

Does the Cumulative Effect of R&D Investment Exist in High-Tech Enterprises?

—Empirical Evidence from China A-Share Listed Companies

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Abstract

In the international society, a new-round revolution is being launched with the continually rise of new technologies. Technical innovation in global perspective has become corporate and national strategy. This article takes the high-tech enterprises from China A-share listed companies as research sample, empirical results demonstrate: The input of R&D investment has a lag period of 2 years and cumulative effect on output; the regression coefficient of initial investment of R&D funding to the current performance is 1.17 that is the type of increasing returns. This article suggests that high-tech enterprises should constantly improve corporate governance mechanism, accelerate transformation of R&D achievements, shorten R&D process to improve R&D efficiency, and establish a value evaluation system for independent innovation projects. The research enriches literature of independent industry, different with the existing research models, with cumulative effect using Cobb-Douglas production function model based on the random effect of panel data.

Keywords

R&D Investment, Cumulative Effect, Lag Period, High-Tech Enterprises

1. Introduction

Scientific and technological innovation of high-tech enterprises is mainly reflected in investment of knowledge innovation, technology innovation, management innovation and Research & Development (referred to as R&D) activities. R&D expenditure and human capital investment occupy more and more shares in enterprises' capital expenditure. In recent years, the increase propor-

tion of R&D investment of listed companies, especially high-tech enterprises, and the further strengthening of innovation awareness have attracted extensive attention from scholars and entrepreneurs, become a topic of great concern.

China's economic development is stepping into a new normal, paying more attention to independent innovation, which gradually rose to the national strategic level. As the carrier and practitioner of scientific and technological innovation, high-tech enterprises play an increasingly important role. China is vigorously promoting all-round innovation with scientific and technological, implementing innovation-driven development strategy, coordinating innovation in multiple forms and cross fields, and adhering to the dominant position of enterprises in innovation. At the same time, innovation-driven is essentially talent-driven, which requires R&D talents to be at the forefront of scientific and technological innovation. Talents are the foundation, and should have an international perspective and leading ability.

More and more countries recognize the importance of science and technology to the national economy in the context of global economic integration. Science and technology promote the growth of national economy and maintain the international competitive position effectively. China has carried out the construction of innovation strategy. Innovation activities are the basis of scientific and technological progress and play an increasingly important role in economic and social construction. However, current research of R&D activities in China shows few literatures about the empirical relationship between R&D investment and enterprise performance based on high-tech enterprises. Existing two main limitations: First, the disclosure of R&D information is inconsistent in various companies, which brings a large difference in the statistical data caliber, making further research difficult. Second, the incompleteness of R&D investment information disclosure makes it difficult to obtain a large amount of basic R&D activity data. This article hopes that the research on the relationship between R&D investment and corporate performance can attract the attention of high-tech enterprises, formulate long-term and effective future development strategies, and provide certain theoretical support for corporate strategic decisions.

2. Literature Review

The correlation between R&D investment and corporate performance is concentrated in three aspects. Initially based on the endogenous growth theory, the R&D investment and enterprise productivity research was formed, using the improved Cobb Douglas production function model and beyond logarithmic production function model in economic theory to discuss the contribution of R&D investment to productivity. The corporate performance of high-tech enterprises introduces profitability into the research framework to discuss the correlation between R&D investment and corporate performance. With the deepening of research, more scholars have found that the intensity of corpo-

rate R&D investment and the company's future performance are more significant.

2.1. Correlation between R&D Investment and Corporate Performance

R&D investment has a positive impact on the company's profitability (Branch, 1974). Positive correlation between R&D investment intensity and operating income market share (McLean & Round, 1978). Different R&D investments have different contribution rates, companies with large R&D investments are superior to small companies (Amir & Sougiannis, 1999), but moderate R&D investment contributes the most to performance of US companies and gives enterprises a comparative advantage (Bosworth & Rogers, 2001). A sample of 244 enterprises from developed countries and regions in the world were selected to study the high-tech enterprises that R&D investment expenditure exceeded 100 million US dollars, found a positive correlation between R&D investment intensity and annual sales revenue growth rate and positive impact is more significant (Roberts, 2001). Studied by 243 emerging enterprises such as Internet and biopharmaceutical industry, introduced the intermediate variable of corporate innovation speed, found that emerging enterprises' R&D investment had a positive impact on corporate performance (Garner, Nam, & Ottoo, 2002). Empirical research on US chemical and pharmaceutical industry from 1975-1996 shows that investment in R&D funds can bring profits to enterprises more than investment in fixed assets (Hsieh, Mishra, & Gobeli, 2003). The 2005 R&D Scoreboard by the UK Department of Trade and Industry showed that: enterprises that use R&D as main influencing factor for competition, such as in medicine and information technology fields, the strength of R&D investment directly affects the rate of return on business profits is positive. In French and German enterprises, R&D expenditure and corporate value show a significant positive correlation, similar to the situation in the US, but for Italian enterprises is not obvious, the control of major shareholders have a certain degree of influence on the correlation between R&D investment and corporate performance (Hall & Oriani, 2006). By analyzing 770 listed companies in the UK, concluded that a positive correlation between R&D investment intensity and the enterprises total revenue (Seraina & Levis, 2008). R&D investment is the most important factor affecting patents and has a positive impact on sales revenue growth (Sohn, Hur, & Kim, 2010). Under the international economic situation, the growth of enterprise R&D investment has a positive correlation with enterprise performance (Ren, Eisingerich, & Tsai, 2015).

Scholars in China have formed two academic views. One view hold that a linear correlation between R&D investment and corporate performance in high-tech enterprises, and the research results are mainly based on a positive correlation (Chen, Zhang, & Chang, 2006; Liang & Yan, 2006; Zhang & Li, 2009; Feng, 2010). In terms of negative correlation: R&D investment and innovation per-

formance have a weak negative correlation (Zhang, Su, & Li, 2011). R&D investment significantly positively correlated with corporate profitability in China's high-tech listed companies, but not significantly positively correlated with development capabilities and cannot efficiently promote the growth of high-tech enterprises (Du, Yan, & Chen, 2014). The fluctuation and intensity of R&D investment affect the corporate performance together, the greater R&D investment fluctuation jump, the higher corporate performance. In addition, the dual innovation focus of decision makers plays an intermediary role (Wu & Xiao, 2015). While another view holds that a non-linear correlation between R&D investment and corporate performance, a few scholars mainly rely on the "inverted U" empirical results (Zhou & Xu, 2007; Cheng & Dai, 2012).

2.2. The Lag of R&D Investment to Corporate Performance

In terms of the lag of corporate R&D investment on performance, length of the lag period varies from industry to industry. Due to the particularity, the pharmaceutical industry has a lagging effect of R&D investment on corporate performance for 5 years, the electronic information industry is lagging by 2 years and other ordinary industries are lagging by 3 years (Goto & Suzuki, 1989). The empirical results show that R&D expenditure increment is 1, the company's surplus increment in the next 7 years is 2, the market value increment is 5 and the company's R&D investment significantly lags behind the improvement of performance (Sougiannis, 1994). Studied the impact of R&D expenditure current year on the operating income the next year by enterprises with high R&D density in different industries, the conclusion drawn that the lag period is different with industries (Lev & Sougiannis, 1996). Focused on the relationship between R&D and future growth, empirical results show a significant positive relationship (Deng, Lev, & Narin, 1999). Follow-up research indicates that R&D investment increases the value of future growth (David & Stephen, 2000). In high-tech listed companies not exist correlation between R&D investment funds and ROA, R&D investment has a two-year lag period for corporate performance (Liang & Zhang, 2005). An empirical study of China's electronic information industry from the micro level shows that the reason for the insignificant positive impact of R&D investment on corporate performance is the lagging effect (Wang & Wang, 2008). R&D investment has a non-positive impact on corporate performance, but R&D human resource input is significantly positively correlated with corporate performance in SME board listed companies and not exist lagging effect (Wang & You, 2009). Using inter-period valuation techniques, investors can readjust the low valuation in the future year if they do not fully confirm the value of R&D in the current year. Based on this, R&D investment is not correlated with the change of stock price in the same period, but is significantly positively in the next year (Luo, Zhu, & Li, 2009). Empirical analysis of the impact of R&D investment on the enterprise operating performance in information technology and manufacturing industry, research results show that it is negative correlation

(Lu & Wang, 2011). Research on listed companies in pharmaceutical manufacturing sector found that the R&D efficiency and R&D investment intensity is low. R&D expenditure is negatively correlated with corporate performance, the lagging effect in 2011 is significant (Wan & Chen, 2014).

3. Empirical Analysis

Hysteresis is that R&D investment does not generate revenue in the year when it occurs, but in several fiscal years after the investment. The theoretical root of the lag in R&D investment from the birth of new technology to the final harvest, it needs to go through many links such as research and development, testing and inspection, application and promotion. This process is not overnight and it takes a period of time for the expected effect to appear. The number of lag periods varies depending on the industry development cycle and technical proficiency.

Cumulative effects originated from environmental impact assessment, which emphasizes that the environmental impact of a single impact activity in a short time may not be obvious and ignored, but if it is repeated multiple times, then the impact will be significant in the future. The cumulative effect arises from the cross-effect and interaction between the multiplier effect and the acceleration effect. The cumulative effect of R&D investment on corporate performance means that the enterprises R&D activities in the short term will not have a significant impact on the corporate performance, but if continuous R&D investment and the resulting promotional force will significantly improve.

3.1. Model

Considering the characteristics of R&D activities of high-tech enterprises that need to go through project approval, research, development, application and other links, it will take a long time to bring economic benefits to the enterprises and should be continuously accumulated, only when the R&D products be mass-produced can the company's performance be improved.

Hypothesis 1: The impact of high-tech enterprise R&D input on output has a lag period and establishes a multiple linear regression model.

$$\text{Performance}_i = \sigma_0 + \sigma_1 \text{investment_int}_{i-j} + \sigma_2 \ln_size_i + \sigma_3 \text{lev}_i + \sigma_4 \text{om}_i + \varepsilon$$

In the model, Performance_i represents the explained variable of R&D output, the quantified indicator taking the factor analysis method which uses four earning indicators (MOPR, ROA, ROE and EPS), four debt-paying indicators (CR, QR, OER and DAR), two development indicators (OPGR and NAGR) and two operating indicators (TAT and ET), the designation and definition of variables showing in **Table 1**.

$\text{Investment_int}_{i-j}$ represents R&D investment intensity in year $i - j$, \ln_size_i represents natural logarithm of total assets in year i , lev_i represents debt asset ratio in year i , om_i is a dummy variable that consider Chairman-CEO Duality in

Table 1. Designation and definition of factor analysis.

Factor	Symbol	Designation
1	MOPR	Main operating profit ratio
2	ROA	Return on total assets
3	ROE	Return on net assets
4	EPS	Earning per share
5	CR	Current ratio
6	QR	Quick ratio
7	OER	Owner's equity ratio
8	DAR	Reciprocal of debt asset ratio
9	OPGR	Operating profit growth rate
10	NAGR	Net assets growth rate
11	TAT	Total assets turnover
12	ET	Equity turnover

year i , ε is random disturbance term, i represents the year ($i = 3, 4$), j represents the lag period ($j = 1, 2, 3$).

Hypothesis 2: The impact of R&D investment of high-tech enterprises on output has a cumulative effect. The corporate performance in year i is positively correlated with the previous cumulative R&D investment in year $i - j$.

$$\text{Profit}_i = A * \text{Investment}_{i-j}^a * \text{Labor}_i^b * \text{Asset}_i^c$$

To establish the linear regression equation, take the natural logarithm on the formula:

$$\text{Ln_Profit}_i = \text{Ln_A} + a\text{Ln_Investment}_{i-j} + b\text{Ln_Labor}_i + c\text{Ln_Asset}_i + \varepsilon$$

In the model, Profit_i represents the explained variable of output that uses main operation profit indicator, i represents the year ($i = 3, 4$) and j represents the lag period ($j = 1, 2, 3$), ε is random disturbance term, A is a constant term. Investment $i - j$ represents the enterprise R&D investment in the $i - j$ year, Labor i represents the employees' number in high-tech enterprises, Asset i represents the total assets in year i . a , b , and c represent the output elasticity coefficients of R&D investment, employees' number and total assets.

3.2. Data and Variable Selection

This paper selects three main industries: information transmission, software and technical service; pharmaceutical manufacturing; computer, communication and other electronic equipment manufacturing. Besides, the typical listed companies, such as telecommunications, radio and television, satellite transmission service industry and Internet related service industry also as the research sample. After strict selection, 153 high-tech listed companies in China from 2010 to 2013 were

selected as the research data, the empirical analysis with spss19.0 and stata15.0 statistic software.

The research selected the period of time from 2010 to 2013 is mainly based on two important factors: first, due to the lag in the disclosure of R&D data, the latest available data is that in 2017, but a part of the data in 2014 and 2016 are undisclosed, which makes it impossible to achieve the cumulative effect of R&D investment and the continuous panel data which is necessary for the analysis of lag period. Second, the period of this time is a golden development stage in which the proportion of R&D investment in China's GDP is approaching 2.0%. The samples of high-tech enterprises are sufficient and have a high growth potential. During this research period, not only data continuity and sufficient degrees of freedom are guaranteed, but also the limitations of research results caused by too few samples are overcome.

The financial data and main operation profit, Assets and Debt asset ratio involved in the factor analysis in this paper were obtained from the CSMAR Financial analysis database of Chinese Listed Companies. Part of the R&D investment data was taken from the CSMAR Financial report database of Chinese listed companies, and the missing values were manually sorted out from the annual financial reports and notes disclosed by the enterprises. The database of Employees' number and the control variables of Chairman-CEO duality were manually sorted out from CSMAR Corporate governance database, China listed company information network, corporate governance Wind information economic data and the Juchao information network, etc.

The variables that this paper involves are explained below, showing in **Table 2**.

1) Core variables

Table 2. Designation and definition of variables.

Designation	Symbol	Definition
Explained variable		
Corporate performance	Performance	Through factor analysis method by 12 indicators in Table 1
Main operation profit	Ln_Profit	Logarithm of the main operation profit
Core variable		
R&D investment	Ln_Investment	Logarithm of the R&D investment expenditure
R&D investment intensity	investment_int	investment_int = R&D investment expenditure/ main operating income
Employees' number	Ln_Labor	Logarithm of the enterprise employee numbers
Assets	ln_size/Ln_Asset	Logarithm of the enterprise total asset size
Control variable		
Debt asset ratio	lev	Debt Asset ratio
Chairman-CEO duality	om	If the duality of Chairman-CEO, the variable = 1; otherwise, the variable = 0

R&D investment: Romer and Lucas, the founders of new economic growth theory, use endogenous technology to explain economic growth, incorporate knowledge capital, material capital and human capital into the research model which mainly reflected the investment of R&D activities. Selecting R&D investment as the explanatory variable can reflect the R&D scale of different enterprises.

R&D investment intensity: High-tech enterprises are a typical technology capital-intensive industry and R&D activities are concentrated on capital investment. R&D investment intensity is an indicator internationally used that can objectively and credibly reflect the investment intensity of R&D funds.

Employees' number: High-tech enterprises are mainly small and medium-sized enterprises that with small scale but good growth. The number of employees used as a regulating variable to effectively reduce the asymmetry of corporate performance.

Assets: External financing ability constrained by the scale of an enterprise. Due to the economies of scale, large enterprises' bargaining power has a comparative advantage. At present, China's high-tech enterprises are with short development process and no strong economies of scale. R&D investment and human resources are limited to a certain extent, so this article examines the impact of firm size on empirical research.

2) Control variables

Debt asset ratio: Due to the high level of corporate motivation for using liabilities, financial pressure is greater and R&D capital investment will be reduced to ensure the normal operation. However, debt capital can reasonably avoid taxes, which is conducive to the rapid growth and enterprise value growth.

Chairman-CEO duality: With the separation of ownership and management, the managers who get equity incentive will attach great importance to the investment of R&D activities and share ownership as a contract makes the interests of shareholders and management consistent. At the same time, the existing literature has proved that the proportion of management shareholding has a positive correlation with R&D investment. Therefore, corporate governance becomes an indispensable factor.

3.3. Factor Analysis

The explained variable's factor analysis process as follow:

1) KMO and Bartlett's test

In **Table 3**, the KMO value is $0.693 > 0.5$, which is suitable for using the factor analysis method. When KMO is close to 1, the analysis effect is better. The significance level of Bartlett's sphericity test is 0.000 and the P value is extremely significant, which is suitable for factor analysis.

2) Extraction of common factor

Table 4 shows former 4 common factors which unrotated eigen value are 4.205,

Table 3. KMO and Bartlett's test.

	Kaiser-Meyer-Olkin Value	0.639
	Approx. Chi-Square	10443.318
Bartlett Test	df	66
	Sig.	0.000

Table 4. Total variance explained.

Factor	Eigen			% of Variance (Unrotated)			% of Variance (Rotated)		
	Eigen Value	% of Variance	Cumulative % of Variance	Eigen Value	% of Variance	Cumulative % of Variance	Eigen Value	% of Variance	Cumulative % of Variance
1	4.205	35.043	35.043	4.205	35.043	35.043	3.301	27.506	27.506
2	3.094	25.783	60.826	3.094	25.783	60.826	2.974	24.786	52.292
3	1.774	14.779	75.605	1.774	14.779	75.605	2.536	21.131	73.424
4	1.571	13.094	88.699	1.571	13.094	88.699	1.833	15.276	88.699
5	0.581	4.845	93.544						
6	0.306	2.554	96.098						
7	0.197	1.644	97.742						
8	0.166	1.386	99.129						
9	0.053	0.438	99.567						
10	0.032	0.271	99.837						
11	0.018	0.154	99.991						
12	0.001	0.009	100.00						

3.094, 1.774 and 1.571 and rotated eigen value are 3.301, 2.974, 2.536 and 1.833, the cumulative variance contribution rate is 88.699%, covering original data more than 80% of 12 indicators.

3) Factor loading and component score

Based on above analysis, standardized indicators can be used as explained variables, showing in **Table 5**. When the factor loading matrix rotated, the maximum variance method in SPSS is used to highlight the practical significance of extraction of the four common factors, and the score of them showing below and total score of the corporate performance can be obtained. Only cited common factor 1 as an example:

$$C_1 = 0.222F_1 + 0.299F_2 + 0.298F_3 + 0.277F_4 - 0.028F_5 - 0.027F_6 - 0.068F_7 - 0.014F_8 - 0.062F_9 - 0.034F_{10} + 0.081F_{11} + 0.017F_{12}$$

For the comprehensive evaluation of corporate performance of high-tech listed companies, 4 common factor scores were substituted into the model with the contribution rate of common factor variances as the weight, the new explained variable is Performance_i:

$$\text{Performance}_i = (C_1 * 0.27506 + C_2 * 0.24786 + C_3 * 0.21131 + C_4 * 0.15276) / 0.88699$$

Table 5. Factor loading (rotated) and component score coefficient matrix.

Name	Factor loading (rotated)				Component			
	Factor1	Factor 2	Factor 3	Factor 4	1	2	3	4
MOPR	0.771	0.222	-0.391	0.140	0.222	-0.007	-0.133	0.007
ROA	0.961	0.041	-0.055	0.102	0.299	-0.033	-0.006	-0.026
ROE	0.938	-0.056	0.151	0.104	0.298	-0.037	0.074	-0.019
EPS	0.869	0.085	0.034	0.000	0.277	0.002	0.040	-0.072
CR	0.053	0.982	-0.146	-0.003	-0.028	0.368	0.095	0.008
QR	0.057	0.983	-0.149	-0.001	-0.027	0.368	0.093	0.009
OER	-0.265	-0.203	0.742	-0.004	-0.068	0.053	0.309	0.036
DAR	0.094	0.943	-0.253	-0.006	-0.014	0.333	0.039	0.001
OPGR	0.063	-0.010	-0.026	0.953	-0.062	0.007	0.012	0.537
NAGR	0.147	0.000	-0.014	0.940	-0.034	0.009	0.019	0.523
TAT	0.188	-0.172	0.862	-0.030	0.081	0.065	0.375	-0.014
ET	-0.006	-0.147	0.976	-0.011	0.017	0.102	0.430	0.017

3.4. Empirical Result

The regression results showing in **Table 6** show that R&D investment intensity of high-tech enterprises has a significant positive correlation with corporate performance whether the lag period is 1 or 2, the coefficients are 2.153 and 4.102 which demonstrates that the role of R&D investment has been gradually brought out with an obvious increasing trend in three years and passed the significance test of 10% and 1% respectively.

From 2010 to 2013, accumulated R&D investment in previous period i ($i = 1, 2, 3, 4$) to the current corporate performance showing in **Table 7** that the sum of regression elasticity coefficient a , b , and c is 1.17 (>1) which determined as the type of increasing return. High-tech enterprises applying new technologies to expand production scale can effectively increase the scale of output.

3.5. Robustness Test

This article used Bootstrap 300 times test showing in **Table 8**. The R&D investment intensity lags1 period passed the 10% significance test and lags2 period passed the 1% significance test, the significance level is consistent with the original. The significance level of the coefficients of variables size, lev and om also same as the original, which further proves the accuracy of model setting.

4. Conclusion and Suggestions

Through the above research model and test of original hypothesis, the following conclusions are obtained:

The input of R&D investment has a lag period of 2 years and cumulative effect on output, when lagged by 2 periods, the regression coefficient is 4.1, which is significant at the 1% level.

Table 6. Regression of R&D investment intensity to corporate performance.

Variables	Lag1 period	Lag2 period
Lag1 investment_int	2.153* (1.68)	-
Lag2 investment_int	-	4.102*** (2.89)
size	0.494*** (5.88)	0.388*** (4.63)
lev	-2.997*** (-7.86)	-2.230*** (-5.59)
om	-0.0816* (-0.60)	-0.0177* (-0.12)
_cons	-9.645*** (-5.49)	-7.644*** (-4.35)
N	441	290

*, **, *** represent significant at 10%, 5% and 1% levels, t statistic in bracket.

Table 7. Regression of R&D investment intensity to corporate performance.

Source	SS	Df	MS	obs	=	566
Model	702.1	3	234.0	Prob > F	=	0
Residual	139.8	562	0.249	R-squared	=	0.834
Total	841.9	565	1.490	Root MSE	=	0.499
Profit	Coef.	Std. Err.	t	P > t	95% Conf.	Interval
Investment	0.0334	0.0156	2.150	0.0320	0.00287	0.0640
Labor	0.450	0.0338	13.30	0	0.384	0.516
Asset	0.687	0.0385	17.84	0	0.611	0.762
CONS	2.037	0.626	3.250	0.00100	0.807	3.267

Table 8. The bootstrap 300 times test.

Variables	Lag1 period	Lag2 period
Lag1 investment_int	2.153* (1.59)	-
Lag2 investment_int	-	4.102*** (1.82)
size	0.494*** (6.13)	0.388*** (5.29)
lev	-2.997*** (-6.63)	-2.230*** (-4.77)
om	-0.0816* (-1.13)	-0.0177* (-0.21)
_cons	-9.645*** (-5.88)	-7.644*** (-5.09)
N	441	290

*, **, *** represent significant at 10%, 5% and 1% levels, t statistic in bracket.

By establishing the Cobb-Douglas production function model, the sum of regression coefficients a , b , and c is 1.17, demonstrating former R&D investment to the current corporate performance of high-tech enterprises during the period of 2010-2013, which is determined incremental remuneration types. High-tech enterprises applying new technologies to expand production scale can effectively increase enterprise output scale.

Based on the above research conclusions, this article makes suggestions to high-tech enterprises:

1) Continuously improve corporate governance mechanism

The reform of China state-owned enterprises has become a hot spot and related policies are being introduced and implemented. However, the distribution of rights of a considerable number of enterprises between management and ownership has not been effectively dealt with. The corporate governance mechanism and awareness are weak, lacking scientific and forward-looking. As a result, relevant policies and guidelines cannot be effectively implemented. R&D activities are ignored. Therefore, to deepen reform, enterprises should thoroughly solve the operation mechanism of enterprise management, improve the level of corporate governance, and remove obstacles to the development of R&D activities from source, actively play the incentive role of corporate governance, promote the equity incentive plan for executives and R&D personnel, combine the interests of employees with the long-term development of the company, improve the incentive method for executive compensation of listed companies, and encourage managers to create better value for the company, thereby promoting sustainable development of the enterprise. Optimizing the structure of the board of directors, the "Chairman-CEO duality" will weaken the ability of the board of directors to process information, thus hindering R&D investment behavior. Therefore, in the process of creating a board of directors of listed companies, listed companies must establish their own unique appointment system to improve appointment requirements. The specific performance is in various aspects such as personal quality, professional quality and work experience. At the same time, listed companies should also define the division of responsibilities of directors and formulate clear rules and regulations. In addition, an evaluation mechanism for directors of listed companies can be established to enhance the sense of responsibility and mission of directors of listed companies.

2) Accelerate transformation of R&D achievements and improve R&D efficiency

R&D activities of high-tech enterprises need a long period to bring economic benefits. R&D investment in the early stage needs to be accumulated continuously. Only when the products developed can be mass produced can corporate performance be improved. Through the empirical model test, the regression coefficient is the most significant when the lag period is 2, which further proves that the transformation of R&D results is not instantly. Therefore, enterprises should strictly control the each link, each stage smooth cohesion, quickly into

production capacity, the rapid popularization of scientific and technological achievements, and timely innovation to speed up product upgrading, effectively shorten the R&D investment into profitability of lag, to speed up the research achievements conversion rate, and improve the development process of research and development efficiency.

Focus on the R&D resource injection of high-tech enterprises, the government needs to encourage enterprises' R&D activities in policies, facilitate the establishment and optimization of relevant systems in terms of bank loans, project approval, tax relief and other aspects, and actively protect R&D patents and property rights in law. To broaden the R&D financing channels of high-tech enterprises. At present, the R&D investment intensity is unevenly distributed between large and small enterprises. The government should further improve the financing environment and financing channels, using the supply chain financial service for small and medium-sized enterprises. In view of the characteristics of high capital demand, long R&D investment period and high capital utilization rate of high-tech enterprises, the government should also strengthen the transformation and accumulation of technological capital of enterprises, issue special loan policies, and make further use of private capital to actively serve small and medium-sized enterprises. Enterprises should implement the strategy of talent cultivation and introduction, R&D activities in two of the most important resource is money and talent, talent is the endogenous power in independent innovation and breakthrough. Professional talent is very important to enterprise development. To strengthen the depth of the enterprises, universities and scientific research units, with the aid of human capital to promote R&D input and output efficiency of performance.

3) Establish a value evaluation system for independent innovation projects

High-tech enterprises have the characteristics of large capital demand, long R&D investment cycle, high capital utilization rate and high project risk. Therefore, the value assessment and feasibility analysis of the initial investment of R&D funds are particularly important for high-tech enterprises. The risk factors in the environment control the project risks and losses within a certain range and limit. Establishing a whole set of feasible and perfect value evaluation system will be the key to whether R&D investment can effectively bring enterprise performance and this is also the key to the high-tech enterprises' sustainable growth.

5. The Limitation and Outlook

For the undisclosed data of some years, the research period is limited, the follow-up research in this paper will try to make up by in-depth collection of first-hand data. Meanwhile, the research object is high-tech enterprises, mainly selected 3 typical industries: information transmission, software and technical service; pharmaceutical manufacturing; computer, communication and other electronic equipment manufacturing. Although the growth and representation of high-tech enterprises in other industries are insufficient, the inclusion of research samples

can expand the research conclusion from the micro level to the meso level, and can make subsequent attempts. Besides, based on the limited available data, only A-share listed companies are included in considered, whether the research conclusions equally applicable to non-listed companies, it remains to be further proved that the entire capital market should be included in the scope of the research as far as possible.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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