R&D INVESTMENT, THE SIGNALING EFFECT OF STOCK DIVIDENDS, AND THE CORPORATE VALUE OF R&D INTENSIVE FIRMS AND BIOTECH FIRMS

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ABSTRACT

This study examines how the market evaluates increases in the R&D spending of R&D intensive firms, particularly biotech firms. In addition, the signaling effects of stock dividend distributions are analyzed to investigate whether a firm's dividend policy mitigates agency conflicts and delivers future sustainable prospects for the firm to the market. The results suggest that the market positively evaluates increases in the R&D expenditures of R&D intensive firms. The findings also confirm the signaling effects of stock dividend distributions. Among R&D intensive firms, these tendencies are stronger for biotech firms. Moreover, the analysis finds that an increase in sales further strengthens the positive association between R&D investment increases and corporate value.

Keywords: R&D Investment Increase, Stock Dividends, Signaling Hypothesis, Sales Increase, Corporate Value.

INTRODUCTION

R&D intensive firms spend huge amounts of money on their R&D projects, but it takes a significant amount of time for these projects to generate sales. In Korea, for particular niche areas such as biotechnology where investing in R&D is vital for a firm's sustainable development, history has shown that firms might generate only 1 billion Korean won (approximately 850,000 US dollars) of sales after 20 years of operation. Such results do not stem from a lack of management acumen to achieve firm performance, but simply reflect industry characteristics. There are many Korean biotech firms that have not been very successful in business for more than 10 years since their inception. According to a 2018 survey by the Korea Biotechnology Industry Organization, 46.3 percent of the companies surveyed took more than 10 years to produce results. Among existing biotech companies, 27.6% were still "before sales" and 38.7% had generated sales but below the break-even point. This has also been the case in Europe. European biotech firms often have little or no sales and, furthermore, their enormous R&D investments result in short-term losses. As an example, Intercell, the fourth-largest EU biotech company, invested more than twice its net sales in R&D in 2010 (Chojnacki & Kijek, 2014).

According to the pecking order theory (Myers & Majluf, 1984), a hierarchy exists in firm financing. Firms initially go for internal funding, and then seek external financing only if internal financing is difficult. External financing is available in two types: debt and equity. Among the two methods, companies prefer debt to equity. R&D spending is an inseparable part of the biotech industry, but the amount of cash invested on R&D is gigantic. On average, it takes 800 million dollars to develop a single product (Kaitin, 2003). Consequently, R&D intensive firms like biotech firms have an inclination to retain cash in the firm to secure funds for R&D investment rather than pursue a shareholder friendly policy that returns profits to shareholders.

A typical method to distribute a company's profits to investors is the payment of dividends. Firms set their dividend policies using various determinants such as firm size, profitability, and even taxes (Denis & Osobov, 2008; Gill et al., 2010). The most common types of dividends are cash and stocks. While Korean listed firms have typically increased their cash dividends by returning profits to shareholders, biotech firms have decreased their cash dividends. It seems obvious that Korean biotech firms listed on both the KOSPI (Korea Composite Stock Price Index: a benchmark stock market in Korea) and KOSDAQ market (Korea Securities Dealers Automated Quotation: for the purpose of providing funds for startup companies) place greater focus on securing R&D funds for future growth than on dividends distribution. For example, Korea's leading biotech company, which made the largest R&D investment among all pharmaceuticals and biotech companies, invested 264 billion Korean won (39% of sales) in R&D in 2016. Most biotech firms have been found to reduce or not to pay cash dividends at all.

Some companies do pay dividends in stocks, although the distribution of stock dividends requires the use of retained earnings as a source. It is acknowledged that firms that implement a bonus issue and a stock dividend have relatively superior corporate characteristics. In other words, the implementation of a bonus issue and a stock dividend is taken as a sign that the company is in good condition. A stock dividend is beneficial for both the company and the shareholder. The shareholder obtains more stocks for free and may expect a better rate of return in the future by allowing the company to reinvest in R&D with the cash reserved.

Investing in R&D has generally been discovered to have a positive influence on enhancing a firm's performance or value (Reynard, 1979; Chan et al., 1990; Lev & Sougiannis, 1996; Chan et al., 2001; Chung et al., 2003; Hall & Orani, 2003; Eberhart et al., 2004). Recent research papers have also confirmed this positive impact (Xu & Sim, 2018; Jin et al., 2018; Lee, 2019). However, R&D itself is considered as a proxy for asymmetric information (Dittmar et al., 2003). In that regard, a firm's stock dividend distribution can play a role in reducing information asymmetry regarding R&D progress. Even though Miller & Modigliani (1961) suggested the dividend irrelevance theory under perfect capital markets, in reality, a dividend policy can be used to communicate with investors and can therefore mitigate the agency problem (Lease et al., 2000).

Biotech companies are booming, and there has accordingly been quite a lot of research on the biotech industry. However, it is still a valuable and interesting area of research because of the unique nature of the industry. Therefore, this research analyzes the impacts on corporate value of increased R&D and also examines whether a stock dividend distribution enhances corporate value by sending a signal that the company is doing well and that current R&D investment is probable to result in sustainable future growth.

The remainder of the paper is organized according to the following: Chapter 2 presents a review of literature and hypotheses. Chapter 3 provides samples and methodologies. Chapter 4 suggests statistics description, correlations, and analysis results. Chapter 5 provides the results and offers discussion. Chapter 6 is the conclusion.

LITERATURE REVIEW AND HYPOTHESES

R&D Investment and Corporate Value

The correlation between R&D investment and corporate value is no longer a new research topic. From the 1970s to the present, many prior studies have consistently shown that investing in R&D has a positive effect on improving a company's performance or value even though R&D investment causes cash outflows (Reynard, 1979; Chan et al., 1990; Lev & Sougiannis, 1996; Chan et al., 2001; Chung et al., 2003; Hall & Orani, 2003; Eberhart et al., 2004; Xu & Sim, 2018; Jin et al., 2018; Lee, 2019). In a way, it's a cliché, but it's still an important issue.

Therefore, researchers observe the issue from a slightly different perspective or in conjunction with other issues. Chan et al. (2001) examined the association between R&D intensity and stock returns based on the asset-pricing theory. Other studies, such as Penman & Zhang (2002) and Eberhart et al. (2004) analyzed relations between current R&D growth and future stock returns. It has also been shown that the relationship between R&D activity and corporate value may depend on ownership concentration or corporate governance (Chung et al., 2003; Lee & O'Neill, 2003).

As mentioned in the introduction, R&D intensive firms, especially for biotech firms, take a considerable amount of time to generate sales. However, for biotech firms, considering their unique characteristics, their sustainable future value through R&D achievement is highly appreciated in the market independently from visible results such as sales (Chan et al., 1990; Chan et al., 2001; Chung et al., 2003; Hall & Orani, 2003; Eberhart et al., 2004). Chan et al. (1990) found that the R&D investments in high-tech industries had a positive market value, but those in non-high-tech industries had an adverse effect on stock prices. Because of the biotech industry's distinctive nature, the market may assign value differently depending on R&D progress. Most of the papers on biotech value relevance have commonly found that R&D outlays are highly evaluated in the market in their development or maturity stage. (Ely et al., 2003; Hand, 2005; Guo et al., 2005; Xu et al., 2007).

On the other hand, due to the high risk and unpredictability of R&D procedures in biotechnology, financial performance may vary depending on the state of investment across firms (Pisano, 2006). Therefore, research concerning the connection between R&D activity and the value of bio companies is still controversial, against the consistent view that the R&D activity of other industries adds corporate value (Xu et al., 2007). Likewise, diversified research on investment in pharmaceutical R&D is still needed (Nivoix & Nguyen, 2018).

Agency Theory and Signaling Hypothesis of Stock Dividends

A firm's dividend policy is driven by various factors. Denis & Osobov (2008) and Gill et al. (2010) identified a number of different determinants such as firm size, growth opportunities, profitability, profit margin, growth in sales, ratio of debt-to equity, and taxes. Desmiza et al. (2019) show the effect of institutional ownership and board of independence on dividend policy. They find that institutional ownership and board of independence are significantly positively associated with dividend payout ratio.

Firms generally distribute dividends in cash or stocks. The most frequent type of dividend distribution is cash dividends and can be paid regularly or irregularly. Unlike cash dividends, stock dividends adopt retained earnings as a resource and are distributed in the form of stocks. Stock dividend distribution could be better for both the company and its shareholders. In particular, stock distributions may give various signals. The dividend relevance theory, developed by Lintner (1962) and Gordon (1963), suggests that a company's dividend policy may directly affect the market value of a company, contrary to the dividend irrelevance theory under perfect capital markets suggested by Miller & Modigliani (1961).

According to Filson et al. (2015), investment in R&D in the biotech sector is particularly critical. However, information asymmetry follows R&D investment for two reasons. First, the

R&D project's future success cannot be guaranteed, and the greater the R&D investment, the greater the uncertainty (Cho & Lee, 2013). Holmstrom (1989) also referred to the high risk due to the probability of failure that is unpredictable in the outcome of the R&D. The second reason is that information on R&D activities is not well disclosed, and projects proceed secretly because of concerns that the ideas could be stolen. According to Deng et al., 1999, shareholders are not able to know exactly which products are under development, nor do they know the value of the products, even though they can figure out how much a firm spends on R&D. Therefore, R&D itself can be a measure of asymmetric information (Dittmar et al., 2003), or it may increase asymmetric information (Aboody & Lev, 2000).

Based on such asymmetric information, the agency theory, pecking order hypothesis, and signaling hypothesis have been developed. The agency theory (Jensen & Meckling, 1976; Jensen, 1986; Hart & Moore, 1994) implies that managers pursue their private benefits instead of aiming at maximizing the value of the company and its shareholders. Under the pecking order hypothesis (Myers & Majluf, 1984), companies prefer raising resources in the following order: internal resources, debt issues, and equity issues.

According to the signaling hypothesis (Spence, 1973; Bhattacharya, 1979), a decision to pay dividends can be used as a signal from a business under the asymmetry of information. Companies can declare stock dividends and send a positive signal regarding their prospects and future profitability improvement. This would be perceived positively by a market. Managers have more information than shareholders about the company's investments, and therefore, they will probably pay dividends as a means of sharing this information with outsiders (Bhattacharya, 1979; John & Williams, 1985; Miller & Rock 1985). According to Bhattacharya (1979), dividends indicate how long a company has the ability to pay interest and dividends.

There are some research on the R&D intensive firms' dividend policy. According to Lease et al. (2000), a policy on dividends is used as a communication tool to deliver information about the company to the market. The association between R&D expenses and dividend payouts is usually negative as R&D intensive firms with high growth opportunities are prone to pay fewer dividends (La Porta et al., 2000; Fama & French, 2001; Li & Zhao, 2008; Lahiri & Chakraborty, 2014). Meanwhile, a dividend policy can reduce the agency cost (Easterbrook, 1984). Dividend distribution may mitigate the agency problem (Rozeff, 1982; La Porta et al., 2000; Lozano et al., 2005). Lin et al. (2017) found that companies with more asymmetric information tended not to pay dividends. Li & Zhao (2008) also concluded that firms having higher agency problems tended to pay smaller dividends than firms with lower agency problems. Institutional ownership may affect the use of dividend policy by a company to mitigate the agency conflicts depending on the firms' performance (Chang et al., 2016). Ultimately, dividend policy decisions are one of the most significant financial decisions that can determine a firm's value (Baker & Powell, 1999; Sáez & Gutiérrez, 2015).

Therefore, based on the above-mentioned theories, this study establishes the following hypotheses.

H1: R&D investment increases in R&D intensive firms will be value relevant, and this tendency will be stronger for biotech firms.

H2: R&D investment increases in R&D intensive firms that distributed stock dividends in the previous year will be more value relevant than those of the firms that did not distribute stock dividends, and this tendency will be stronger for biotech firms.

The market knows that significant time is required to generate sales, particularly for biotech firms, and an increase in sales will further increase corporate value. Therefore, Hypothesis 2.1 has also been extended in view of the fact that an increase in the R&D of biotech firms directly results in growth in sales.

H2.1: An increase in sales will further increase the value of R&D investment increases of biotech firms. This tendency will be stronger for firms that distributed stock dividends in the previous year.

RESEARCH DESIGN

Selection of Sample

The research uses a sample constructed from the Korea Investors Service database for the period of 2000 through 2017. The sample includes publicly listed Korean companies that have annual accounting periods that end on December 31. For consistency in comparison, financial companies are excluded. Top and bottom 1 percent of the variables are winsorized. The final sample includes 21,673 firm-year observations. The scope of the biotechnology field used in this study includes both biopharma firms and biotechnology firms. Biopharma or biotech firms account for 5.64% of the sample firms. The sample distribution is shown in Table 1.

Table 1
INDUSTRY SAMPLE DISTRIBUTION

Industry	Number of Firm-Year Observations	%
Agriculture / Forestry / Mining / Fishing	111	0.51
Manufacturing	12,455	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	1,667	5.64
Others	2,130	9.83
Total	21,673	100

Research Model and Variables Measurement

The ordinary least squares regression (OLS) model for testing Hypothesis 1 is the following.

$$\text{Tobin's } q_{i,t} = \alpha + \beta 1RDincHRDint_{i.t} + \beta 2RDincbio_{i.t} + \sum\alpha_j X_j + \sum\alpha_k IND_k + \sum\alpha_l YEAR_l + \varepsilon_{i,t} \quad (1)$$

The dependent variable is Tobin's q, which is used to appraise the value of a firm. Tobin's q was first launched by Griliches (1981), and it is the most commonly used metric of market value (McConnell & Servaes, 1990; Simon & Sullivan, 1993; Rao & Ruekert, 1994; Dahya et al., 2007). Tobin's q is the equity plus liabilities market value, divided by total assets. $RDincHRDint_{i,t}$ is the interaction between $RDinc_{i,t}$ and $HRint_{i,t}$. $RDinc_{i,t}$ equals 1 if the firm increases its R&D spending in year t and $HRDint_{i,t}$ is coded 1 where R&D intensity is above the median, and 0 otherwise. $RDincbio_{i,t}$ represents the interaction between $RDinc_{i,t}$ and bio, the biotechnology dummy variable. $X_{i,t}$ represents the control variables that may have an effect on corporate value. As control variables, size, growth in sales, leverage (Jensen, 1986), investment, and market-to-book value are included. IND and YEAR are dummy variable for the industry and dummy variable for the year, respectively.

The model of OLS regression used to examine Hypothesis 2 is the following.

$$\text{Tobin's } q_{i,t} = \alpha + \beta 1 RDintHRDint_{i.t}ST_{i.t-1} + \beta 2 RDintbio_{i.t}ST_{i.t-1} + \sum \alpha_j X_j + \sum \alpha_k IND_k + \sum \alpha_l YEAR_l + \varepsilon_{i,t} \quad (2)$$

Explanatory variables $RDincHRDint_{i,t}ST_{i,t-1}$ and $RDincbio_{i,t}ST_{i,t-1}$ are included to analyze Hypothesis 2. $RDincHRDint_{i,t}ST_{i,t-1}$ is the interaction between $RDincHRDint_{i,t}ST_{i,t-1}$ and $ST_{i,t-1}$. $ST_{i,t-1}$ equals 1 if a firm distributed a stock dividend in year t-1, and 0 otherwise. $RDincbioST_{i,t-1}$ is the interaction term between RDincbio and $ST_{i,t-1}$. The model also includes control variables that can affect corporate value, including size, sales growth, STD, investment, and market-to-book value. Again, IND is dummy variable for the industry and YEAR is dummy variable for the year.

To investigate Hypothesis 2-1, the model below was used.

$$\text{Tobin's } q_{i,t} = \alpha + \beta 1 RDintbioPS_{i.t}ST_{i.t-1} + \beta 2 RDintbioPS_{i.t}ST_{i.t-1} + \sum \alpha_j X_j + \sum \alpha_k IND_k + \sum \alpha_l YEAR_l + \varepsilon_{i,t} \quad (3)$$

Explanatory variables $RDincbioPS_{i,t}$ and $RDincbioPS_{i,t}ST_{i,t-1}$ are used to analyze Hypothesis 2.1. $RDincbioPS_{i,t}$ is the term of interaction between $RDincbio_{i,t}$ and $PS_{i,t}$. $PS_{i,t}$ equals 1 if a firm's sales increase, and 0 otherwise. $RDincbioPS_{i,t}$ $ST_{i,t-1}$ is the interaction between $RDincbioPS_{i,t}$ and $ST_{i,t-1}$. The model also includes control variables which may influence corporate value, including size, growth in sales, STD, investment, and market-to-book value. Again, IND is dummy variable for the industry and YEAR is dummy variable for the year.

RESULTS OF EMPIRICAL ANALYSIS

Statistics Description

Table 2 demonstrates the variables descriptive statistics. The mean (median) value for TQ is 1.3813 (0.5816). 50% of R&D intensive firms (6% of biotech firms) showed R&D investment increases. In addition, 6% of R&D intensive firms (1% of biotech firms) that distributed stock dividends during the previous year showed R&D investment increases during the following year. The mean (median) control variables – SIZE, LEV, GROW, MTB, and INV - values are 18.5675 (18.3605), 0.1025 (0), 0.3835 (-0.0205), 1.3705 (1.0196), and 0.2506 (0.1323), respectively.

Table 2
STATISTICS DESCRIPTION OF VARIABLES

Variables	Mean	StdDev	Median	Q1	Q3
TQ	1.3813	2.9469	0.5816	0.3109	1.1562
RDincHRDint	0.5053	0.5000	1	0	1
RDincbio	0.0622	0.2415	0	0	0

Table 2
STATISTICS DESCRIPTION OF VARIABLES

RDincHrdintST	0.0557	0.2294	0	0	0
RDincbioST	0.0081	0.0894	0	0	0
RDincbioPS	0.0214	0.1447	0	0	0
RDincbioPSST	0.0044	0.0665	0	0	0
SIZE	18.5675	1.4969	18.3605	17.5686	19.3327
LEV	0.1025	0.1161	0	0.0632	0.1672
GROW	0.3835	2.2159	-0.0205	-0.1767	0.0747
MTB	1.3705	1.0436	1.0196	0.6183	1.7639
INV	0.2506	0.4946	0.1323	0.0547	0.2533

Note.

TQ : *Tobin's Q,* the market value of equity plus liabilities, all divided by total assets.

RDincHRDint : interaction term between RDinc and HRDint. RDinc is coded as 1 if the firm's R&D investment increases, 0 otherwise. HRDint is coded 1 where R&D intensity is above the median, 0 otherwise.

RDincBio : interaction term between RDinc and biotech firm dummy.

RDincHRDintST : interaction term between RDincHRDint and ST. ST is coded 1 if the firm distributes stock dividends in year t-1.

RDincbioST : interaction term between RDincbio and ST.

RDincbioPS : interaction term between RDincbio and PS. PS is coded 1 if the firm's sales increase, 0 otherwise.

RDincbioPSST : interaction term between RDincbioPS and ST.

SIZE : natural log of total assets.

LEV : short term liabilities divided by total assets.

GROW : growth in sales, the sales changes = $(sales_t – sales_{t-1})/sales_{t-1}$.

MTB : market-to-book ratio, market value of equity divided by book value of equity.

INV : fixed assets (except land and construction in progress) divided by total assets.

Table 3
CORRELATIONS

Variables	*TQ*	*RDinc HRDint*	*RDincbio*	*RDincHRDintST*	*RDincbio ST*	*RDincbio PS*	*RDincbio PSST*	*SIZE*	*LEV*	*GROW*	*MTB*	*INV*
TQ	1											
RDincHrdint	0.1066*	1										
RDincbio	0.1148*	0.1000*	1									
RDincHRDint ST	0.2752*	0.2404*	0.0493*	1								
RDincbioST	0.1722*	0.0475*	0.3501*	0.2800*	1							
RDincbioPS	0.1515*	0.0603*	0.5744*	0.0687*	0.3300*	1						
RDincbioPSST	0.1824*	0.0369*	0.2594*	0.2113*	0.7409*	0.4518*	1					
SIZE	0.1030*	-0.1157*	-0.1104*	0.0323*	0.003	-0.0536*	0.0081	1				
LEV	-0.1325*	-0.0645*	-0.0282*	-0.0469*	-0.0197*	-0.0155*	-0.0061	-0.0632*	1			
GROW	0.6701*	0.0134*	-0.0126*	0.1590*	0.0407*	0.0507*	0.0725*	0.2086*	-0.0074	1		
MTB	0.3776*	0.1823*	0.1639*	0.1221*	0.1083*	0.1113*	0.0819*	-0.1272*	-0.0891*	0.0234*	1	
INV	0.5812*	0.0096	0.0057	0.1414*	0.0636*	0.0626*	0.0997*	0.2381*	0.0294*	0.7540*	-0.0141*	1

Note. See the variable definitions in Table 2. * Significant at the 0.05 level

The results of the Pearson correlation are shown in Table 3. There are significant favorable correlations between TQ (market value) and all explanatory variables (*RDincHRDint*, *RDincbio*, *RDincHRDint*ST, *RDincbioST*, *RDincbioPS*, *RDincbioPSST*) ($p < 0.01$). There are also significant positive correlations between TQ and the control variables other than LEV (p < 0.01). The variance inflation factors (VIFs) are calculated for testing multi-collinearity. VIFs for all variables less than 10, mean VIF 1.47. No multi-collinearity problems are evident.

Results and Discussion of OLS and the Robust Regression

Table 4 shows both the OLS and the robust regression results for the association between the market value and the R&D spending increases of R&D intensive firms and biotech firms. Previous research has asserted that R&D investment had a positive impact on corporate value. Similar to the existing evidence, the results for the OLS regression show that the increase in R&D investment is significantly positively associated with the market value of R&D intensive firms (p<0.01), and this tendency is stronger for biotech firms. The results thus provide support for H1. They indicate that R&D investment increases for R&D intensive firms (biotech firms) are suggestive of value relevance as long as the market recognizes the particular importance and necessity of investing in R&D for future sustainable growth of companies. Of course, it cannot be ruled out that these results may imply that information about the R&D processes of R&D intensive firms (biotech firms) is not accurately delivered to the market and is being overvalued.

Among the control variables, three variables GROW, MTB, and INV are positively associated with market value, whereas SIZE and LEV have negative associations with market value. A robust regression analysis is additionally conducted, and the findings are in line with the OLS results.

Table 4
REGRESSION RESULTS

Variables	Expected Sign	Dependent Variable: *TQ*	
		OLS Regression	Robust Regression
Constant	?	-0.1208 (-0.47)	-0.1207 (-0.52)
RDincHRDinc	+	**0.0780*** (3.07)**	**0.0780*** (3.06)**
RDinbio	+	**0.6112*** (10.75)**	**0.6112*** (7.70)**
SIZE	+/−	-0.0166* (-1.75)	-0.0166* (-1.76)
LEV	−	-2.4429*** (–21.88)	-2.4429*** (-25.53)
GROW	+	0.6269*** (73.18)	0.6269*** (22.38)
MTB	+	0.8938*** (69.01)	0.8938*** (44.01)
INV	+	1.1337*** (29.25)	1.1337*** (9.32)
Industry dummy variables		Included	Included
Year dummy variables		Included	Included
F value		1056.82***	170.49***
Adjusted R^2		0.6322	0.6328
N		21,673	21,673

Note: See the variable definitions in Table 2. The parentheses show t-values. * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 5 shows the analysis results for Hypothesis 2. These are for companies that made stock dividends in year t-1. Table 4 exhibits the results for companies that did not pay stock dividends in year t-1. Comparing the two results, it is confirmed that companies that made stock dividends in year t-1 had a more significant positive association with market value in year t (p < 0.01) than companies that did not. To test whether the parameters that are generated from two different regressions are equal to each other, the test of equality of coefficients is performed. The equality hypothesis is rejected at the 1% level (degrees of freedom: 83.60). A stock dividends distribution may elicit a significant enhancement to corporate value in the following year. Thus these results support Hypothesis 2. Stock dividends are generally perceived as a policy issued by a company in good condition or a company with the potential for future growth. In particular, for companies that need to withhold internal resources for their R&D investment, stock dividend payouts are a good way to save cash and signal the market to future R&D success. The results seem to support the signaling hypothesis. A declaration of stock dividends conveys information about the company and sends a positive signal concerning the company's future growth potential. Therefore, it mitigates agency conflicts, and the market accepts this positively and looks forward to future R&D success. The results also seem to indicate the validity of the attention hypothesis (Grinblatt et al., 1984; Arbel & Swanson, 1993) in which the firm obtains another opportunity to secure market attention. This can be seen in the results, in which the tendency is stronger for biotech companies.

Among the control variables, GROW, MTB, and INV are positively associated with market value, while SIZE and LEV are negatively connected with market value. Additionally, a robust regression analysis is conducted, and the results correspond to OLS results.

Table 5
REGRESSION RESULTS

Variables	**Expected Sign**	**Dependent Variable: *TQ***	
		OLS Regression	**Robust Regression**
Constant	?	0.0269 (0.11)	0.0269 (0.12)
RDincHRDincST	**+**	**0.6022*** (9.36)**	**0.6022*** (5.03)**
RDinbioST	**+**	**2.0862*** (15.14)**	**2.0863*** (5.77)**
SIZE	+/−	-0.0230** (-2.45)	-0.0231*** (-2.48)
LEV	−	-2.4952*** (–22.58)	-2.4952*** (-26.02)
GROW	+	0.6303*** (73.95)	0.6303*** (22.68)
MTB	+	0.8959*** (70.70)	0.8959*** (44.36)
INV	+	1.1140*** (28.88)	1.1140*** (9.27)
Industry dummy variables		Included	Included
Year dummy variables		Included	Included
F value		1085.26***	168.56***
Adjusted R^2		0.6365	0.6371
N		21,673	21,673

Note: See the variable definitions in Table 2. The parentheses show t-values. * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 6 indicates the ways in which sales increases have an effect on the value relevance of biotech firms when they increase their R&D investment. This takes into consideration the assertion that increases in R&D directly results in sales growth. As can be seen in the results, sales increases strengthen a positive relationship between R&D investment increases and the value of R&D biotech firms. The results indicate that sales growth is acting as a catalyst in the positive association between the R&D investment increase and the corporate value of biotech companies, as the market has been looking forward to the generation of sales for these biotech companies. An increase in sales may also be a product of proving that R&D investment has not been spent in vain. It could mean that a firm’s R&D has been successful and the firm has entered a stage of future sustainable growth. Table 6 also shows the results of analysis on market value when there are increases in the R&D expenditures and the growth in sales of the biotech firms that made stock dividends in the previous year. Sales growth seems to further boost the positive association between increased R&D spending and corporate value when a firm made stock dividends in the previous year.

There are again significant correlations between the market value of a firm and the control variables. MTB, GROW, and INV have positive correlations to market value, while SIZE and LEV are negatively correlated. The results of the robust regression analysis are compatible with the results of OLS.

Table 6
REGRESSION RESULTS

Variables	**Expected Sign**	**Dependent Variable: *TQ***	
		OLS Regression	**Robust Regression**
Constant	?	-0.0151 (-0.06)	-0.0151 (-0.06)
RDincbioPS	+	**0.7847*** (7.67)**	**0.7847*** (4.08)**
RDincbioPSST	+	**2.4359*** (11.79)**	**2.4359*** (4.38)**
SIZE	+/-	-0.0210** (–2.23)	-0.0210** (–2.25)
LEV	-	-2.5176*** (–22.76)	-2.5176*** (-26.25)
GROW	+	0.6284*** (73.70)	0.6284*** (22.61)
MTB	+	0.9018*** (71.18)	0.9018*** (44.80)
INV	+	1.1022*** (28.53)	1.1022*** (9.21)
Industry dummy variables		Included	Included
Year dummy variables		Included	Included
F value		1082.72***	169.35***
Adjusted R^2		0.6360	0.6366
N		21,672	21,672

Note: See the variable definitions in Table 2. The parentheses show t-values. * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 7
FIXED EFFECT REGRESSION RESULTS

Panel A.

Variables	**Expected Sign**	**Dependent Variable: *TQ***
		Fixed Effect Regression
Constant	?	-4.6421*** (-7.88)
RDincHRDincST	+	**0.5353*** (8.04)**
RDinbioST	+	**1.4091*** (9.38)**
SIZE	+/−	0.2099*** (6.58)
LEV	−	-1.9237*** (–12.48)
GROW	+	0.5832*** (65.54)
MTB	+	0.7956*** (42.29)
INV	+	1.4145*** (33.61)
Industry dummy variables		Included
Year dummy variables		Included
F value		1383.91***
Adjusted R^2		0.6095
N		21,672

Panel B.

Variables	**Expected Sign**	**Dependent Variable: *TQ***
		Fixed Effect Regression
Constant	?	-4.8354*** (-8.23)
RDincbioPS	+	**0.5863*** (5.24)**
RDincbioPSST	+	**2.3654*** (11.52)**
SIZE	+/−	0.2212*** (6.95)

Table 7 FIXED EFFECT REGRESSION RESULTS		
LEV	–	-1.9347*** (-12.57)
GROW	+	0.5816*** (65.46)
MTB	+	0.7982*** (49.54)
INV	+	1.4060*** (33.44)
Industry dummy variables		Included
Year dummy variables		Included
F value		1389.84***
Adjusted R^2		0.6087
N		21,672

Note: See the variable definitions in Table 2. The parentheses show t-values. * p < 0.10, ** p < 0.05, *** p < 0.01.

Results of Fixed Effect Regression

Panel data analysis offers a more precise inference of model parameters and pools information to produce more precise predictions of individual outcomes and confident outcomes (Jianu & Jianu, 2018). However, panel data heterogeneity may lead to misspecification problems and inconsistency. Therefore, for verifying the main hypotheses of the study, the fixed effect regressions are conducted to reexamine the signaling effects of stock dividend distributions (Panel A) and the effect of sales growth on the association between R&D investment increases and corporate value (Panel B). As shown in Table 7 Panel A&B, these findings are compatible with OLS results.

Additional Analysis

An additional analysis is performed to reexamine how firm performance improvement impacts the value relevance of investment increases in R&D of biotech firms. For the additional analysis, two different measures earnings before interest and taxes (EBIT) and net income (NI) are used as proxies for firm performance. Table 8 shows the additional analysis results. As shown in Table 8, firm performance improvement and stock dividend payouts in the previous year have significant positive effects on corporate value ($p < 0.01$).

Table 8 ADDITIONAL ANALYSIS RESULTS			
Variables	**Expected Sign**	**Dependent Variable: *TQ***	
		Model 1.	**Model 2.**
Constant	?	-0.0071 (-0.03)	0.0162 (0.06)
RDincbioEBIT	+	**0.3127*** (3.72)**	-
RDincbioEBITST	+	**1.8671*** (8.90)**	-
RDincbioNI	+	-	**0.1991** (2.37)**
RDincbioNIST	+	-	**1.5958*** (7.45)**
SIZE	+/–	-0.0229** (–2.42)	-0.0233** (-2.46)
LEV	–	-2.5181*** (–22.63)	-2.5244*** (-22.67)
GROW	+	0.6276*** (73.25)	0.6268*** (73.38)
MTB	+	0.9082*** (71.24)	0.9121*** (71.52)
INV	+	1.1360*** (29.30)	1.1291*** (29.07)
Industry dummy variables		Included	Included
Year dummy variables		Included	Included
F value		1065.69***	1061.86***

Adjusted $\bar{R}^2$		0.6323	0.6315
N		21,672	21,672

Notes.
RDincbioEBIT : RDincbio interaction term with EBIT. EBIT is coded as 1 if the firm's EBIT increases, 0 otherwise.
RDincbioEBITST : RDincbioEBIT interaction term with ST.
RDincbioNI : RDincbio interaction term with NI. NI is coded as 1 if the firm's NI increases, 0 otherwise.
RDincbioNIST : RDincbioNI interaction term with ST.
Note: See the variable definitions in Table 2. The parentheses show z-values. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

CONCLUSIONS

The dividend policy of a firm is driven by various circumstances in which the firm is in. Cash dividends can be distributed if the company pulls in large profits and generates sufficient cash. However, for R&D intensive firms, which require huge amounts of R&D investment, cash will probably to be assigned to the company to secure R&D investment funds rather than put toward a shareholder friendly policy. This is because, based on the pecking order hypothesis, companies prefer internal resources first when funds are needed (Myers & Majluf, 1984; Ross, 1977). Meanwhile, the signaling hypothesis allows firms to deliver messages about prospects that can mitigate the agency problem through dividend distribution. Firms send a signal through stock dividend distribution instead of paying cash dividends. This tendency is likely to appear in R&D intensive firms.

The study initially looked at how R&D investment increases of R&D intensive firms and/or biotech firms were being evaluated in the market and second, how the signaling effects of stock dividend payouts were examined. This study also looked at whether an increase in sales could further enhance the value of the firms with R&D investment increases.

According to the analysis results, the R&D investment increases of R&D intensive firms positively affected corporate value, and this tendency was stronger for biotech firms. Second, when stock dividends were distributed in the previous year, R&D investment increases in the following year were more positively related with corporate value. Therefore, this result seems to confirm the signaling effect of stock dividend distributions. Additionally, the market seemed to assess firms with R&D investment increases more positively if their sales increased. This may indicate that the market judged that R&D investment increases directly led to sales growth. In conclusion, the analysis found that corporate value was even further enhanced if the following three conditions were satisfied: stock dividends payment in year t-1, R&D investment increases in year t, and sales growth in year t.

The findings may have important consequences in that a dividend policy can serve as a win-win strategy for R&D intensive (biotech) firms and their shareholders. By adopting a stock dividends payment policy, R&D intensive (biotech) firms do not have to leave a shareholder friendly policy and may have opportunities to invest in R&D, hoping for future sustainable growth, with cash reserved by not giving cash dividends. On the shareholder side, they get more stocks and may look forward to benefiting from stock value rises through firms' future sustainable growth by accepting signals from firms. Furthermore, as shown in this research, if there is evidence that an increase in the R&D of biotech firms has been successful, such as an increase in sales, the faith in the future sustainability of the company appears to be further strengthened. Policymakers also need to consider R&D intensive (biotech) companies' features and develop measures to support their sustainable growth.

Because the number of biotech samples is relatively small, this paper could not conduct analysis focused only on biotech companies. Nevertheless, this study offers some contributions to the current related literature by looking at how the market values the R&D investment increases of R&D intensive firms, particularly biotech firms, in connection with the signaling hypothesis. Although research on biotechnology has been ongoing, it is still considered an interesting topic due to the specificity of the industry. It is the author's hope that by extending the work done in this paper, a more elaborate analysis can be carried out. In the future, it would be interesting if various types of dividends could be more elaborately linked with capital structure. Another interesting area for further studies would be a comparative study between countries, with the expectation that the results will be different.

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