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The Time-Lag Analysis of R&D Investment and Corporate Performance

—Based on the Sample Data of Natural Person Holding Companies

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***Abstract*—The time-lag phenomenon between R&D investment and corporate performance has been researched by scholars recently. This study selects sample data from 228 natural person holding companies of GEM. It uses EXCEL, SPSS20.0 statistical software for data statistics and analysis to explore the time lag of R&D investment and corporate performance. The result shows that R&D investment in natural person holding companies has a positive effect on the corporate performance, which has a characteristic of time lag and the effect is more obvious than the first. It is suggested that R & D investment should be increased, lean scientific research team should be set up to promote the long-term development of the company.**

Keywords—Natural Person Holding; R&D Investment; Corporate Performance; Time Lag; Correlation Analysis

I. INTRODUCTION

R&D (research and development), refers to the systematic and creative activities which is in order to increase the amount of knowledge in the field of science and technology, and use this knowledge to create a new application, including basic researches, applied researches and experimental development[1]. R&D investment can be divided into R&D capital investment and R&D personnel investment. Time lag means the current R&D investment will not be displayed in the current performance. It will delay one period, two periods, or even longer. The natural person holding company is a joint stock company directly or indirectly controlled by the natural person(Qin lina, Li kai, 2007)[2]. This study mainly refers to the listed company directly controlled by natural person. Tiantong, China's first natural person holding company, went public in 2001.With the development of Chinese stock market and the continuous promotion of state-owned enterprise reform, more and more natural person holding companies have been listed in SME and GEM board. By the end of 2016, there are 818 listed companies of SME board, and 568 listed companies of GEM board, and those listed companies are mostly holding company controlled by natural person directly or indirectly.

As we all know, Huawei and Qingdao Haier are very focused on R&D investment, and the proud performance of this two companies shows that R&D investment is the key factor to maintain the competitive advantage. There are some great risks on the innovation investment of the private high-tech enterprises listed on the GEM, especially the natural person holding company with weak financial strength. Its R&D investment may be successful, or fail. Does R&D investment affect corporate performance? Does this effect have a time lag? This study tries to answer the questions above in order to provide some practical reference for our country's corporate governance.

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II. PROPOSING RESEARCH HYPOTHESES

In theory, companies must invest in R&D if they want to grow in the long term, or they will die. However, the R&D investment faces many risks, such as high input cost, high risk, low success rate, etc. There are many reasons for failure of R&D investment, such as the lack of potential demand of new products, the mismatch between new products and current demand, marketing adverse, the mismatch between technology and market, etc. From the point of reality, even if the R&D input is successful, the current period of R&D input would not necessarily increase the benefit in the current years; it may also affect the current level of performance because of the large investment and no time to benefit.

From the point of empirical results, domestic and international scholars carry out a serious of studies about the relationship between R&D investment and corporate performance, and draw the different conclusions. However, most scholars agree that there are significant positive correlation between them, and have the characteristic of time lag. Many foreign scholars' studies show that R&D investment is positively correlated to the future estimation of market value, and the earnings are better after more than two years lag. The domestic scholars, such as Jiao Shaofei, ZhangWei and Yang Xuanliang (2010)[3]have found that R&D investment has a positive effect on corporate performance, at the same time, the improvement of corporate performance has strengthened the power of R&D investment. But there shows significant lag between input and output (Wen Ke, Zhang Jing Song Qi, 2013)[4]. Based on the study of Zhao Yuehong and Xu Min (2013)[5], it shows that R&D investment has a negative effect on company's operating profit ratio, and has a significant positive influence on operating profit ratio in the lag one, two and three. The correlation coefficient of lag two is the largest among them. In Wang Xiaoting's study (2015)[6], it shows that R&D investment has

a positive effect on corporate profitability and the market value of enterprises in SME board high-tech enterprises, but it doesn't show the time lag. According to the research of Deng Xidong and Zhang Man (2016) [7], the R&D investment of high-tech enterprises has a significant positive correlation on enterprise value. Natural person holding companies that listed on the GEM belong to high-tech enterprises whose asset size is not too much (relative to the state-owned enterprises), and its sponsors or senior management team is mostly scientific and technological research and development personnel. They may be focus on R&D investment closely related to the company's long-term development.

Therefore, this paper puts forward two hypotheses:

Hypothesis 1a: the R&D investment of natural person holding company is conducive to the improvement of company performance.

Hypothesis 2b: The influence of R&D input of natural person holding company on company performance is time-lag. The effects of lag one and two are likely to be different.

III. SAMPLE SELECTION AND DEFINITION OF VARIBLES

This paper has selected listed natural person holding companies as on the GEM as samples by the end of 2013, excluding ST and * ST companies, companies with missing data during 2013 and 2015. Finally, it has 228 valid samples, and the study period is from 2013 to 2015. The data were derived from CNINF, CSMAR Solution professional securities websites. First, the data were sorted by EXCEL, and then using SPSS20.0 statistical software for descriptive statistical analysis and correlation analysis.

This study takes increasing rate of business revenue (IRBR) and operating profit ratio (OPR) as a measure target of corporate performance, and takes R&D capital intensity (RDCI) and R&D employee intensity (RDEI) as a measure target of R&D input index. The specific definitions and calculation methods are shown in table 1.

TABLE I. DEFINITION AND COMPUTING METHOD OF VARIABLE

Variable Code	Variable Name	Calculation Method of Variable
IRBR	Increasing Rate of Business Revenue	(Business income of current year - Business income of last year) / Business income of last year
OPR	Operating Profit Ratio	Operating profit of current year / Business income of current year
RDCI	R&D Capital Intensity	R&D expenditure / Main business income of current year
RDEI	R&D Employee Intensity	R&D employee / Total number of companies

Notes: Arranged by the author

IV. DESCRIPTIVE STATISTICS AND CORRELATION ANALYSIS

A. Descriptive statistics

According to the descriptive statistics in table 2: (1) The increasing rate of business revenue (IRBR) in -0.35 ~ 6.07, the mean value is 0.5149, indicates that most companies' development ability are still optimistic. Operating profit ratio (OPR) is in -0.55~0.45, indicating that the sample companies' profitability is below 0.5. (2) R&D capital intensity (RDEI) in 0.01~0.63, and R&D employee intensity (RDEI) in 0.15 ~ 0.54, shows that natural person holding company has large differences on the strength of funds and personnel.

B. Correlation analysis of R&D investment and corporate performance

From the correlation analysis of R&D investment and corporate performance by using Pearson method, considering that the company's annual performance is influenced by many factors and have volatility, it takes three years' average value to analyze from 2013 to 2015 will be more rigor and reliability. It can be seen from table 3 that the increasing rate of business revenue (IRBR) and the operating profit rate (OPR) have a positive correlation with R&D investment (capital intensity and employee intensity).

TABLE II. DESCRIPITIVE STATISTICS OF VARIABLES

Variable Code	Variable Name	Minimum	Maximum	Mean Value	Standard Deviation
IRBR	Increasing Rate of Business Revenue	-0.35	6.07	0.5149	0.8027
OPR	Operating Profit Ratio	-0.55	0.45	0.111	0.1171
RDCI	R&D Capital Intensity	0.01	0.63	0.0753	0.0684
RDEI	R&D Employee Intensity	0.15	0.54	0.3183	0.3549

Notes: Arranged by the author

TABLE III. CORRELATION ANALYSIS OF R&D INVESTMENT AND CORPORATE PERFORMANCE

Variable Code	Correlation Analysis	IRBR	OPR	RDCI	RDEI
IRBR	Relevance	1	0.033	.143*	.044*
	Significance		0.624	.031	0.034
OPR	Relevance	0.033	1	.013*	.148*
	Significance	0.624		0.043	0.025
RDCI	Relevance	0.143	0.013	1	.138*
	Significance	0.031	0.043		0.037
RDEI	Relevance	0.044	0.148	0.138*	1
	Significance	0.034	0.025	0.037	

Notes: Arranged by the author **P<0.01,* P<0.05

TABLE IV. THE TIME DELAY ANALYSIS OF R&D INVESTMENT AND CORPORATE PERFORMANCE

Inspection Period	Correlation analysis of time lag			R&D Investment Indicators		Results Summary
				RDCI	RDEI	
Inspection One: R&D Investment in 2013 and corporate performance in 2014	Performance Indicators	IRBR	Relevance	0.061	-0.106	One Year Lag: Results are not significant
			Significance	0.356	0.112	
		OPR	Relevance	0.03	0.038	
			Significance	0.654	0.57	
Inspection Two: R&D Investment in 2014and corporate performance in 2015	Performance Indicators	IRBR	Relevance	0.122*	0.036	One Year Lag: Results are partly significant
			Significance	0.045	0.591	
		OPR	Relevance	-0.075	0.177**	
			Significance	0.258	0.007	
Inspection Three: R&D Investment in 2013 and corporate performance in 2015	Performance Indicators	IRBR	Relevance	.103**	-.106**	Two Years Lag: Results are significant
			Significance	0.001	0.001	
		OPR	Relevance	.077**	-.074**	
			Significance	0.000	0.000	

Notes: Arranged by the author **P<0.01,* P<0.05

C. The time lag analysis of R&D investment and corporate performance

The analysis results in table 3 do not reflect the time lag problems of R&D investment and corporate performance. Therefore, this study has another time lag analysis of R&D investment and corporate performance (table 4). The test 1 and 2 in table 4 lag one year, and the test 3 lags two years.

It can be seen from test 1 that the R&D capital intensity (RDCI) of 2013 has a positive correlation with increasing rate of business revenue (IRBR) and operating profit ratio (OPR) of 2014, but the correlation is not significant. The R&D employee intensity (RDEI) of 2013 has a negative correlation with increasing rate of business revenue (IRBR), and a positive correlation with operating profit ratio (OPR) of 2014, but the correlation is also not significant.

It can be seen from test 2 that the R&D capital intensity (RDCI) of 2014 has a significantly positive correlation at the level of 0.05 with increasing rate of business revenue (IRBR) of 2015, but has a negative correlation with operating profit ratio (OPR) which is not significant. The R&D employee intensity (RDEI) has a positive correlation with increasing rate of business revenue (IRBR) which is not significant; however, it has a significantly positive correlation at the level of 0.01 with operating profit ratio (OPR).

It can be seen from test 3 that the R&D capital intensity (RDCI) of 2013 has a significantly positive correlation with increasing rate of business revenue (IRBR) and operating profit ratio (OPR). The R&D employee intensity (RDEI) of 2013 has a significantly negative correlation with increasing rate of business revenue (IRBR) and operating profit ratio (OPR).

V. CONCLUSIONS AND SUGGESTIONS

Based on the mean value test of whole study period, the R&D investment of natural person holding companies listed on GEM is positively correlated with the companies' performance, which means hypothesis 1 works. From the lag study, the influence of R&D investment on the performance does have a time lag, and the lag of two years is more significant than one year, which means hypothesis 2 works. However, in the study of two years lag, it shows that the R&D employee intensity (RDEI) has significantly negative correlation with the company's performance by chance. It means the R&D investment is not the more, the better. Leaders mastering core technology skills and capable teams are necessary for an enterprise's development, and it is not just measured by the number of scientific researches. In order to boost the company's long-term development, it is recommended to invest more in R&D, build a lean research team and continuously develop new products.

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