

# Empirical Study on the correlation between Research and Development Investment and Business Performance in Traditional Chinese Medicine Industry

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**Abstract**—The traditional Chinese medicine (TCM) industry is one of China's unique industries that have international comparative advantages, which gain key support from the government. Financial data of 42 listed TCM companies on the A-share market from 2012 to 2019 are picked out as sample data, and correlation analysis, multiple linear regression analysis, and lag analysis are conducted. Research shows that research and development (R&D) investment of TCM companies in the A-share market is positively correlated with business performance. Therefore, it is suggested that TCM companies should increase investment in R&D, strengthen industry-university-research collaboration, and that the government should strengthen their protection of intellectual property and promote the sustainable and healthy development of the TCM industry.

**Keywords**—Research and Development; Business Performance; Traditional Chinese Medicine

## 1 INTRODUCTION

The pharmaceutical industry is called “a sunrise industry that never declines”. With a developing world economy, accelerated aging and people's better understanding of health, the pharmaceutical industry has maintained sustained growth in recent years. The outbreak of the Covid-19 pandemic made it the major concern of the world. The TCM industry is one of China's unique industries that have international comparative advantages, which has gradually become a key industry receiving support from the government in the past decades[1]. Lying in a typical industry intensified with knowledge, technology, and capital, TCM companies' development is closely related to R&D investment. Statistics from 2012 to 2019 of 42 leading TCM companies listed on the A-share market are taken as sample data to analyze impacts of R&D investment on business performance. The result provides the theoretical basis for companies to promote sustainable development and gain profits and puts forward suggestions to better facilitate the TCM industry.

Many scholars analyzed the impact of R&D investment on business performance and came to four different conclusions: R&D investment has a significant positive impact, no impact or a negative impact on business performance, and there is a lag between R&D investment and business performance. Geoffrey A VanderPal used R&D intensity as the independent variable and eight financial indicators including return on total assets and return on net assets as dependent variables, with the data from 103 American high-tech manufacturing companies from 1979 to 2013 as a sample to analyze the impact of R&D investment on company performance. The multiple regression model brought the conclusion that there was a significant positive correlation between R&D investment and business performance.[2] Most scholars believe that R&D investment promotes business performance, but some other scholars believe that there is no significant correlation between the two indicators. C. Sharma analyzed the data of Indian manufacturing companies from 1994 to 2006 and found that the output elasticity of R&D lied basically between 10% and 13%; and in the study of the relationship between R&D investment and total factor productivity, it was shown that 1% increase in R&D investment led to a 15% increase of total factor productivity, so there was no obvious correlation between R&D investment and business performance.[3] Wu Zhong and Zhong Suyan conducted an empirical analysis of the relationship between R&D expenditure and financial performance of 48 listed Chinese medicine companies on the Shenzhen Stock Exchange and the Shanghai Stock Exchange from 2012 to 2016. They concluded that there was a negative correlation between the R&D expenditure and financial performance of listed Chinese medicine companies.[4] Based on the analysis of the impact of R&D investment on business performance, some scholars concluded that there is lagged impact of R&D investment on business performance. Martin (2012) used the data of 3700 Australian companies from 1995 to 2006 as a research sample and pointed out that R&D investment had a significant positive correlation with the performance in the current period and the two lagging periods, and the impact on the performance two years later was significantly weakened.[5]

## **2 THEORY FOUNDATION**

### **2.1 Technical Innovation Theory**

Schumpeter believes that innovation mainly results from companies' R&D investment. Stronger innovation abilities and a higher probability of successful innovation are all endogenous gains from companies' R&D systems. R&D occurs in every step of technical innovation and has a relation with business performance to some extent. Technical innovation plays an important role in TCM companies, the key to which lies in R&D activities. By increasing investment in R&D activities, companies can obtain new products or reduce costs, maintaining their advantages in technology and products, thus improving competitiveness to occupy a higher market share for a long time.

### **2.2 Input-output theory**

Economist Wassily proposed Input-output Theory basing on General Equilibrium Theory, which quantifies the relation between the input of production factors and the distribution of output. It believes that economic growth mainly results from the input and the output per unit input. Increasing the input of production factors and improving efficiency will promote

economic growth. R&D, as one of the production factors of science and technology, stimulates economic growth.

TCM companies feature a long period of high returns, which requires high input and shows high risks, leading to uncertainty of profits. The complexity of R&D investment in technology-intensive industries requires companies to conduct researches on the feasibility of R&D and evaluate the return on output before investing. Only in this way can risks and costs be controlled within a certain range and sufficient funds flow to more R&D personnel, thus enhancing the core competitiveness.

### **3 MODEL, ASSUMPTION AND SAMPLE**

#### **3.1 Research Hypothesis**

Based on the above analysis and related literature, we believe that R&D investment can improve business performance. Therefore, the following hypothesis is proposed:

R&D investment in the TCM industry is positively related to business performance.

#### **3.2 Sample Selection and Data Sources**

Financial data are selected from 2012 to 2019 of 42 leading companies listed on the A-share market in the TCM industry including R&D expenditures, net profits, and total assets. Data are organized and analyzed with SPSS analysis software.

#### **3.3 Variable Selection**

##### **3.3.1 Explanatory variable**

According to Chinese accounting standards, R&D expenditures during the development stage should be capitalized and others should be expensed. Therefore, R&D investment includes capitalized and expensed R&D investment. Required data can be directly obtained from annual reports. Thus, total R&D investment is used as the explanatory variable.

##### **3.3.2 Explained variable**

Economic value added (EVA) is the net operating profit that excludes equity and debt from net profit after tax. EVA is a business-performance assessment tool that evaluates the ability of business operators to effectively use capital and create value for shareholders, reflecting the realization of the company's ultimate objectives. Thus, EVA is chosen as the explained variable, and data are obtained from the Guotai'an China Economic and Financial Research Database.

##### **3.3.3 Control variable**

As TABLE I shows, there are many factors related to R&D investment, including the type, size, and equity structure of the company. Therefore, to control the influence brought by individual characteristics of companies, the size and profit of companies are introduced as control variables, thus excluding individual differences and making the regression results more reliable.

The company's size has a great impact on business performance. Generally speaking, larger companies make autonomous decisions on R&D investment and they are more likely to receive capital support. The natural logarithm of total assets at the end of the period is introduced to measure the firm size. Besides, profit also affects business performance. In general, companies with higher profits have more funds to invest in R&D. Thus, net profit at the end of every year is chosen to measure companies' profit.

**TABLE I.** VARIABLE SELECTION

Variable Types	Variable Name	Symbols	Variable calculation formula
Explanatory variable	Total R&D investment	RD	Number taken from annual report
Explained variable	Economic value added	EVA	Fetches in the Guotai'an database
Control Variable	Enterprise size	S	Natural logarithm of total assets
	Corporate profit	P	Number taken from annual report

### 3.4 Model design

As shown in the table above, the relation between total R&D investment and EVA is selected for research. Referring to researches and analysis of other scholars, multiple linear regression is adopted as the model to analyze the relationship between research investment and business performance of listed companies in the TCM industry.

The regression model is constructed according to the hypothesis:

$$EVA_{ij} = a_0 + a_1RD_{ij} + a_2S_{ij} + a_3P_{ij} + \varepsilon_{ij} \quad (1)$$

In the model (1),  $EVA_{ij}$  represents the economic value added of the  $i$ th enterprise in year  $j$ .  $RD_{ij}$  represents the total R&D investment of the  $i$ th enterprise in year  $j$ .  $S_{ij}$  represents the natural logarithm of the total assets of the  $i$ th enterprise at the end of year  $j$ .  $P_{ij}$  represents the net profit of the  $i$ th enterprise in year  $j$ .  $S_{ij}$  and  $P_{ij}$  are control variables,  $a_0$  is the intercept term, and  $\varepsilon_{ij}$  is the random variable introduced to eliminate the influence of other factors.

### 3.5 Correlation Analysis

As TABLE II shows, the correlation analysis based on the Spearman coefficient shows that the correlation coefficient between total R&D investment and EVA is 57.7% and passes the 1% significance test, indicating that there is a positive correlation between R&D investment and EVA.

**TABLE II.** CORRELATION COEFFICIENT

		EVA	RD	S	P
Correlation Coefficient		1.000	.577**	.571**	.919**
Spearman's rho	EVA	.	.000	.000	.000
	N	336	336	336	336

<b>RD</b>	Correlation Coefficient	.577**	1.000	.766**	.690**
	Sig. (2-tailed)	.000	.	.000	.000
	N	336	336	336	336
<b>S</b>	Correlation Coefficient	.571**	.766**	1.000	.741**
	Sig. (2-tailed)	.000	.000	.	.000
	N	336	336	336	336
<b>P</b>	Correlation Coefficient	.919**	.690**	.741**	1.000
	Sig. (2-tailed)	.000	.000	.000	.
	N	336	336	336	336

\*\* . Correlation is significant at the 0.01 level (2-tailed).

### 3.6 Multiple Linear Regression Analysis

As TABLE III shows, there is a strong positive correlation between total R&D investment and EVA. The model summary shows that the R-value of the model is 0.944, which explains the goodness of the fit of data, indicating that the explanatory variables can explain 89% of the variation of the explained variables.

From the ANOVA results, the significant value corresponding to the F-value is 0.00, less than 5%, demonstrating that the regression equation can be considered credible. From the regression coefficient table, the regression coefficient of total R&D investment on EVA is 0.098 and the t-value is also greater than 2, which means the effect of total R&D investment on EVA is significant.

In summary, it is concluded that there is a positive relationship between total R&D investment and economic value added.

**TABLE III.** REGRESSION RESULTS OF R&D INVESTMENT AND EVA

Model Summary <sup>b</sup>						
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson	
1	.944a	.891	.890	204918670.72997388	1.532	

a. Predictors: (Constant), P, RD, S  
b. Dependent Variable: EVA

ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	113438570935528360000	3	37812856978509455000	900.485	.000b
	Residual	13941231655761498000	332	41991661613739456		
	Total	127379802591289850000	335			

a. Dependent Variable: EVA  
b. Predictors: (Constant), P, RD, S

Coefficients <sup>a</sup>								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3943595218.240	361372585.907		10.913	.000		

RD	.468	.109	.098	4.272	.000	.632	1.583
S	-187207047.478	16752492.463	-.289	-11.175	.000	.494	2.026
P	.874	.019	1.055	45.303	.000	.608	1.646

a. Dependent Variable: EVA

### 3.7 Lag Analysis

TABLE IV. LAG ANALYSIS OF R&D INVESTMENT AND EVA

	Lag one period			Lag three periods			Lag five periods		
	Regression coefficient	t	sig.	Regression coefficient	t	sig.	Regression coefficient	t	sig.
RD	0.090	3.783	0.000	0.084	2.833	0.005	0.084	2.034	0.044
Adj-R2	0.889			0.881			0.869		
F-sig.	0.000			0.000			0.000		

Considering the long return period of R&D investment in the TCM industry, a lag analysis is conducted.

As TABLE IV shows, based on the results of the lag analysis, situations of the total R&D investment lagged one period, three periods and five periods all pass the significance test. The adjusted R-squared shows the goodness of fit of the model, in line with the long return period of inputs in TCM companies. The regression coefficients are slightly lower, telling that the investment in R&D funds makes the operation capital less efficient and has a slight negative impact on the short-term business performance.

### 3.8 Summary

The following conclusion can be verified from the empirical analysis in this chapter:

The hypothesis that the R&D investment of TCM companies in the A-share market is positively related to business performance is valid.

## 4 CONCLUSION AND SUGGESTION

### 4.1 Conclusion

Through the empirical analysis, the conclusion is that there is a positive correlation between the R&D investment and business performance of TCM companies in the A-share market. Although R&D expenditure will have certain impacts on the financial performance of the current period, if we consider the long-term interest and the overall strategy of the company, planned R&D activities are not only important to support for improving the overall strength of the company but also an inexhaustible source and motivation for companies to obtain sustainable competitive advantages.

## 4.2 Suggestions

Listed TCM companies should conduct R&D activities in a proper way, raise their awareness of independent R&D, increase R&D investment, and actively upgrade their R&D strategies. Besides, it is necessary to conduct a feasibility analysis on R&D activities, evaluating risks and benefits, and using various methods to hedge risks.

The government should strengthen its protection of intellectual property in the TCM industry. To strengthen the protection of the intellectual property is to protect companies' R&D results, with which companies can receive adequate compensation for their R&D investment. Also, companies will pay attention to developing sustainable competitiveness and facilitate the financial performance with R&D investment, getting rid of short-term decisions that only focus on current interest.

TCM companies should enhance their cooperation with universities and scientific research institutions to establish a cluster structure of technological innovation, with companies as the main body, universities and scientific research institutions as the core, and the market as the orientation. With such a structure, companies can make up for their technical shortcomings and achieve more progress in scientific researches. Moreover, high-level industry-university-research collaboration bases need to be built to promote innovation capabilities, which will contribute to the construction of a complete innovation value chain.

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