

R&D accounting treatment, firm performance, and market value: Biotech firms case study

Namryoung Lee

School of Business, Korea Aerospace University,

South Korea

nrlee@kau.ac.kr

Abstract. This study examines the correlation between R&D accounting treatment and market value in association with the firm's performance, with a focus on biotech firms. Firstly, the results of the analysis show that capitalized R&D has a positive correlation with market value, consistent with existing literature. In the case of biotech firms, capitalized R&D has a higher value relevance compared to other industries. Secondly, this study examines the effect of a decrease in capitalized R&D on market value. It is found that the decrease in capitalized R&D has a negative effect on market value, however, this is not the case for biotech firms. In particular, in years where major biotech firms acknowledge and correct their accounting error, capitalized R&D decrease seems to have a more positive effect on market value. Additionally, this study extends the inquiry in association with the company performance and finds the decrease in capitalized R&D has a significant positive association with market value when the firms get better performance. But when the firm's performance gets worse, a decrease in capitalized R&D adversely affects the market value. However, this is not the case for biotech firms, suggesting excessive expectation around the R&D process of biotechnology firms.

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1. INTRODUCTION

Global biotechnology market is steadily growing and is expected to surpass USD 775 billion by 2024, according to Global Market Insights, Inc. According to IBIS World research report, the US biotechnology market has grown at average annual growth rate of 1.5% from 2013 to 2018, and the market size (based on sales) in 2018 was USD 107.6 billion. European biotechnology market has also grown and 2018 was rated as a great year for biotech in Europe. The list of biotech companies valued at more than €1B is growing all the time, with some impressive acquisitions taking place. As innovation and strategic

transformation is at the core of biotechnology, this industry in Europe is now attracting a lot of promising young business people.

Korean bioindustry is also experiencing explosive growth over the past 2-3 years. Multinational pharmaceutical companies are now paying attention to Korean bioventures. Global investors are weighing investments at emerging markets such as South Korea in addition to the existing investment destinations such as the US, Europe and Israel.

In 2018, eight out of ten stocks showing rapid growth were biotech (biopharma) stocks. Seven of the **10 largest** Korean companies listed at KOSDAQ (Korean Securities Dealers Automated Quotations)¹ by **market cap were also** biotech firms. This is because, despite uncertainty, there is great anticipation for the potential growth of biotech firms. There are, however, some voices of concern that the current stock prices are already overvalued. R&D spending is an important productive input, however, it is also a major source of information asymmetry (Aboody and Lev, 2000; Moehrl and Walter, 2008).

For biotech companies, R&D investment is essential in developing innovative new drugs and creating future sustainable value. Top three global biotech companies (by market cap) such as Johnson & Johnson, Pfizer, and Roche are investing more than USD 8 billion a year in R&D. In recent years, Korean biotech stocks prices fluctuate frequently, recording both the highest and the lowest figures. A frequently controversial issue here is how to treat R&D in the biotech sector – as capitalization or as expenses? According to the Korean FSS (Financial Supervisory Service), as of the end of 2016, 55%, or 83 of biopharma companies were capitalizing their R&D investments. While capitalized R&D ratio to total assets of all listed companies amounts to a mere 1%, capitalized R&D ratio to total assets of the biotech industry is said to reach 4%. In Korea, R&D capitalization is allowed when the conditions required by the KIFRS (Korean International Financial Reporting Standards) are met, it is also debatable as to whether accounting standards are being applied appropriately.

However, it has been confirmed that capitalization eases the tendency to reduce R&D investments (Oswald and Zarowin, 2007) and R&D expensing has been proven to cause under-investment in R&D (Dukes et al., 1980; Shehata, 1991; Wasley and Linsmeier, 1992). As such, in an industry such as biotech where R&D investment is essential, a decrease in R&D investments can serve as an obstacle to new drug development. This raises the question of how to interpret market's reaction to biotech firms' surging based on the anticipation of successful development of new drugs, even when the forecast for revenue or profit is uncertain. Such excitement over biotech stocks is driven by the anticipated future benefits from successful R&D.

This study examines the market value of R&D capitalization, with a focus on biotech firms in particular. As consistently proved in previous studies, value relevance of R&D capitalization is higher than that of R&D expensing (Lev and Sougiannis, 1996; Chambers, Jennings and Thompson, 1999; Healy, Myers and Howe, 1999; Monahan, 1999). Then, whether it is done voluntarily or compulsorily when a firm decreases the amount of capitalized R&D, one may question whether it leads to a decline in value relevance. Some major Korean biotech firms have acknowledged and corrected their accounting errors by restating their financial statements or recognizing impairment losses. In general, when capitalized R&D amount decreases, there is a likelihood that it would have a negative impact on market value. But in the case of biotech firms, a decrease in capitalized R&D will not deter the market from valuing a firm highly, with high expectations for future success of massive R&D investment. As such, this study also examines market's reaction to adjustments made to R&D capitalization.

The remainder of the paper is organized as follows. Chapter 2 provides literature review and the hypotheses. Chapter 3 discusses the research samples and methodology. Chapter 4 presents descriptive

¹A trading board of Korea Exchange (KRX) in South Korea established in 1996.

statistics, correlations, and regression results. Chapter 5 discusses the results and suggests conclusions from the analysis.

2. LITERATURE REVIEW AND HYPOTHESES

2.1. R&D accounting treatment, earnings management and value relevance

There have been two main streams of studies on R&D investment having a positive correlation with future earnings or market value (Chan et al., 2001; Joos and Zhdanov, 2008). In one stream, on R&D expenditures, literature has found that discretionary R&D capitalization is being used for opportunistic earnings management. Companies' investment in R&D causes cash outflows and thus is geared towards an increase in long-term value rather than short-term profit. But in the case of companies with low performance or profit, capitalizing R&D spending is opportunistically used as a means for earnings management through discretionary accounting treatment (Aboody and Lev 1998; Cazavan-Jeny et al. 2011; Markarian et al. 2008; Dinh et al., 2016). Nelson et al. (2003) conduct a survey and find that firms are mostly using R&D capitalization as earnings management strategies. Using Italian listed companies, Markarian et al. (2008) also find that companies tend to capitalize R&D expenditures to smooth earnings. Cazavan-Jeny et al. (2011) find that R&D capitalization is negatively associated with stock prices when R&D capitalization is opportunistically used. Dinh et al. (2016) analyze the association between R&D capitalization and benchmark beating. They find a negative association between market values and strategic use of R&D capitalization for benchmark beating. However, they also find the market values R&D capitalization positively for well-performing firms not seeming to use R&D capitalization for opportunistic earnings management purpose.

The reduction of discretionary spending on R&D is also found to be used for real earnings management (Dechow and Skinner, 2000; Graham *et al.*, 2005; García Osma and Young, 2009). Several studies have confirmed that the market lowers the value of firms that discretionally cut R&D investments for earning management purpose (Baber et al., 1991; Bushee, 1998; Dechow and Sloan, 1991; García Osma and Young, 2009; Mande et al., 2000).

But as mentioned in the introduction, it has been verified that R&D accounting treatment affects the size of R&D investment, and as such, there are also arguments that support R&D capitalization. Especially for corporations in their early stages, R&D capitalization can be seen as a sign for future success. Therefore, many studies have been conducted on the information usefulness or value relevance of R&D capitalization. Many preceding studies have proved that R&D capitalization is considered a more value-relevant information, compared to R&D expense. Lev and Zarowin (1999) confirm that the capitalization of R&D offers useful information for users of financial information. Oswald and Zarowin (2007) demonstrate the value relevance of R&D capitalization of UK firms and suggest that R&D capitalization may be informative. Depending on the life cycle stage of a firm, R&D capitalization may differently affect the value relevance of a firm. For firms in the growth stage of R&D activities, capitalization may be more value relevant (Oswald, 2008). Lev and Sougiannis (1996) find that the contribution of capitalized R&D to profits is sustained over five to nine years. By examining the value relevance of R&D reporting in France, Germany, the UK, and the US, Zhao (2002) find that capitalized R&D has a greater association with stock price than expensed R&D. Chambers et al. (2003) analyze the value relevance of accounting information in cases where R&D spending is capitalized or expensed, and find that capitalization increases profits, enhances the explanatory power of the stock price, and is better able to explain firm value. Using Australian company data, Ahmed and Falk (2006) also analyze the value relevance of R&D accounting treatment and verify that capitalized R&D is more value relevant than expensed R&D.

Meanwhile, spending more R&D investment than market expectation can be interpreted as managers providing a positive signal on future profits and future investment opportunities in a situation where information asymmetry exists (Qian et al., 2012). Qian et al. (2012) measure discretionary R&D expenditures to verify the effect of discretionary R&D expenditures and find that discretionary R&D expenditures support the signal hypothesis and not the managerial over-optimism hypothesis. In addition, markets are found to react more favourably to increase in R&D investment of high-tech industry compared to that of low-tech industry (Chan et al., 1990; Eberhart et al., 2004). Wang et al. (2016) also find that R&D capitalization leads to higher market value. Zakari and Saidu (2017) examine the impact of accounting treatments of R&D spending on financial statements. Though the results clearly show the reduction of net assets and equity by expensing R&D, they suggest that potential investors and other financial information users would take notice of a great amount of R&D spending as a sign of probable future benefits.

2.2. R&D and value relevance of biotech firms

In the case of Biotech firms, R&D investment is essential and the amount is much greater than in any other industry. As for pharmaceutical firms, it is said that an average of \$800 million is needed to develop one drug (Kaitin, 2003) and R&D investment is constantly needed as research diversification is required (Nivoix & Nguyen, 2018). In terms of firm size, it is found that large firms are likely to invest more in R&D activities (An & Wang, 2010; Choi & Lee, 2018; Khoshnevis & Teirlinck, 2018).

Since such a large amount of money is required, both the company and investors have high expectations for R&D investment, as well as concerns for its uncertainty. Chan et al. (1990) confirm that the value relevance of R&D investments varies across industries and that in the high-tech industry R&D investments have a positive effect on stock price, but a negative effect in the non-high-tech industry. R&D investment has been found to positively impact on firms' performance (Jin et al. 2018). Xu and Sim (2018) find that R&D intensity is positively related with firm performance in emerging markets.

Several preceding studies examine the value relevance of biotech industry R&D spending. Given the nature of the biotech industry, R&D progresses over a long period of time that includes several stages, and thus the value relevance may differ for each stage. Hand (2005) proves that a firm's maturity, R&D growth rate, and R&D intensity affect the value-relevance of R&D expenditures. What was commonly found is that R&D outlays are more value relevant to the development or maturity stage (Ely et al., 2003; Xu et al., 2007). This may be due to the belief that as the R&D stages progress, the likelihood of success increases. Ely et al. (2003) confirm that R&D spending has greater equity valuation implications in high potential firms than in low potential firms, and prove that value relevance is higher in later development stages than in the early stage. Xu et al. (2007) examine the value-relevance of both R&D expenditures (financial) and uncertainty measures (nonfinancial) of biotech firms which is an issue of high uncertainty. They find that nonfinancial uncertainty information is more value-relevant in the maturity stage. Guo et al. (2005) also find that product development stage, as well as total number of products, percentage of protected drug indications by patents, affect the determination of the valuation of biotech firms completing an IPO. This study analyzes the correlation between capitalized R&D and value relevance, based on the findings of preceding studies, and compares the case of Korean biotech firms. Compared to other industries, biotech firms have a greater scale of R&D spending, but they also have higher expectations for their success.

Based on this, Hypothesis 1 is as follows:

H1. Capitalized R&D will be value relevant, and capitalized R&D of biotech firms will be more value relevant than that of firms in other industries.

Meanwhile, as regulation and supervision on biotech firms are strengthened and firms themselves admit their errors, capitalized R&D has been reduced, either voluntarily or compulsorily. In 2017, some of the major biotech firms acknowledged their accounting errors of the past and restated financial statements by converting the capitalized R&D to expenses. Some firms recognized impairment losses. As has been verified in preceding studies, capitalization of R&D has a higher value relevance than expensing. Therefore, if capitalized R&D decreases, it is likely that the information usefulness or value relevance in the market will also drop. However, in the case of biotech firms, because they admitted to their accounting errors, they were able to build further trust and confidence of the market, as well as anticipation for the future, which can lead to rather higher value relevance. Meanwhile, when capitalized R&D decreases or the existing capitalized R&D is converted to expenses, this affects the firm's performance. Therefore, in this study, additional verification will be carried out by linking a decrease in capitalized R&D with performance. However, even if capitalized R&D decreases, if the firm's performance does not drop, then it is anticipated that the market value for capitalized R&D will not drop. But if capitalized R&D decreases and performance drops, it is anticipated that this will have a negative effect on market value. Exceptionally, even in such a case, we expect that the market value for R&D of biotech firms will not decrease as these firms still retain the market's confidence. Accordingly, this study sets the following Hypothesis 2, and sub-hypothesis 2-1 and 2-2.

H2. A decrease in capitalized R&D has a negative effect on value relevance, but this is not the case for the decrease in capitalized R&D of biotech firms. In a given year that biotech firms decrease capitalized R&D through accounting correction, the decreased capitalized R&D has even greater value relevance.

H2-1. Even in cases where capitalized R&D decreases, if performance increases, the decreased capitalized R&D does not have a negative effect on value relevance.

H2-2. If capitalized R&D decreases and performance, too, decreases, the decreased capitalized R&D has a negative effect on value relevance. But this is not the case for biotech firms.

3. METHODOLOGY

3.1. Sample selection

Table 1

Industry Distribution of the Sample

Industry	Number of Firms	%
Agriculture / Forestry / Mining / Fishing	111	0.51
Manufacturing	12,900	59.52
Electricity / Water supply / Environment	213	0.98
Construction	843	3.89
Wholesale / Retail	1,661	7.66
Transportation / Warehousing	389	1.79
Lodging / Restaurants	10	0.05
Publication / Broadcasting / Communication	1,523	7.03
Medical / Computer / Information	614	2.83
Real Estate / Renting / Leasing	57	0.26
Biopharma/Biotech	1,222	5.64
Others	2,130	9.83
Total	21,673	100

This study employs financial data made available by KIS-DATA, a database developed by Korea Investors Service, Inc., for the years 2000 to 2017. The sample includes publicly traded nonfinancial firms on the Korean Stock Exchange (KSE, KOSPI²) that have a fiscal year-end of December 31, and have unimpaired capital. The top and bottom 1% of all continuous variables are winsorized to moderate the influence of outliers. Thus, the final sample includes 21,673 firm-year observations. 5.64% of the sample firms are biopharma or biotech firms. Table 1 below shows the industry distribution of the sample.

3.2. Regression model and measurement of variables

For empirical analysis, the OLS model is employed with Tobin's Q as the dependent variable. The first regression model for Hypothesis 1 is as follows.

$$\text{Tobin's } q \text{ (market-to-book ratio)}_{i,t} = a + \beta_1 \text{RDCAP}_{i,t} + \beta_2 \text{RDCAPbio}_{i,t} + \sum a_j X_j + \sum a_k \text{IND}_k + \sum a_l \text{YEAR}_l + \varepsilon_{i,t} \quad (1)$$

Tobin's q is computed as the market value of equity plus liabilities, all divided by total assets. Tobin's q is employed to assess a firm's value as used in prior studies (McConnell and Servaes, 1990; Simon and Sullivan, 1993; Rao et al., 1994; Dahya et al., 2007). RDCAP_{i,t} is the capitalized amount of R&D, divided by total assets. RDCAPbio_{i,t} is with the RDCAP biotech firm dummy variable. X_{i,t} is the other factors affecting Tobin's Q (explained below), IND is the industry indicator variables, and YEAR is the year indicator variable. The model includes control variables that can affect firm value. These variables include size, leverage, sales growth, market to book value, and investment. Size, which is measured as the natural log of total assets, is included to control for size effects. Size is defined as the book value of total assets and may have a positive association with market value. Leverage is the total liabilities divided by total assets. Leverage may have a negative association with market value (Jensen, 1986). Sales growth is included to control for growth. The market-to-book ratio is calculated as the market value of equity divided by the book value of equity. A firm's investment decisions might have an effect on firm value, and therefore, investment is used as a control variable. Finally, industry dummy variables, defined by the one-digit Korea Standard Industry Code, and year dummy variables are included as control variables.

For the analysis of Hypothesis 2, explanatory variables including RDCAPdec, RDCAPdecbio, and RDCAPdecbioYR17 are used. RDCAPdec is a dummy variable which is coded as 1 if the firm decreases capitalized R&D amount in year t. Otherwise, it is coded as 0. RDCAPdecbio is the RDCAPdecbiotech dummy variable. RDCAPdecbioYR17 is the RDCAPdecbio dummy variable specifically for YR 17. YR17 is a dummy variable which is coded as 1 if the year is 2017 and coded as 0 otherwise. The regression model for Hypothesis 2 is as follows:

$$\text{Tobin's } q \text{ (market to book ratio)}_{i,t} = a + \beta_1 \text{RDCAPdec}_{i,t} + \beta_2 \text{RDCAPdecbio}_{i,t} + \beta_3 \text{RDCAPdecbioYR17}_{i,t} + \sum a_j X_j + \sum a_k \text{IND}_k + \sum a_l \text{YEAR}_l + \varepsilon_{i,t} \quad (2)$$

The regression model for Hypothesis 2-1 is:

$$\text{Tobin's } q \text{ (market-to-book ratio)}_{i,t} = a + \beta_1 \text{RDCAPdecPS}_{i,t} + \beta_2 \text{RDCAPdecPSbio}_{i,t} + \sum a_j X_j + \sum a_k \text{IND}_k + \sum a_l \text{YEAR}_l + \varepsilon_{i,t} \quad (3)$$

²The Korea Composite Stock Price Index or KOSPI is the index of all common stocks traded on the Stock Market Division- previously, Korea Stock Exchange-of the Korea Exchange. It is the representative stock market index of South Korea, like the Dow Jones Industrial Average or S&P 500 in the United States.

RDCAPdecPS is an RDCAPdec dummy variable for positive sales, where PS is coded as 1 if the change in sales is positive, and 0 otherwise. RDCAPdecPSbio is similar to the above, but specific to biotech firms.

For the analysis of Hypothesis 2-2, explanatory variables including RDCAPdecNS and RDCAPdecNSbio are used. RDCAPdecNS is the RDCAPdec dummy variable for negative sales, where NS is coded as 1 if the change in sales is negative, and 0 otherwise. RDCAPdecNSbio is this same variable, but specific to biotech firms.

The regression model is as follows.

$$\text{Tobin's } q \text{ (market-to-book ratio)}_{i,t} = a + \beta_1 \text{RDCAPdecNS}_{i,t} + \beta_2 \text{RDCAPdecNSbio}_{i,t} + \sum a_j X_j + \sum a_k \text{IND}_k + \sum a_l \text{YEAR}_l + \varepsilon_{i,t} \quad (4)$$

4. EMPIRICAL RESULTS AND DISCUSSION

4.1. Descriptive statistics

Table 2 shows the descriptive statistics for the main variables. The mean (median) for TQ (Tobin's Q) is 1.3813(0.5816). The mean (median) values for RDCAP and RDCAPbio are 0.0252 (0.0003) and 0.0008 (0). The mean (median) values for RDCAPdec, RDCAPdecbio, and RDCAPdecbioYR17 are 0.4044 (0), 0.0281 (0), and 0.0018 (0), respectively. The descriptive statistics for those variables mean that 40% (3% of biotech firms) of the sample firms decreased capitalized R&D. The mean (median) values for RDCAPdecPS, RDCAPdecPSbio, RDCAPdecNS, and RDCAPdecNSbio are 0.1495 (0), 0.0088 (0), 0.2549 (0), and 0.0192 (0), respectively. The descriptive statistics for those variables mean that 15% of the sample firms that decreased capitalized R&D were performing well and 26% of the sample firms that decreased the capitalized R&D amount were performing poorly.

The mean (median) values for control variables SIZE, LEV, GROW, MTB, and INV, are 18.5675(18.3605), 0.4220(0.4198), 0.3835(-0.0205), 1.3705(1.0196), and 0.2506(0.1323), respectively.

Table 2

Descriptive Statistics

Variables	Mean	StdDev	Median	Q1	Q3
<i>TQ</i>	1.3813	2.9470	0.5816	0.3109	1.1562
<i>RDCAP</i>	0.0252	1.3187	0.0003	0	0.0027
<i>RDCAPbio</i>	0.0008	0.0388	0	0	0
<i>RDCAPdec</i>	0.4044	0.4908	0	0	1
<i>RDCAPdecbio</i>	0.0281	0.1652	0	0	0
<i>RDCAPdecbioYR17</i>	0.0018	0.0427	0	0	0
<i>RDCAPdecPS</i>	0.1495	0.3566	0	0	0
<i>RDCAPdecPSbio</i>	0.0088	0.0936	0	0	0
<i>RDCAPdecNS</i>	0.2549	0.4358	0	0	1
<i>RDCAPdecNSbio</i>	0.0192	0.1374	0	0	0
<i>SIZE</i>	18.5675	1.4969	18.3605	17.5686	19.3327
<i>LEV</i>	0.4220	0.2091	0.4198	0.2560	0.5727
<i>GROW</i>	0.3835	2.2159	-0.0205	-0.1767	0.0747
<i>MTB</i>	1.3705	1.0436	1.0196	0.6183	1.7639
<i>INV</i>	0.2506	0.4946	0.1323	0.0547	0.2533

Notes:

- TQ : Tobin's q, computed as the market value of equity plus liabilities, all divided by total assets
RDCAP : capitalized amount of R&D, divided by total assets.
RDCAPbio : RDCAP variable specific to biotech firms
RDCAPdec : a dummy variable which is coded as 1 if the firm decreases capitalized R&D amount in year t, 0 otherwise
RDCAPdecbio : RDCAPdec dummy variable specific to biotech.
RDCAPdecbioYR17 : RDCAPdecbio dummy variable with the YR 17 variable, where YR17 is a dummy variable coded as 1 if the year is 2017, and coded as 0 otherwise.
RDCAPdecPS : RDCAPdecsales positive dummy variable, where PS is coded as 1 if the change in sales is positive, 0 otherwise.
RDCAPdecPSbio : RDCAPdecPSdummy variable for biotech firms.
RDCAPdecNS : RDCAPdec dummy variable with NS, where NS is coded as 1 if the change in sales is negative, and 0 otherwise.
RDCAPdecNSbio : RDCAPdecNSdummy variable for biotech firms.
SIZE : natural logarithm of total assets
LEV : total liabilities divided by total assets
GROW : sales growth
MTB : market-to-book ratio, market value of equity divided by book value of equity.
INV : plant, property, and equipment (except land and construction in progress) divided by total assets

The Pearson correlation results are reported in Table 3. Significant correlations are observed between market value (TQ) and some of the explanatory variables (RDCAP, RDCAPbio, RDCAPdecbio, RDCAPdecbioYR17, RDCAPdecPS, RDCAPdecPSBio, RDCAPdecNSbio) ($p < 0.01$).

Table 3

Correlations

Variable	TQ	RDCAP	RDCAPbio	RDCAPdec	RDCAPdecbio	RDCAPdecbioYR17	RDCAPdecPS	RDCAPdecPSbio	RDCAPdecNS	RDCAPdecNSbio	SIZE	LEV	GROW	MTB	INV
TQ	1.0000														
RDCAP	0.1159 0.0000	1.0000													
RDCAPbio	0.0804 0.0000	0.0290 0.0000	1.0000												
RDCAPdec	-0.0259 0.0001	-0.0211 0.0006	-0.0595 0.0000	1.0000											
RDCAPdecbio	0.0655 0.0000	-0.0070 0.2565	-0.1301 0.0000	0.2059 0.0000	1.0000										
RDCAPdecbioYR17	0.1145 0.0000	-0.0048 0.4344	-0.1366 0.0000	0.0521 0.0000	0.2529 0.0000	1.0000									
RDCAPdecPS	0.0740 0.0000	-0.0121 0.0497	-0.0405 0.0000	0.5088 0.0000	0.0787 0.0000	0.0557 0.0000	1.0000								
RDCAPdecPSbio	0.0784 0.0000	-0.0054 0.3811	-0.1237 0.0000	0.1144 0.0000	0.5558 0.0000	0.2770 0.0000	0.2249 0.0000	1.0000							
RDCAPdecNS	-0.0927 0.0000	-0.0139 0.0244	-0.0338 0.0000	0.7097 0.0000	0.1674 0.0000	0.0131 0.0329	-0.2454 0.0000	-0.0552 0.0000	1.0000						
RDCAPdecNSbio	0.0244 0.0003	-0.0047 0.4428	-0.0721 0.0000	0.1696 0.0000	0.8239 0.0000	0.1153 0.0000	-0.0587 0.0000	-0.0132 0.0313	0.2390 0.0000	1.0000					
SIZE	0.1030 0.0000	0.0436 0.0000	0.0042 0.4925	-0.0349 0.0000	-0.0753 0.0000	-0.0046 0.4540	0.0226 0.0002	-0.0409 0.0000	-0.0577 0.0000	-0.0627 0.0000	1.0000				
LEV	-0.1211 0.0000	0.0026 0.6782	-0.0078 0.2038	-0.0226 0.0002	-0.0480 0.0000	-0.0274 0.0000	-0.0217 0.0004	-0.0245 0.0001	-0.0077 0.2083	-0.0410 0.0000	0.1161 0.0000	1.0000			
GROW	0.6724 0.0000	0.1101 0.0000	0.0018 0.7745	-0.0608 0.0000	-0.0148 0.0161	0.0326 0.0000	0.1310 0.0000	0.0228 0.0002	-0.1757 0.0000	-0.0333 0.0000	0.2080 0.0000	0.0556 0.0000	1.0000		
MTB	0.3771 0.0000	-0.0015 0.8299	0.0359 0.0000	0.0749 0.0000	0.1155 0.0000	0.0756 0.0000	0.0173 0.0107	0.0760 0.0000	0.0709 0.0000	0.0869 0.0000	-0.1289 0.0000	0.0255 0.0002	0.0242 0.0004	1.0000	
INV	0.5820 0.0000	0.1096 0.0000	0.0339 0.0000	-0.0679 0.0000	-0.0121 0.0489	0.0338 0.0000	0.0641 0.0000	0.0186 0.0025	-0.1289 0.0000	-0.0273 0.0000	0.2395 0.0000	0.1329 0.0000	0.7555 0.0000	-0.0142 0.0370	1.0000

Note: See Table 2 for variable definitions.

Significant positive correlations are also seen between earnings management and some of the control variables (SIZE, GROW, MTB, INV) ($p < 0.01$). Significant negative correlations are observed between firm value and some of the explanatory variables (RDCAPdec, RDCAPdecNS) ($p < 0.01$). Significant positive correlations are also seen between firm value and LEV ($p < 0.01$). To test for multi-collinearity, the variance inflation factors (VIFs) are computed. No multi-collinearity problems are evident.

4.2. Regression results

Table 4 represents both the OLS regression and the Fixed Effect regression results for the association between the capitalized R&D and the firm's market value. The results for the OLS regression show that the capitalized R&D has significant positive association with market value ($p < 0.01$) and that capitalized R&D for biotech firms has a more significant positive association with market value ($p < 0.01$) than that of firms in other industries. Thus, the results provide support for H1. The results imply that R&D capitalization information for biotech firms appears to be more value relevant. These results confirm that biotech companies are receiving positive feedback on the high expectations of R&D investment success through aggressive R&D accounting treatment. A large amount of R&D invested in the biotech industry compared to other industries and its capitalization are considered to be well aligned with the future sustainable success of biotech firms. Significant associations are also seen between market value and the control variables. Some of the control variables (SIZE, GROW, MTB, INV) has a significant positive association with market value, and LEV has a significant negative association with market value. The results for the fixed effect regression remained consistent with the OLS results for the explanatory variables.

Table 4

Regression Results

Variables	Expected Sign	Dependent Variable: <i>TQ</i>	
		Ordinary Least Square	Fixed Effect
Constant	?	-0.8035*** (-3.26)	-6.6529 *** (-11.38)
<i>RDCAP</i>	+	0.0676*** (8.32)	0.0624*** (7.93)
<i>RDCAPbio</i>	++	5.1134*** (14.49)	5.3395*** (13.65)
<i>SIZE</i>	+ / -	0.0673*** (7.23)	0.3693*** (11.54)
<i>LEV</i>	-	-2.7516*** (-43.68)	-2.5480*** (-25.42)
<i>GROW</i>	+	0.6158 *** (74.19)	0.5749*** (65.48)
<i>MTB</i>	+	1.0051*** (81.18)	0.8848*** (54.60)
<i>INV</i>	+	1.2285 *** (32.62)	1.4590 *** (35.10)
Industry dummies		Included	Included
Year dummies		Included	Included
<i>F value</i>		1,183.73***	1,446.61***
<i>Adjusted R²</i>		0.6564	0.6227
<i>N</i>		21,673	21,673

Note: See Table 2 for variable definitions. t-values are shown in parentheses. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Table 5 represents both the OLS regression and the Fixed Effect regression results for the association between the decrease in capitalized R&D and the firm's market value. The results for the OLS regression show that the decrease in capitalized R&D is negatively associated with a market value ($p < 0.01$). However, the decrease in capitalized R&D for biotech firms is positively associated with a market value ($p < 0.01$). In addition, the decrease in capitalized R&D for biotech firms in a certain year, when major biotech firms switched R&D accounting treatment from capitalizing to expensing by restating their financial statements or by a recognized impairment loss of the capitalized R&D, has a stronger positive association with market value ($p < 0.01$). Thus, the results provide support for H2. The results confirm that capitalized R&D decrease of biotech firms is considered to improve accounting transparency, therefore it does not hurt the positive evaluation about the future value of biotech firms aiming at sustainable technology development through R&D investment. Rather, they seem to have received a better evaluation in the market. The results infer that biotech firms' accounting error

correction, regardless of whether it has been done voluntarily or compulsorily, appears to be a reliable indication for R&D success and positively affects a firm's market value.

Significant associations are also seen between market value and the control variables. Some of the control variables (SIZE, GROW, MTB, INV) are positively associated with a market value, whereas LEV is negatively associated with a market value. The results for the fixed effect regression remained consistent with the OLS results for the explanatory variables except for the RDCAPdecbio.

Table 5

Regression Results

Variables	Expected Sign	Dependent Variable: TQ	
		Ordinary Least Square	Fixed Effect
Constant	?	-0.8302*** (-3.36)	-6.7095*** (-11.41)
<i>RDCAPdec</i>	-	-0.1174*** (-4.75)	-0.0889*** (-3.64)
<i>RDCAPdecbio</i>	+	0.1794** (2.20)	-0.2080*** (-2.07)
<i>RDCAPdecbioYRI7</i>	++	2.1322*** (8.07)	0.9515*** (3.37)
<i>SIZE</i>	+ / -	0.0705*** (7.53)	0.3749*** (11.65)
<i>LEV</i>	-	-2.7601*** (-43.54)	-2.5936*** (-25.73)
<i>GROW</i>	+	0.6134*** (73.69)	0.5719*** (64.82)
<i>MTB</i>	+	1.0077*** (80.47)	0.8901*** (54.59)
<i>INV</i>	+	1.2586*** (33.33)	1.4948*** (35.82)
Industry dummies		Included	Included
Year dummies		Included	Included
<i>F value</i>		1,136.15***	1,364.51***
<i>Adjusted R²</i>		0.6535	0.6181
<i>N</i>		21,673	21,673

Note. See Table 2 for variable definitions. t-values are shown in parentheses. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.

Table 6 Panel A. represents the OLS regression results for the comparative effect of the decrease in capitalized R&D on the firm's market value, depending on the firm's performance. The results in Model 1 show that the association between the decrease in capitalized R&D and market value has a significant positive association with market value ($p < 0.01$) when the firms get better performance. The results apply to all industries and provide support for H2-1. When the firm's performance is good, the decrease in R&D capitalization does not seem to mitigate the faith in R&D success. However, the results in Model 2, when the firm's performance get worse, show that the association between the decrease in capitalized R&D and market value is negatively associated with a market value ($p < 0.01$). In conclusion, when capitalized R&D decreases, the market tends to focus more on the firm's performance. Exceptionally, the decrease in capitalized R&D of biotech firms and market value is positively associated with a market value ($p < 0.01$), even when the firms get worse performance. Thus, the results provide support for H2-2. Regardless of the decline in R&D capitalization or the decline in firms' performance, positive evaluation about biotech firms' future success of the market remains unchanged. This may imply enormous expectation and unconditional affirmation around the R&D process of biotechnology firms. Policymakers should recognize the special nature of biotechnology companies and ensure to create an environment where they can cultivate their sustainable growth potential in the future, in a way of not interfering with the wise decisions of investors.

Table 6

Regression Results
Panel A. OLS Regression Results

Variables	Expected Sign	Dependent Variable: TQ	
		Model 1.	Model 2.
Constant	?	-1.6151*** (-5.84)	-1.5412*** (-5.58)
RDCAPdecPS	+	0.1259*** (3.39)	-
RDCAPdecPSbio	+	0.7210*** (4.81)	-
RDCAPdecNS	-	-	-0.3230*** (-10.09)
RDCAPdecNSbio	+	-	0.2358** (2.23)
SIZE	+ / -	0.0936*** (8.94)	0.0933*** (8.93)
LEV	-	-2.9516*** (-41.70)	-2.9607*** (-41.82)
MTB	+	1.0359*** (74.37)	1.0485*** (75.06)
INV	+	3.3380*** (118.67)	3.3128*** (117.29)
Industry dummies		Included	Included
Year dummies		Included	Included
F value		1,183.73***	834.88***
Adjusted R^2		0.6564	0.5668
N		21,673	21,673

Significant associations are also seen between market value and the control variables. Some of the control variables (SIZE, GROW, MTB, INV) are positively associated with a market value, and whereas is negatively associated with a market value. Panel B of Table 6 represents the fixed effect regression results. For the explanatory variables except for RDCAPdecNSbio, these results remained consistent with the OLS results.

Fixed Effect Regression Results

Variables	Expected Sign	Dependent Variable: TQ	
		Model 1.	Model 2.
Constant	?	-7.6749*** (-11.85)	-7.5090*** (-11.61)
RDCAPdecPS	+	0.0835** (2.36)	-
RDCAPdecPSbio	+	0.4805*** (3.10)	-
RDCAPdecNS	-	-	-0.2544*** (-8.23)
RDCAPdecNSbio	+	-	-0.2560** (-2.15)
SIZE	+ / -	0.4048*** (11.42)	0.4009*** (11.33)
LEV	-	-2.7843*** (-25.09)	-2.7958*** (-25.25)
MTB	+	0.9051*** (50.46)	0.9112*** (50.84)
INV	+	3.6340*** (128.67)	3.6066*** (127.06)
Industry dummies		Included	Included
Year dummies		Included	Included
F value		1,071.85***	1,078.42***
Adjusted R^2		0.5246	0.5251
N		21,673	21,673

Note: See Table 2 for variable definitions. t-values are shown in parentheses. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

4.3. Robustness regression

An analysis is carried out on the regression models using robust regression techniques to eliminate the influence of outlier biases in all specifications. As can be seen in Table 7, the results of the study remain consistent when running through the robustness check.

Table 7

Clustered Robust (year) Regression Results
Panel A. TQ – RDCAP

Variables	Expected Sign	Dependent Variable: <i>TQ</i>
		Model 1.
Constant	?	-0.8035 (-1.04)
<i>RDCAP</i>	+	0.0676*** (2.22)
<i>RDCAPbio</i>	++	5.1134*** (6.19)
<i>SIZE</i>	+ / -	0.0673 (1.60)
<i>LEV</i>	-	-2.7516*** (-5.96)
<i>GROW</i>	+	0.6158*** (14.65)
<i>MTB</i>	+	1.0051*** (7.01)
<i>INV</i>	+	1.2285 *** (9.55)
Industry dummies		Included
Year dummies		Included
<i>Adjusted R²</i>		0.6569
N		21,673

Panel B. TQ – RDCAPdec

Variables	Expected Sign	Dependent Variable: <i>TQ</i>
		Model 1.
Constant	?	-0.8302 (-1.08)
<i>RDCAPdec</i>	-	-0.1174* (-1.90)
<i>RDCAPdecbio</i>	+	0.1794 (1.08)
<i>RDCAPdecbioYR17</i>	++	2.1322*** (8.46)
<i>SIZE</i>	+ / -	0.0705 (1.64)
<i>LEV</i>	-	-2.7601*** (-5.85)
<i>GROW</i>	+	0.6134*** (15.89)
<i>MTB</i>	+	1.0077*** (6.84)
<i>INV</i>	+	1.2586*** (9.70)
Industry dummies		Included
Year dummies		Included
<i>Adjusted R²</i>		0.6540
N		21,673

Panel C. TQ – RDCAPdecPS vs. RDCAPdecNS

Variables	Expected Sign	Dependent Variable: TQ	
		Model 1.	Model 2.
Constant	?	-1.6151 (-1.31)	-1.5412 (-1.28)
RDCAPdecPS	+	0.1259** (2.28)	-
RDCAPdecPSbio	+	0.7210** (2.22)	-
RDCAPdecNS	-	-	-0.3230** (-2.71)
RDCAPdecNSbio	+	-	0.2358** (2.82)
SIZE	+ / -	0.0936 (1.51)	0.0933 (1.51)
LEV	-	-2.9516*** (-7.36)	-2.9607*** (-7.28)
MTB	+	1.0359*** (6.64)	1.0485*** (6.60)
INV	+	3.3380*** (15.70)	3.3128*** (16.04)
Industry dummies		Included	Included
Year dummies		Included	Included
Adjusted R^2		0.5663	0.5674
N		21,673	21,673

Note: See Table 2 for variable definitions. t-values are shown in parentheses. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

5. CONCLUSION

While the accounting treatment of R&D has continuously become a topic of debate, it has taken on even more significance as an issue as Korean biotech firms have seen their stock prices surge. R&D capitalization is allowed as long as certain conditions are met, but some people have raised the legitimacy of this treatment and argued for a new guideline on the application of more transparent accounting rules. However, as has been verified in preceding studies, R&D accounting treatment affects R&D investment and expensing of R&D triggers under-investing in R&D (Dukes et al, 1980; Shehata, 1991; Wasley and Linsmeier, 1992; Oswald and Zarowin, 2007). Cuts in R&D may undermine the company's competitiveness, with the blow being especially hard on biotech firms where R&D investments are usually larger than in other industries.

As such, this study first analyzed the correlation between capitalized R&D and its value relevance as has been done in preceding studies and conducted a comparative analysis of Korean biotech firms. The analysis showed that in line with the findings of preceding studies, capitalized R&D had a positive correlation with market value, and compared to firms in other industries, capitalized R&D of biotech firms had a greater value relevance. This seems to be due to the high expectations of the market about the future success of the massive R&D spending of biotech firms.

Next, based on the empirical studies that state that capitalization of R&D has a higher value relevance compared to expensing of R&D, a second hypothesis was set that when capitalized R&D decreases, the information usefulness or value relevance in the market would also drop. For this hypothesis, the case of biotech firms was also compared. The analysis results showed that a decrease in R&D capitalization had a negative effect on market value but this was not found in the case of biotech firms. Moreover, specific years were examined for which major biotech firms voluntarily, or because of an audit, corrected accounting errors. It was found that perhaps due to the increase in expectation for accounting transparency and future R&D success, such moves had a positive effect on market value. In further analysis, a decrease in capitalized R&D and firm performance was associated. If firm performance does not drop despite a voluntary or forced decrease in capitalized R&D, then decreased capitalized R&D

is found to be value relevant. In the case that both capitalized R&D and firm performance drop, there was a negative correlation with market value. However, in the case of biotech firms, even in such situations, the market value for R&D information did not drop. In most cases, it appears that the market places much confidence in biotech firms and their R&D information usefulness. However, current and potential investors are carefully required to make wise judgments. Particularly, policymakers should create an environment in which investors can help them distinguish between positive and negative activities of biotech companies, but they should respect the particular circumstances of the biotechnology companies and not impede their potential for future growth. The share of biotech firms is relatively small in the larger market, which may lead to the concern that the analysis is less sophisticated. Despite such limitations, this study is meaningful in that it conducted a comparative analysis on biotech firms by associating R&D accounting treatment, firm performance, and the firm's market value. Future research may consider to explore whether there will be a change in practices since then. The issue of limited data availability may be tackled by considering companies internationally by exploring with different practices across countries.

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