

## R&D Expenses and Operating Performance in Pharmaceutical Industry

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**Abstract.** With the development of economic globalization, the R&D activities of pharmaceutical companies can not only improve their business performance, but also enhance their core competitiveness in the industry, reflecting the development potential and future value of the enterprise to some extent. Taking the pharmaceutical industry as an example, the paper emphatically studies the selection of 133 pharmaceutical listed companies. Through empirical analysis, the relationship between R&D input intensity and corporate performance is established. It is concluded that there is a significant positive correlation between research and development expenses and operating performance of pharmaceutical companies. The greater the R&D input intensity of pharmaceutical companies, the higher the company's operating performance. Therefore, pharmaceutical companies need to spend more on R&D, adjust the investment level in this area, and propose a reasonable budget plan to deepen the positive impact of R&D investment.

### 1. Introduction

The pharmaceutical industry is both a capital-intensive industry and a knowledge-intensive industry. R&D activities are closely related to the development of the pharmaceutical industry. China's pharmaceutical industry has undergone tremendous development. The strong demand has greatly stimulated the development of the pharmaceutical industry and has become a new driving force for the company's innovation growth.

In terms of R&D, first and foremost, domestic pharmaceutical manufacturing companies actively introduce foreign capital, and new technologies, new equipment, and new products are flooded into the domestic market. Domestic pharmaceuticals have evolved from imitation to innovation, drawing on foreign advanced technology and experience. Secondly, multinational corporations have increased the scale and intensity of the transfer of production. Many drugs have been entrusted to Chinese pharmaceutical companies for production. These changes have further promoted the cooperation between Chinese and foreign pharmaceutical manufacturers. Thirdly, large pharmaceutical research institutions from all over the world are unanimously optimistic about China's R&D environment and huge market space. Last but not least, the vigorous development of medical R&D outsourcing business is also one of the causes.

The paper selects the report data of listed companies in the pharmaceutical industry for the past five years. R&D input intensity (RD) is taken as the explanatory variable. The return on equity (ROE) and earnings per share (EPS) are explained variables. At the same time, the company scale and financial leverage are introduced. Corporate growth and actual tax burden, etc. are introduced as control variables to reinforce the corresponding relationship between causal variables.

### 2. Literature Review

The amount of R&D activity invested is affected by the size of the firm (Connollyra and Hirschey, 2005), and the size of the firm also affects the level of performance generated by R&D investment [1].

Another study shows the impact of financial leverage on R&D investment. Companies with higher debt are more inclined to invest less R&D expenses (Nam, Ottoo and Thornton, 2003)[2].

Two indicators for measuring corporate performance: product speed and market speed are mainly reflected in the normal production and operation of the company (Susanna Khavu W, 2001)[3].

On the correlation between R&D costs and business performance, previous scholars have also done a lot of research. The impact of capitalization on R&D expenditures on corporate value is positive. The correlation is particularly evident in companies with stable development periods and strong R&D input or both (Oswald and Dennis Ray, 2000)[4]. The data from South Korea also suggests that the stock price is positively correlated with the amount of R&D expenditures of the company, indicating that R&D expenditures affect firm value (Hana and Hanry, 2004)[5]. In 2005, Thomas, Nissim and Lev not only studied the empirical relationship between the method of conditional capitalization of R&D costs and the potential contribution to the promotion of corporate performance, but also applied the straight-line approach to the development of intangible assets. The costs incurred are amortized assuming possible useful lives. The final conclusions reveals that conditional capitalized R&D cost treatment can increase the degree of correlation between corporate performance and projected benefits, while the treatment of R&D costs can also intensify the correlation between corporate performance and financial indicator data [6]. In the international arena, numerous scholars have used data from different countries to study the relationship between innovation and investment[7] and the issue of R&D expenses in information disclosure[8]. However, in China's pharmaceutical industry, the research practices on such issues are still lacking.

### **3. Research Hypotheses**

Taking the listed companies in the pharmaceutical industry as the target, the paper mainly selects the financial statement data of 133 listed companies in the pharmaceutical industry in 2011-2015 as a sample, which basically satisfies the conditions for a large sample. The financial indicators and financial data used in the paper source from the CSMAR database. Through certain processing and transformation, 40 valid data for 2011, 50 effective data for 2012, 62 valid data for 2013, 66 are finally obtained. Valid data for 2014, 71 valid data for 2015, totaling 289 valid data for the time span of the study.

According to the concept of Enterprise Resource, enterprises can obtain extraordinary returns through extraordinary resources, and independent research and development can increase intangible assets of enterprises, enrich internal resources, improve operating performance, and obtain excess returns. According to the theory of economic growth, lack of innovation may become an important factor constraining the growth of enterprises. The new technologies generated by creative development can improve product quality and output efficiency, and thus improve business performance.

The paper assumes that the independent development of innovative activities of pharmaceutical companies has a positive effect on business performance. Based on this, the following hypotheses and alternative assumptions are proposed:

$H_0$ : There is no positive correlation or correlation between R&D expenses and operating performance of pharmaceutical companies.

$H_1$ : There exists a positive correlation between R&D expenses and operating performance of pharmaceutical companies, and the correlation is significant.

### **4. Empirical Research**

#### **4.1 Model design**

Exploring the correlation between research and development expenditures in China's pharmaceutical industry and business performance is the main content of the paper. To this end, two assumptions are

proposed and a multiple linear regression model is constructed to test whether the above assumptions are true. The model is as follows:

In order to study the impact of R&D expense on business performance in the pharmaceutical industry, Model 1 and Model 2 were set up to test H0 and H1:

$$\text{Model 1: ROE} = \alpha_0 + \alpha_1 \text{RD} + \alpha_2 \text{Size} + \alpha_3 \text{Lev} + \alpha_4 \text{Growth} + \alpha_5 \text{Tax} + \varepsilon$$

$$\text{Model 2: EPS} = \alpha_0 + \alpha_1 \text{RD} + \alpha_2 \text{Size} + \alpha_3 \text{Lev} + \alpha_4 \text{Growth} + \alpha_5 \text{Tax} + \varepsilon$$

(Where  $\varepsilon$  denotes a random variable)

The coefficient of the regression result is positive, which indicates that the explanatory variable is positively related to the business performance, while the negative coefficient is negatively related. The greater the absolute value of the coefficient, the stronger the correlation between the corresponding explanatory variable and business performance. The section headings are in boldface capital and lowercase letters. Second level headings are typed as part of the succeeding paragraph (like the subsection heading of this paragraph).

## 4.2 Variable selection

The paper selects the report data of listed companies in the pharmaceutical industry in the past five years, taking R&D investment intensity (RD) as explanatory variables, return on equity (ROE) and earnings per share (EPS) as explanatory variables. It also introduces the enterprise size, financial leverage, corporate growth, and the actual tax burden as controllable variables to strengthen the correspondence between causal variables.

### 1) Explained variables

Return on equity (ROE). Considering the serious situation of insider trading and market manipulation in China's capital market, the paper selects the weighted average return on net assets after deducting non-recurring gains and losses as the evaluation index of business performance.

Earnings per share (EPS). Earnings per share, which has the advantages of market indicators and accounting profit indicators, can relatively reflect the business performance of an enterprise, and are usually utilized as an alternative variable of the ROE to test the stability of the model.

### 2) Explain the variables

R&D investment intensity: R&D investment intensity (RD) indicates the selected variables of the study. In the Cathay Pacific database, R&D investment data are listed under "Management Expenses" and are usually disclosed as "Development Expenses". RD, also known as R&D expense ratio, refers to the ratio of R&D investment to current main business income, which reflects the ratio between current expenses and operating income of R&D activities.

R&D investment intensity (RD) = development expenditure / main business income. Due to the size of different enterprises and the revenue level of enterprises under the scale effect and the relative index, R&D investment intensity is selected to enhance the comparability among enterprises.

### 3) Control variables

R&D investment intensity (RD) on the macro and micro levels and many other factors: In view of the availability of data, the control variables in the paper fully consider the factors that may affect the intensity of R&D investment at the micro level, such as Size, Lev, Growth and Tax.

## 4.3 Correlation analysis

There is a certain correlation between the test results, ROE, EPS, R&D investment intensity and other control variables. Among them, the correlation of net intangible assets at 0.05 level and earnings per share is not significant. There is significant correlation between the asset-liability ratio, operating income growth and return on equity at the 0.01 level.

Table 1. Correlation Test Matrix

	RD	ROE	EPS	Net bal of intangible assets	TDR	Operating income growth rate	Income tax
RD	1.0000						
ROE	0.2140** 0.0002	1.0000					
EPS	0.2796** 0.0000	0.7581** 0.0000	1.0000				
Net bal of intangible assets	-0.0493 0.4035	-0.1261* 0.0322	0.0493 0.4036	1.0000			
TDR	-0.0321 0.5864	-0.2591** 0.0000	-0.1899** 0.0012	0.2879** 0.0000	1.0000		
Operating income growth rate	0.0587 0.3203	0.2887** 0.0000	0.1622** 0.0057	-0.0510 0.3874	-0.1570** 0.0075	1.0000	
Income tax	-0.1216* 0.0389	0.3729** 0.0000	0.4874** 0.0000	0.6406** 0.0000	0.1487* 0.0114	0.0956 0.1050	1.0000

\*\* indicates  $p < 0.01$ , two-tailed test was significantly related.

\* indicates  $p < 0.05$ , two-tailed test was significantly related.

#### 4.4 Regression analysis

Table 2. Regression Analysis of Return on Equity

Source	SS	df	MS	ROE	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
Model	41.385886	5	8.2771771	RD	17.72454	4.559247	3.89	0	26.69888	8.7502
Residual	53.141359	283	0.1877787	Net bal of intangible assets	-1.21e-08	1.40e-09	-8.69	0	-1.49E-08	-9.39e-09
Total	94.527244	288	0.3282196	TDR	-10.36417	2.489399	-4.16	0	-15.26426	-5.46408
				Operating income growth rate	8.45385	2.15613	3.92	0	4.209763	12.69794
				Income tax	8.68e-08	7.28e-09	11.92	0	7.24e-08	1.01e-07
				_cons	9.516737	1.112851	8.55	0	7.326221	11.70725
				goodness of fit	R <sup>2</sup>				0.4607	
					Adj-R <sup>2</sup>				0.4512	

The regression results in the table above displays the correlation between variables and ROE. The change in R&D intensity (RD) per unit of R&D results in a 17.72454 ROE shift in the same direction, that is, RD has a positive correlation with the business performance and a significant correlation. The goodness of fit of the regression model was good, with R<sup>2</sup> of 0.4607 and Adj-R<sup>2</sup> of 0.4512. Therefore, it can be concluded that increasing the R&D expenses and raising the R&D expenses and the ratio of the main business income can have a positive impact on the business performance.

Among the control variables, the income tax expense and operating income growth rate are positively correlated with the business performance. The increase of 1 unit operating income will increase the return on net assets by 8.45385 units. As a consequence, increasing the operating income growth rate will make the business performance band positive. The regression illustrates that the increase of the scale of intangible assets will reduce the performance of the enterprise, that is, there is a negative correlation between the two. It is different from the usual regression results, mainly for the following two reasons: Firstly, it is due to the net intangible assets. However, as the scale of intangible assets in pharmaceutical industry is characterized by a large base and a high proportion, it is also in line with the reality that the actual asset size of an enterprise is assessed. Secondly, the liquidity of intangible assets poor cannot be realized promptly, leading to possession of considerable money. It will also have an adverse impact on the current net profit. At the level of  $p < 0.01$ , there is a significant negative correlation between asset-liability ratio and return on net assets. In other words, the return on equity decreases as the ratio of assets to liabilities increases. According to the regression results shown in Table 2, the rise of asset-liability ratio of 1 unit will result in a decrease of 10.36417 units of ROE. The main reasons are as follows: First of all, research and development is a large-investment high-risk activity. In the case of failed R&D, it is of small probability to recover the expenditure of

research event of in the previous stage, will inevitably reduce the current pre-tax income and the impact of return on net assets, followed by R&D activities need enterprises with strong financial support, investment in research and development activities beyond the capacity of enterprises. The enterprises raise funds by raising financial leverage, which implies operational risk. With the increase of it, it may impact on the performance of enterprises in the business process level.

Table 3. Regression Analysis of Earnings Per Share

Source	SS	df	MS	ROE	Coef.	Std.Err.	t	P> t	[95%Conf. Interval]
Model	41.385886	5	8.2771771	RD	1.283524	0.2628906	4.88	0	1.800993 0.7660549
Residual	53.141359	283	0.1877787	Net bal of intangible assets	-4.82e-10	8.05e-11	-5.99	0	-6.41e-10 -3.24e-10
Total	94.527244	288	0.3282196	TDR	-0.5790563	0.1435412	-4.03	0	-0.8616002 -0.2965125
				Operating income growth rate	0.1585952	0.1243245	1.28	0.203	-0.086123 0.4033134
				Income tax	5.05e-09	4.20e-10	12.04	0	4.23e-09 5.88e-09
				_cons	0.497814	0.0641681	7.76	0	0.3715067 0.6241213
				goodness of fit	R <sup>2</sup>		0.4378		
					Adj-R <sup>2</sup>		0.4279		

The above regression results demonstrate the correlation between variables and earnings per share. The change of R&D intensity (RD) per unit of R&D results in a net change of net income per share of 1.283524 units. It means that there is a positive correlation between RD and the long-term operating performance of the enterprise and the correlation is significant. The goodness of fit of the regression model was good with R<sup>2</sup> of 0.4378 and Adj-R<sup>2</sup> of 0.4279. Therefore, the paper concludes that "increasing R&D expenditure and increasing R&D investment intensity can have a positive impact on the long-term business performance of enterprises in pharmaceutical industry."

Among the control variables, income tax expense and operating income growth rate are positively correlated with business performance. Each increment of operating income growth rate will correspondingly increase earnings per share by 0.1585952 units. The regression results suggest that the increase of the scale of intangible assets will reduce the business performance, which implies a negative correlation between the two, namely an increase of 1 unit net intangible assets will reduce 4.82 e-10 units of earnings per share. The reason for this effect is similar to its effect on return on net assets. At the p < 0.01 level, there is a significant negative correlation between asset-liability ratio and earnings per share, that is, earnings per share decreases as the ratio of assets to liabilities increases. According to the regression results shown in Table 3, an increase in the gearing ratio of 1 unit will result in a decrease of 0.5790563 units per share.

## 5. Conclusion

It can be observed from the research conclusions that there is a significant positive correlation between the R&D expenses of pharmaceutical companies and their business performance. The greater the intensity of R&D investment in pharmaceutical companies, the higher the company's operating performance. In this sense, pharmaceutical companies need to spend more on research and development, and then adjust the level of investment in this area, and put forward a reasonable budget plan to deepen the positive impact of research and development investment. In addition to that, in the process of obtaining data, fewer data are available in the medical field, less than 40% of effective data before 2012 to be exact. In recent years, the proportion of valid data has been on the rise year by year, which had remained below 60% by 2015. There is little disclosure of research and development information in the pharmaceutical listed companies, and the fairness and truthfulness of the data are also relatively low. Therefore, the relevant disclosure in this field needs to be strengthened. The specific conclusions are as follows:

(1) The investment in R&D of Chinese listed pharmaceutical companies is insufficient, and the input intensity is obviously low.

(2) The R&D investment of pharmaceutical companies can, to a certain extent, enhance the business performance of the company.

(3) The pharmaceutical company's R&D information disclosure system needs to be improved, and the quality of information disclosure needs to be improved.

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