The Impact of the R&D Investments towards Short-term Corporate Valuation -- Evidence from Chinese Listed Healthcare Companies

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Abstract. R&D investments impact the corporate valuation in the healthcare industry, and the outbreak of COVID-19 influences their relationship. This paper applied simple linear regression to analyse the influence of R&D investments on corporate valuation among Chinese listed healthcare companies, showing an enormous difference between R&D intensity and personnel. R&D intensity will have a negative relationship with corporate valuation in the current year, while R&D personnel will positively influence it. Further, after the pandemic outbreak, the nexus between corporate valuation and R&D intensity transferred into positive, while its R&D personnel counterpart is still not significant. These results display that it is essential for Chinese listed healthcare companies to improve corporate valuation through altering their R&D policy, such as recruiting R&D personnel, paying attention to R&D investments and their effectiveness, and learning the experience from the epidemic outbreak. In addition, this paper also enriches the literature review of R&D spending and corporate valuation.

Keywords: healthcare industry, R&D investments, corporate valuation, COVID-19

1. Introduction

Chinese play more attention to healthcare in recent years, on account of the population aging, improvement of living standards, and especially, the outbreak of COVID-19. Hence, the healthcare industry is related to well-being and has enormous improvement potential [1]. Innovation is essential for the healthcare industry, because it will not only broaden the area of healthcare treatment, but also enhance the productivity of existing therapy, fulfilling the increasing demand [2].

Corporate valuation defines the firm's value through its capacity of generating cash flow now as well as in the future [3]. It is an excellent and common way to determine whether to conduct a decision or not in companies. Although the research about the nexus between research and development (R&D) investments and corporate valuation is limited, numerous reports are mentioning the effect on the financial performance, export state, etc. According to Artz et al., having a credible performance of innovation is widely deemed as the key determinant of enterprise performance and strength among competitions [4]. Aw et al. believed that R&D investments and export states are interdependent [5]. In other words, R&D investments will cause higher productivity and more exports, or vice versa. The firm performance always impacts share price and corporate valuation eventually.

This paper chooses data from listed healthcare companies in China to explore the link between R&D expenditures and current year's corporate valuation. This research also chose COVID-19 as the moderate variable, because the epidemic outbreak significantly influences firms' performance. Thus, this paper enriches the literature research of R&D spending on corporate valuation theoretically, and it also gives enterprises some guidance about R&D investments.

2. Literature Review

2.1 R&D Investments Impact on The Healthcare Industry

There are two main functions for companies to have R&D activities, including enhancing R&D effectiveness straightly and absorbing outside resources [5]. According to researchers from America,

Japan, and Germany, companies whose return sensitivity is higher will spend more on R&D, and high-tech firms are one kind of them[6]. Nam (2017) also found that the healthcare industry needs great R&D investments and patent information to offer international facilities [10].

According to Vanderpal (2015), tangible assets investments are only half as effective as R&D investments, and R&D spending positively correlates with operating performance, productivity, and market value [8]. Chuang (2003) realized a noticeably positive nexus between firm value and R&D investments, if an enormous number of security analysts monitor the managerial performance in the companies and outside directors occupy a significant percentage [9]. Utilizing earnings per share and price-earnings ratio as indicators, Freihat & Kanakriyah discovered that R&D spending positively influence on enterprises [10]. Through analyzing the link between R&D investments and fair value in the advanced nations, including America, Japan, and Germany, Bae (2003) believed there is a positive correlation, while the degree fluctuated among different countries [6]. However, Ravšelj and Aristovnik (2020) concluded that no significant relationship exists between short-term corporate valuation and R&D investments, while there is a positive link among its financial performance counterparts [11]. Differently, according to Biswas (2021), R&D investments are vital for the corporations to innovate and maintain competitiveness. Although it is an expenditure in the short run, R&D activities will be in favor of the company in the long run, because innovation has a long-life cycle [12]. Huang (2020) believed that the healthcare industry has the same situation. R&D investments will generate intangible assets, leading to technological superiority and high quantity of products in the long-term, while it will cause noteworthy and negative effects on short-term financial performance [13].

2.2 COVID-19 Impacts on Firm's Performance

The World Health Organization declared that Coronavirus Disease 2019 (COVID-19) - the epidemic affecting every aspect of Chinese life - has become a global pandemic from January 30, 2020. COVID-19 influences macroeconomics through the supply-demand ratio, value of import and export, mass psychology, Purchasing Managers Index (PMI), Prosperity Index, etc.[14]. There are several negative effects on financial performance among Chinese listed companies both now and in the future, including income, profitability, investment behaviors, share and other security prices [15]. However, the effect is different among various industries because of core business diversity and adaptation level of external environment [8]. For example, according to the first quarter of 2020, the industries covering transportation, tourism, and firms depending on these industries had suffered the most serious hits [15]. As for the hospital, the hospital and ICU are overwhelmed by sharply growing patients in America, resulting in suspended outpatient departments, elective surgery and financial performance finally [16]. In terms of medical device enterprises, according to Peng and Yuan (2021), the financial performance among 62 Chinese listed companies in 2020 was better than that in 2019 [17]. Su et al. (2021) also believed R&D investments are conducive to enterprise advantages after epidemic outbreak [18].

3. Research Hypothesis

According to Tan et al. (2017), R&D investments are vital for the company in the knowledge-based economy, and the high-tech industry always faces some challenges of managing relative R&D activities [19]. Therefore, as a high-technology industry, it is essential for healthcare companies to comprehend the correlation between R&D investments and corporate valuation.

A direct nexus exists between R&D activities and market share, sale growth rate, as well as profit margin [20]. However, the relationship was only significant ($p<0.1$) two years and five years later, showing a lag effect, because with the R&D expenditure, a company will suffer a higher risk, leading to a lower share price in the short run [21]. Biswas (2021) believed that R&D investments are a kind of expense in the short-term resulting in an underreaction，but time will correct [12]. Zhang J. & Zhang L.H. (2014) also found that R&D investments should spend some time on transferring into

new technology and being in favor of financial performance, especially for profitability [22]. Consequently, the first hypothesis is as follows:

Hypothesis 1: R&D investments have a negative nexus with current year corporate valuation.

The epidemic causes many challenges in different fields and countries, especially in the healthcare industry [23]. As for demand, nations are more concerned about their health compared with the past, while in terms of the supply, some treatments have to pause due to the localized epidemic outbreak or shortage of medical resources. Consequently, due to the COVID-19, the supply and demand structure in the healthcare industry has changed.

Zhou (2021) believed that higher R&D intensity and a more reasonable investment structure can help companies to reduce financial risk from unexpected accidents like COVID-19 outbreak [24]. Biswas (2021) affirmed R&D investments have an essential function of enhancing financial performance after COVID-19. After analyzing about 40,000 listed and unlisted firms in India, he found that R&D firms had better performance in return on sales and gross income than non-R&D enterprises during the epidemic quarter. In addition, R&D manufacturing firms had a lower negative capital adequacy ratio from the COVID-19 [12]. Consequently, the second hypothesis is as follows:

Hypothesis 2: The outbreak of COVID-19 affects the nexus between the R&D investments and corporate valuation during the same year.

4. Data, Variables, and Methodology

4.1 Sample Selection and Data Sources

Two hypotheses are validated by Chinese listed healthcare companies from 2014/1/1 to 2021/12/31 in this paper. To begin with, healthcare is one of the foundations of well-being, confronting the challenges of the epidemic outbreak, aging population, medical system reform, and equality in healthcare resources in China [22]. Furthermore, there is only a little research mentioning the nexus between R&D investments and corporate valuation, while Vanderpal (2015) found that R&D expenditure being conducive to financial performance is widely studied in the financial literature. Nevertheless, mixed trends occur [26]. Lastly, the results between different industries are fluctuant, according to Wu & Zhao (2013), in high-tech industries, R&D expense will improve the financial performance of mechanical equipment industry and information technology industry in the current year, while the electronics industry and biotechnology industry have one year and two years lag effect respectively [27]. Hence, this research will focus on the healthcare industry among Chinese listed companies. The observations contain 409 corporations and 2775 firm-years, utilizing the Wind database and annual financial reports among the Chinese listed healthcare companies.

4.2 Variables

4.2.1. Dependent Variable

Discounted cash flow (DCF) method in the current year is used as an indicator of corporate valuation in this research. DCF is the motion estimations of the present and future value of the company, utilizing the value streams such as investments, cash flow, etc [28]. With the control variable, DCF performance is better than PE regarding forecast error for the missed target prices [29].

4.2.2. Independent Variable

This research uses the R&D intensity and R&D personnel as indicators of R&D investments. Compared with unquantifiable indicators such as creativity, using quantifiable indicators (like investments in capital and technical personnel) as explanatory variables, research will be more scientific and reasonable [22].

In empirical studies, R&D intensity is always the index of R&D investments among various firms. The ratio covers the expenditure on efforts to develop products and services or figure out current and potential problems [10]. Absolute value is unscientific and subjective than the level of R&D expenditure; therefore, it is better to apply the ratio to compare R&D expenses among different companies within an industry or various industrial groups [13, 30].

Only a few researchers apply R&D personnel as an index. In this paper, R&D personnel includes research staff, scientists, engineers and etc in the companies. It is essential for the staff to generate creative ideas from others' perspectives and insights, then combine this information creatively to find practical solutions and innovation [31].

4.2.3. Moderating Variable

This research uses COVID-19 as a moderating variable. Because the COVID-19 is a rare event in our history and causes some negative effects on corporate financial performance among Chinese listed companies [15]. There are only two years of data from the outbreak, whose cross-section data is not enough to contrast with consequences from 2014 to 2021, so this research also compares the results from 2017 to 2019.

4.2.4. Control Variable

To exclude other explanations, there are five control variables in the research. Firstly, larger companies have more channels and resources, so they can enjoy economies of scale and are easier to generate capital as well as enhance industry barriers; hence, firm size is controlled applying log coefficients of total assets [11, 18]. Secondly, a higher fixed asset turnover will be in favor of productivity and performance; thus, this research controls fixed assets turnover [18]. Thirdly, market concentration will affect the company strategies and resource distribution; therefore, this research controls market competition using Herfindahl-Hirschman Index as an indicator [18, 20]. Fourthly, more sales volume will enhance the income, profitability, and above-normal rates of return, leading to higher share price and corporate valuation; therefore, sales growth rate also is a control variable [6,11,18,30]. Lastly, there are some adverse effects between firm performance and financial leverage ratio because companies have to pay more debt and invest less; consequently, financial leverage is controlled by utilizing the asset-liability ratio [11].

Table 1. Variables and definitions

Variables	Indicators	Definitions
Dependent variable		
Corporate valuation	DCF	Net present value of future value streams in next five years
Independent variable		
R&D investments	R&D intensity R&D personnel	R&D expenditure/operating income The number of research staff
Moderating variable		
COVID-19	Nil	Compare the relationship between IV and DV before and after COVID-19
Control variable		
Firm size	Log coefficients of total assets	Nil
Fixed assets turnover	Nil	Operating income/average net fixed assets
Market concentration	Herfindahl-Hirschman Index	$HHI= S_1^2+ S_2^2+\ldots + S_n^2$ Where: S_n=the market share percentage of firm n expressed as a whole number instead of a decimal
Sales volume	Sales growth rate	The growth rate of sales from year t-1 to year t
Financial leverage	Asset-liability ratio	Total assets/total liability

4.3 Econometric Model

This paper constructed the following four linear regression models to analyze the hypotheses. Models (1) and (2) correspond to *H1*, while models (3) and (4) correspond to *H2*.

$$DCF\ (billion) = \alpha + \beta_1 INT + \beta_2 TA + \beta_3 FAT + \beta_4 HHI + \beta_5 SGR + \beta_6 ALR + \varepsilon \quad (1)$$

$$DCF\ (billion) = \alpha + \beta_1 PER + \beta_2 TA + \beta_3 FAT + \beta_4 HHI + \beta_5 SGR + \beta_6 ALR + \varepsilon \quad (2)$$

$$DCF\ (billion) = \alpha + \beta_1\ INT + \beta_2 COVID + \beta_3 COVID * INT + \beta_4 TA + \beta_5 FAT + \beta_6 HHI + \beta_7 SGR + \beta_8 ALR + \varepsilon \quad (3)$$

$$DCF\ (billion) = \alpha + \beta_1\ PER + \beta_2 COVID + \beta_3 COVID * PER + \beta_4 TA + \beta_5 FAT + \beta_6 HHI + \beta_7 SGR + \beta_8 ALR + \varepsilon \quad (4)$$

Among these models, α is a constant term, β_1 is the coefficient of independent variables covering R&D intensity and R&D personnel. Model (1) (2) stands for the current year discounted cash flow (DCF). Except for β_1, other βs are the coefficient of control variables including log coefficients of total assets (TA), fixed assets turnover (FAT), Herfindahl-Hirschman Index (HHI), sale growth rate (SGR), and asset-liability ratio (ALR). ε is an ordinary error term. Based on the above two models, the purpose of models (3) and (4) is to measure the moderating function. Both β_2 (the coefficient of COVID-19) and β_3 (the coefficient of the interaction term) are used to control the moderating variable.

5. Results and Discussion

5.1 Descriptive Statistics

Table 2 sums up the descriptive statistics for all variables. According to the data, the average DCF is 3.453 billion, and the mean R&D intensity is 2.279, while that of R&D personnel is 0. However, the standard deviation of R&D personnel is far more than others, which is 28,841.

Table 2. Descriptive statistics

Variables	N	Min	Max	Mean	Std. Dev.
DCF (billion)	2,787	-8.285	8.999	3.453	7.884
INT	2,775	9.43 e-06	1,860	2.279	42.80
PER	2,787	348.2	1,025	0	28,841
TA	2,787	7.449	11.21	9.352	0.559
FAT	2,787	0	263.5	4.444	13.54
HHI	2,787	0.0157	0.0215	0.0178	0.00195
SGR	2,787	-0.948	944.1	1.024	21.05
ALR	2,787	0.0143	1.783	0.314	0.186
COVID	2,787	0	1	0.280	0.449
COVID*INT	2,775	0	1,860	0.854	35.83
COVID*PER	2,787	0	28,841	136.9	840.4

5.2 Regression Analysis

5.2.1. R&D Intensity and DCF

The data are substituted into models (1) and (3) to analyse the results between R&D intensity and DCF, using the linear regression method and conducting the regression with STATA. According to Table 3, the p values are not more than 0.05, passing the significance test. As for the whole trend (from 2014 to 2021), a negative nexus exists between R&D intensity and DCF in the current year. Specifically, when the level of R&D intensity increases by 1%, DCF in the current year will decrease by 28.3%. As for the period after the epidemic breakout, covering 2020 to 2021, the negative relationship converted into positive. In other words, the degree of R&D intensity rises by 1%, DCF will go up by 38.2% during 2020 to 2021, compared with a 44.8% decline during 2017 to 2019.

Table 3. Estimated results of R&D intensity and DCF

Variable	2014-2021	2017-2019	2020-2021
INT	-0.283***	-0.448**	0.382**
	(-3.15)	(-2.38)	(2.19)
TA	515.922***	-10.729	547.530**
	(4.80)	(-0.08)	(1.99)
FAT	47.831***	72.263***	67.461
	(5.57)	(5.39)	(1.27)
HHI	10,385.404*	14,820.925**	16,216.144
	(1.75)	(2.21)	(1.23)
SGR	-0.454	-3.131***	0.518
	(-1.09)	(-6.15)	(1.17)
ALR	-64.529	-5.607	460.387
	(-0.47)	(-0.06)	(1.33)
Constant	-4,856.851***	-164.375	-5,486.579**
	(-4.46)	(-0.14)	(-2.00)
Observations	2,775	1,135	779
Observations	0.300	0.322	0.110
R-squared	0.298	0.319	0.103

5.2.2. R&D Personnel and DCF

The sample data are substituted into models (2) and (4) to analyse the results between R&D personnel and DCF, using the linear regression method and conducting the regression with STATA. According to Table 4, in terms of the whole trend (from 2014 to 2021), the p value is less than 0.01, passing the significance test. R&D personnel positively impact DCF in the current year. Specifically, R&D personnel increases by 1%, while the DCF in the current year will also grow by 9.7%. As for the period after the epidemic breakout (covering 2020 to 2021), it does not pass the significance test, meaning an unclear relationship.

Table 4. Estimate results of R&D personnel and DCF

Variable	2014-2021	2017-2019	2020-2021
PER	0.097***	0.139***	0.007
	(3.25)	(6.04)	(0.09)
TA	458.097***	-75.666	506.578*
	(4.40)	(-0.60)	(1.96)
FAT	47.252***	71.678***	67.940
	(5.84)	(5.40)	(1.24)
HHI	8,922.564	12,636.106*	15,939.841
	(1.52)	(1.91)	(1.24)
SGR	-0.326	-2.992***	0.190
	(-0.87)	(-6.48)	(0.58)
ALR	-71.101	-44.597	349.796
	(-0.54)	(-0.53)	(1.11)
Constant	-4,318.941***	445.259	-5,061.289*
	(-4.08)	(0.39)	(-1.94)
Observations	2,787	1,144	780
R-squared	0.311	0.333	0.107

5.3 Discussion

5.3.1. R&D Intensity and Corporate Valuation

There are four causes for the negative nexus between R&D intensity and corporate valuation in the same year. First, companies will confront higher uncertainties and risks with R&D expenditure [7,11,31]. Consequently, a lower level of profitability may undermine investors' confidence, so they will delay their investments. Secondly, according to Artz et al. (2010), R&D spending will positively impact the number of patents, while patents may not transfer into product announcements and lead to effectiveness [4]. Third, there is a long-term cycle from investing in R&D to producing products, while one year is a short run [11,13]. According to Ravšelj and Aristovnik (2020), R&D spending will positively affect both financial performance and corporate valuation in the long-term [11]. Lastly, some companies invest blindly to get the subsidy from the government, leading to the sunk cost [13].

5.3.2. R&D Personnel and Corporate Valuation

There is an opposite conclusion between R&D intensity and personnel, may because of the indicator of the independent variable. DCF is sensitive to spending. In other words, a company will have a higher valuation if the cost of the capital is lower. R&D intensity measures funding, while R&D personnel represents the quantity of staff focusing on research or developing the technicality, which only includes the cost of salaries and welfare. Consequently, two indicators have adverse results. Besides, more R&D staff in favour of solving the existing problems and creating new healthcare treatment, because interaction between various kinds of knowledge and specialists is essential to problem-solving, and knowledge generation should be through knowledge interchange and incorporation [19].

5.3.3. Relationship after COVID-19 Outbreak

The link between R&D intensity and corporate valuation converts from negative to positive due to the epidemic. Biswas (2021) also has similar results, which are positive nexus between R&D expenditure and financial performance during epidemic quarters, since R&D activities may enhance resilience and flexibility such as utilizing contactless delivery [12]. In addition, it is the pandemic that helps the rapid realization of R&D investments in the healthcare industry, such as remedy for COVID-19 - some hospitals have higher revenue on account of COVID-19 hospitalizations and medicines - and digitalization of healthcare [8, 16].

The nexus between R&D personnel and corporate valuation is not significant. Two reasons may cause this situation. To begin with, in China, inhabitants will restrict inter-city or intra-city travel if local breaks out epidemic [23]. Consequently, companies may suspend business irregularly. Besides, the data covers the early stages of the outbreak, which is unstable and different from the normalization of the epidemic.

6. Conclusion

This research analyses the link between R&D investments and corporate valuation during the same year. The conclusion is that R&D intensity negatively influenced corporate valuation in the current year, while a positive relationship exists in its R&D personnel counterpart. Noticeably, after COVID-19 explosion, R&D intensity and corporate valuation positively connected within a year, while that of R&D personnel is not significant in this research. Based on the theory, there are several implications in this paper.

Firstly, enterprises can recruit R&D personnel from various areas and treasure them. The basest level offers an environment suitable for scientific research and keeps them away from outside interference [13]. In addition, not only knowledge exchange and combination, but also collaborative innovation with government, competitions, universities, and so on is essential for innovation [19].

Secondly, corporations should pay attention to R&D investments and their effectiveness. To begin with, companies should reject blind research and do the research based on the need instead of government subsidiary-oriented, leading to lower sunk costs [13]. Furthermore, companies should be confident of the return on their R&D investments, although based on this research, it causes a negative

effect in the current year. According to Huang (2020), time will lessen the negative influence year by year on the healthcare industry [13]. Similarly, Rabiei and Dadkhah (2014) believe that R&D spending will positively influence market share, sales, and profitability as long-term projects [20]. Freihat and Kanakriyah (2017) also found that technology investments – part of R&D investments – can retain or even enhance the rate of return on staff and capital [10]. Last, it is vital for the board of directors (BOD) to balance short-run and long-run performance. Managers always pursue short-term goals because it will reflect their capacity and reward, which may lead to lower R&D spending [11]. Under the conflict between managers' interests and long-run company performance, BOD needs to balance the interests of both sides.

Thirdly, firms can learn the experience from the outbreak of COVID-19 to confront the emergency in the future [8]. According to research, R&D expenditure will benefit corporate valuation in the current year after the epidemic, because the healthcare industry has a changing supply-demand structure and R&D companies can adapt to it fast and flexibly.

However, this study only uses DCF to evaluate corporate valuation. DCF is susceptive to the cost of capital and has some limitations. To have an all-sides and insightful observation of the topic, Cohen & Neubert (2019) used 14 criteria to value companies, from which is further study learning [28].

In a high-tech industry, innovation is essential for healthcare enterprises to develop a competitive edge, enhance profitability, etc, eventually increasing corporate valuation, although it needs certain years to correct. Despite the existing limitations, this research can provide some thoughts on this topic.

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