093**	0.169***	0.143***	1							
Age	2.834	0.305	-0.163***	0.206***	-0.00100	0.162***	1						
Size	22.14	1.249	-0.322***	0.644***	0.282***	0.252***	0.321***	1					
debt	0.332	0.176	-0.335***	0.302***	0.290***	0.344***	0.196***	0.567***	1				
Inst	2.865	6.724	0.0460	-0.077**	-0.0510	-0.137***	-0.281***	-0.148***	-0.118***	1			
Indep	0.378	0.0585	0.091**	-0.107***	0	-0.0110	0.194***	-0.0580	0.098***	-0.0520	1		
Stat	0.0190	0.0801	-0.00900	0.078**	0.0480	0.215***	0.0220	0.117***	-0.0310	0.091**	0.141***	1	
Dual	0.337	0.473	0.0670	-0.195***	-0.0340	-0.190***	-0.101***	-0.249***	0.195***	-0.0570	0.149***	-0.121***	1

(2) Testing the moderating effect of value cognition complexity

To further test the moderating effect of value cognition complexity, this moderating variable and the corresponding product term are included in this model. Ac-cording to Model 3, the regression coefficient between innovation capability and value cognition complexity is -0.013 ($p<0.1$), indicating that value cognition complexity negatively regulates the relationship between innovation capability and corporate performance. Thus, Hypothesis 2 is verified.

(3) Testing the moderating effect of value cognition complexity and R&D leap on innovation capability and corporate performance

To further test the regulatory effect of the dual interaction between value cognition complexity and R&D leap, the quadratic product term and cubic product term of innovation capability, value cognition complexity, and R&D leap are included in the model. According to Model (4), the regression coefficient of the cubic product term (INN-Nc-RDL) is 0.004 ($P<0.001$), indicating

that the interaction term between value cognition complexity and R&D leap positively affects the relationship be-tween innovation capability and corporate performance. Thus, Hypothesis 3 is verified.

Table 3: Stratified regression analysis results

	Model (1)	Model (2)	Model (3)	Model (4)
Age	-0.250	-0.275	-0.290	-0.254
	(-1.31)	(-1.43)	(-1.53)	(-1.35)
Size	-0.286***	-0.350***	-0.360***	-0.343***
	(-5.46)	(-6.18)	(-6.36)	(-6.08)
Debt	0.217	0.145	0.131	0.103
	(0.90)	(0.60)	(0.53)	(0.42)
Inst	0.014**	0.014**	0.015**	0.014**
	(2.00)	(1.96)	(2.11)	(2.02)
Indep	0.153	0.309	0.349	0.395
	(0.25)	(0.50)	(0.57)	(0.65)
Stat	-0.062	-0.185	-0.255	-0.348
	(-0.15)	(-0.46)	(-0.58)	(-0.83)
Dual	-0.126*	-0.101	-0.101	-0.100
	(-1.77)	(-1.40)	(-1.37)	(-1.35)
IND	-0.460***	-0.537***	-0.523***	-0.526***
	(-4.22)	(-5.01)	(-4.93)	(-4.96)
INN		0.056**	0.053**	0.051**
		(2.32)	(2.17)	(1.97)
Nc			-0.002	-0.008
			(-0.09)	(-0.46)
INN-Nc		-0.013*	-0.023***	
			(-1.78)	(-2.58)
RDL				0.008
				(0.59)
INN-RDL			0.000	
				(0.09)
Nc-RDL				-0.008*
				(-1.89)
INN-Nc-RDL				0.004***
				(2.61)
_cons	2.478***	2.566***	2.553***	2.537***
	(23.24)	(24.07)	(23.87)	(23.78)
N	546	546	546	546
Waldχ^2	897.61	883.31	875.09	901.12

4.3 Robustness test

To verify the reliability of the above research results, the independent variable measurement method is changed in this paper and the number of applications for patents of the invention is used instead of the total number of patent applications to measure innovation capability. According to Table 4, the above research results are still valid.

Table 4: Robustness test and analysis results

	Model (1)	Model (2)	Model (3)	Model (4)
Age	-0.250	-0.236	-0.243	-0.227
	(-1.31)	(-1.21)	(-1.27)	(-1.18)
Size	-0.286***	-0.337***	-0.347***	-0.343***
	(-5.46)	(-5.76)	(-5.97)	(-5.88)
Debt	0.217	0.177	0.138	0.073
	(0.90)	(0.72)	(0.56)	(0.29)
Inst	0.014**	0.014**	0.015**	0.015**
	(2.00)	(2.05)	(2.19)	(2.19)
Indep	0.153	0.270	0.302	0.347
	(0.25)	(0.44)	(0.49)	(0.56)
Stat	-0.062	-0.152	-0.233	-0.365
	(-0.15)	(-0.38)	(-0.55)	(-0.86)
Dual	-0.126*	-0.120*	-0.118	-0.120
	(-1.77)	(-1.68)	(-1.61)	(-1.61)
IND	-0.460***	-0.532***	-0.522***	-0.530***
	(-4.22)	(-4.76)	(-4.72)	(-4.78)
INN		0.045*	0.043	0.041
		(1.66)	(1.59)	(1.46)
Nc			0.005	-0.001
			(0.27)	(-0.07)
INN-Nc		-0.015*	-0.019**	
			(-1.94)	(-2.15)
RDL				0.000
				(0.01)
INN-RDL			0.005	
				(0.92)
Nc-RDL				-0.007
				(-1.46)
INN-Nc-RDL				0.003*
				(1.82)
_cons	2.478***	2.556***	2.551***	2.539***
	(23.24)	(23.00)	(22.85)	(22.61)
N	546	546	546	546
Waldχ^2	897.61	873.76	870.92	875.58

5 CONCLUSIONS AND ENLIGHTENMENT

5.1 Conclusions

This paper analyses and tests the impact of corporate innovation capability on corporate performance from the perspectives of value cognition and punctuated equilibrium. Also, it examines the moderating effect of internal cognitive characteristics of organizations on their innovation capability and corporate performance, as well as the moderating effect of the joint interaction between R&D leap and internal cognitive characteristics on innovation capability and corporate performance. The following three conclusions are finally drawn in this paper: Corporate innovation capability makes a positive impact on corporate performance; value cognition complexity negatively regulates the positive relationship between innovation capability and corporate performance and the relationship between innovation capability and corporate

performance is jointly regulated by R&D leap and value cognition complexity. In the case of a small R&D leap and a low value cognition complexity, this relationship is positive.

5.2 Theoretical Contribution

First, the two branches of the strategic management field, namely capability and cognition, are connected. The two major schools in the field of strategic management have been developing on parallel but separate paths for a long time, with a lack of connections and integration. In fact, the nature and usefulness of corporate capabilities are constrained by managers' cognitive factors.

Second, research is made from the perspective of R&D leap in response to the research gap of "there has been no matching between R&D leap and value cognition characteristics to study its effect on corporate innovation capability improvement". The allocation method of the value cognition complexity and R&D leap that helps improve corporate performance is found, which deepens value cognition research. Most of the previous value cognition research are based on the impact of internal resources of organizations on cognition but ignores the effect of the overall characteristics of cognition, as a group of cognitive mode, on corporate innovation.

6 SHORTCOMINGS AND FUTURE DIRECTION

First, due to the small number of AI listed companies from 2011 to 2021, there are only 73 enterprise samples, with small sample size. In the future, more enterprise samples can be studied. Second, some data are obtained by manually encoding the annual reports and social responsibility reports of these listed companies and they involve subjectivity and deviations to some extent.

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