

The Effects of Research and Development Expenditure on the Firm Value: Focusing on the Portfolio's Excess Return

Shi Yeong Choi

Gangnam-daero Branch, KB Bank

Kun Woo Kim*

School of Management, Kyung Hee University

Abstract

To analyze the effects of R&D expenditure on the firm value of Korean firms, we classified portfolios based on R&D activity levels. After that, we conducted a time-series analysis to assess excess returns from the portfolios. To carry out such an analysis, an empirical analysis of excess returns in the capital market was performed by using the monthly earning rate of stocks from 2000 to 2013. The purpose of this research is to provide basic data on investment to stakeholders in the capital market by analyzing the effects of R&D on the firm value and to overcome scholarly limitations by offering a new model of analysis. The criteria for classifying the portfolios were based on R&D expenditure levels. The analysis models follow the Fama-French Three-Factor Model and the Carhart Four-Factor Model. The analyses results are as follows. Extrapolating monthly profit rates based on R&D expenditure levels, portfolios with low R&D expenditures showed higher earning rates than those with high R&D expenditures. This suggests that high R&D expenditures did not translate into high earning rates. The investor depreciates the R&D expenditures related profitability and the possibility of success in the market, leading to falls in stock prices and a failure to give a positive effect on the firm value. Our research differs from the previous investigations as we carried out an empirical analysis based on the actual investors' attitudes about R&D expenditures and how these can generate excess earnings. Our research results show that the data related to R&D expenditure are not reflected fully in the market.

Keyword Research and Development, Firm value, Excess return, Three factor model.

*Corresponding author: kwkim@khu.ac.kr

1. Introduction

Studies on research and development (R&D) activities by a firm and firm values are generally divided into two categories depending on what is selected as the dependent variable. One conducts an empirical analysis by using Tobin's Q as the proxy variable for firm value, and the other utilizes price earning ratio in the capital market. In the case of the former, only a simple causal relationship is measured, resulting in a possible omitted variable bias or a sample selection problem. In the case of the latter, the limitation is that it cannot properly reflect expectations of investors in the capital market along with the risks. In this study, we divided portfolios with a high level of R&D activities and portfolios without in order to analyze the impact that R&D activities of domestic firms have on their firm value, and we also conducted an empirical analysis on how much excess return was gained through time-series analysis.

Technological innovation possesses paramount importance in handling the rapidly changing international economic environment, technological environment, short product lifespan, and globalization of firms. Because firms desperately need to secure corresponding competitiveness, technological issues are becoming a factor of the most important decisions (Jung et al., 2008).¹⁾ Thus, social interest in R&D activities is increasing, and the importance of R&D is more emphasized. Especially in the perspective of business administration, many firms put emphasis on innovation. It is because firms regard innovation as the method for the securement of competitive advantage and a core source for future products, technology, and service that guarantees the growth and competitive advantage of the firm.(Balkin et al., 2000).

Recently, firms have been expanding investments on intangible assets as well as investments on tangible assets. Especially, it is an undeniable fact that R&D investment, which is represented as an intangible assets, positively contributes to the future profit and market value of the firm (Sougiannis, 1994). Therefore, investment analysts are suggesting various analyses regarding firms or industries with a high R&D expenditure ratio, and investors are also likely to invest in firms with much R&D expenditures (Ahn et al., 2005). This is because they believe that it fosters demand of the stocks, ultimately enhancing the firm value. According to Ahn (2002), R&D expenditures have different characteristics from general capital or financial expenditures (equipment, factory, inventory, or financing). He especially insisted that there are the following differences between R&D and those expenditure items.

1) According to the press release of the Bank of Korea and National Statistics Office in December 2014, Confirmed Estimation of Korean Capital Stock(1970-2012), Korea's "R&D expenditure/GDP" ratio in 2012 was 4.0%, which was the top rank in the globe, and the volume of R&D expenditure was in the world's 6th, following the United States, Japan, China, and etc.(Source: http://news.inews24.com/php/news_view.php?g_serial=873270&g_menu=022600)

First, while most R&D projects such as the development of medicine or software with a special purpose grant exclusivity or opportunity for innovation to the firm, capital expenditures on equipment or factories do not bring significant exclusivity or opportunity for innovation. Therefore, many firms are expanding to R&D expenditures, and sometimes erroneous R&D expenditure execution becomes a danger to the firm. Second, not all the information on a firm's R&D value and productivity is reported on its financial statement. Thus, there is an information asymmetry in firms with R&D expenditures.²⁾ Third, most of the tangible and financial assets are traded in the regular market where the information on the value of the asset and productivity is provided, but R&D expenditures are not in such markets where the prices are formed. Because the valuation of R&D investments are harder for such reasons, the decision-making on R&D investments should be done more prudently. Fourth, accounting measurements and reporting standards for R&D are very different from that of other assets. For example, while financial assets are assessed on a regular basis in market price and tangible assets reflect change in the assets' value through recognition of asset impairment, it is not easy to reflect such asset changes on R&D. Considering such characteristic, the information on R&D could be an attractive information source for investors because public information is asymmetric.

Studies that analyze whether Tobin's Q is high when R&D expenditure level is high assume that the information on R&D expenditures is already reflected in the current stock price. In contrast, studies that analyze whether the stock price of a firm with a high level of R&D expenditure shows excess returns assume that the information of R&D expenditures is not yet thoroughly reflected in the stock price.

The purpose of this study is to provide basic data regarding investments to stakeholders in the capital market through attempting a new analysis to break through the academic limitations in analyzing the effects of R&D investment on a firm's value under such background.

The structure of this study is as follows. After Chapter I, Introduction, in Chapter II, we will comprehensively explore the preceding research and theoretical studies. In Chapter III, we will explore study design, in Chapter IV, we will suggest results of the empirical analysis, and then in Chapter V, we will describe the conclusion of this study.

2) According to Ahn et al(2005), it was found that error in analyst's earnings forecast and standard deviation of expected profit is higher in firms and industries with high R&D expenditure ratio. He insisted that this shows the higher the ratio of firm's intangible asset expenditure is, the higher the information asymmetry between the firm and investor is.

2. Background

The major category of preceding research on R&D expenditure is the study of the effects of R&D investment on market value or firm value. Those are papers that representatively studied what effects expenditure on R&D makes on firm value or management performances.

2.1 R&D and Firm value

For the question of what effects does firm R&D activities have on firm value, there has been various studies. Among those, for overseas studies that report that R&D expenditures have a positive(+) effect on firm value, there are Morck et al. (1988), Chan et al. (1990), Connolly and Hirschey (1990), Morck and Yeung (1991), Doukas and Switzer (1992), Chauvin and Hirschey (1993), Szewczyk et al. (1996), Chen and Kim (1997), Bae and Kim (2003), and Everhart et al. (2004).

Korean studies include Choi (1994), Kim and Seo (2007), Heo et al. (2007), Kim (2007), Kwon (2007), Kim (2008), and Kim and Ki (2009) also indicate that R&D expenditures have positive(+) effects on firm value. In contrast, Jung et al. (2005) report that R&D expenditures have negative effects or no significant effect on the firm value. Research on KOSDAQ registered firms by Kim and Shin (2006) also shows that R&D expenditures do not have a significant effect on firm value.

The theory that R&D expenditure is related to firm value starts from the assumption that R&D expenditures could enhance future firm value and operation results by developing a new product or service and improving the quality of existing products and services of the firm.

Positions that argue that R&D expenditures are for developing a new technology or imitating and applying the technology developed by the competitor firms so that R&D investment of the firm is not a cost in the term and that utility should be capitalized as an intangible capital that is realized in the future have been suggested by many researchers (Weiss, 1969; Miansian, 1969; Branch, 1974; Grbowski and Mueller, 1978; Hirschey 1982 ; Chauvin and Hirschey 1993 ; Sougiannis 1994; Lev and Sougiannis 1996). R&D expenditures have effects on the productivity of the firm and contribute to the increase of revenue and profit, and in the market, it is reported that R&D expenditures serve as a positive indication of stock price to investors (Lev, 2001).

Representative studies that reported that R&D expenditure of the firms have a positive effect on firm value are following: Hirschey(1982) studied relationships between R&D and public relations expenditures and firm value. Tobin's Q, the book value compared to the market value, has been adopted as the dependent variable, and book value, accounting profit, fully expensed R&D expenditures, public relations expenditures, industrial concentration, profit growth rate, and risk in the future expected profit flow have been used as independent variables and control variables.

The result of the study reported that while accounting profit, R&D expenditures, and public relations expenditures have significant positive (+) relations with firm value, future expected profit flow has a significant negative (-) relation with the firm value.

Hirschey and Weygandt (1985) is the upgrade of Hirschey (1982). Effects of public relations expenditures and R&D expenditures on the stock price were analyzed in the cases of 390 U.S. firms. The results indicated that R&D expenditures have a positive effect on excessive market value, both in the durable goods industry and the nondurable goods industry. Accounting profit, R&D expenditures, and public relations expenditures have shown positive effects on the market value and the R&D expenditures have shown a significant positive (+) effect on the stock price.

Chan et al. (1990) analyzed the profit rate by the announcement effect in the cases of 96 firms that had announced R&D expenditures from 1979 to 1989. Considering the excess earning rate, which was positive on the announcement date, R&D was regarded to have a positive effect on the firm value. In addition, while R&D expenditure growth in the high-tech sector had a positive effect on stock price, R&D expenditure growth in the non-high-tech sector had a negative effect on the stock price.

Chauvin and Hirschey (1993) used the market value of the stock for the dependent variable and cash flow, growth rate, risk, market share, public relations expenditure, and R&D expenditure for the independent variables in the analysis of 20 U.S. firms from 1988 to 1990. The results indicated that only public relations expenditures and R&D expenditure had positive effects on the market value of the stock.

Cho (1992) analyzed the relationship between the stock holding of the executive and R&D concentration and the relationship between the stock holding of the major external shareholder and R&D concentration in U.S. manufacturing firms, with data from 1980 to 1986. Based on the result of forming portfolios based on the stock share of the executive ranking and comparing mean R&D concentration level of each portfolio, it was found that higher stock share of the executive leads to higher R&D concentration.

On the other hand, there are studies that have shown that R&D expenditures have negative effects on firm value. Bublitz and Ettredge (1989) analyzed the effect of public relations expenditures and R&D expenditures on cumulative average residual in 328 firms from 1974 to 1983, and the result was that public relations expenditures have a negative effect and the effect of R&D expenditures were statistically insignificant.

Lev and Zarowin (1999) reported that R&D expenditure growth indicated negative functions in net profit, cash flow, and net asset value in 6,800 firms from 1977 to 1996. In addition, Kwon and Lee (2004), a Korean study that showed that R&D expenditures of the firm has a negative effect on firm value, analyzed 106 venture firms for 3 years from 2001 to 2003, with R&D concentration,

revenue growth rate, stock return rate, and leverage ratio as the independent variables and Tobin Q as the dependent variable, and the result was that R&D concentration has a negative effect on firm value. Kim and Song (2004) researched the relation between total R&D expenditure and firm profit and the relation between net asset operation profit rate and net asset profit rate in 78 listed firms from the chemical industry, electricity and electronic industry, machinery, and medicine, from 1996 to 2000, and the result was that R&D expenditure in a term does not have any special effect on the firm performance in the same term.

Kim and Kang (2012) divided the period from 1988 to 2010 to IMF crisis and global crisis and empirically analyzed the correlation between R&D expenditure and firm value in Korean listed firms. They thought that IMF crisis and global crisis would have had a great effect on business management since they had a great effect on the Korean economy. To summarize their result, before and after the IMF crisis, the correlation between R&D expenditures and firm value was statistically not significant. However, before and after the global crisis, the relation between R&D expenditures and firm value showed a 1% level of significance and a positive(+) correlation. Based on those results, they insisted that R&D expenditure enhances the anticipative response capacity in various possible future financial environments, plans enhancing future competitiveness in uncertainty, and contributes in a motivational aspect.

In short, the majority of studies on R&D expenditures and firm value reported a statistically significant positive (+) correlation. It is reported that R&D expenditure, the expenditure of an intangible capital, has a positive relation with proxy variables that represent the firm value, such as Tobin's Q and ROA.

2.2 Excess Returns

The major methodology of this study is to form a portfolio based on the level and characteristics of R&D expenditures and analyze the corresponding excess earning rate. The measuring model of excess earning rates is the 3 factor model of Fama and French (1993). For the representative study of the excess earning rate, there are many studies by the subjects. Literature arranging was done focused on the recent studies. First, Kam and Shin (2014) empirically studies the relation between capital investment and stock return in the Korean capital market. For their empirical analysis, they used stock price and financial statements data of qualified manufacturing firms listed in the KOSPI market from 1999 to 2013. Their analysis method was a performance analysis of investment strategy and the portfolio which was formed based on the three variables of capital investment, free cash flow, and leverage ratio. For that, the three factor model of Fama and French (1993) was used. The result of analysis indicates that considering the fact that free cash flow and leverage ration,

which are proxy variables of capital investment and agent problem respectively, showed insignificant alpha, capital investment cannot be useful information is understanding the direction of stock return rate in Korean capital market.

In the study by Kim (2009), as the result of the empirical analysis sample period from January 1998 to October 2007 on whether the better explanatory factor for rate of return in the Korean stock market is change in a firm's characteristics or risk factors, it is insisted that considering that explanatory power of SMB's estimation vanishes if the firm characteristic is controlled, the characteristic model of Daniel and Titman (1997) explains the rate of return difference in the Korean stock market better than the factor model of Fama-French (1993).

In Ko and Kim (2010), as the result of the verification of explanatory power of a firm characteristic variable on stock return rate from 1987 to 2009, it was analyzed that firm size has a significant cross-sectional explanatory power. In the study of Kim and Byun (2011), which categorized 704 firms into 6 portfolios in accordance with the factor model of Fama and French (1993) and researched the rate of return of SMB, the result showed a statistically negative value.

In the result of studying 809 non-financial firms from January 1987 to December 2010 on whether the firm size and market value/book value ratio possesses cross-sectional explanatory power by market circumstances, Um (2012) suggested there is a negative(-) correlation between the firm size and excess return rate. Kim (2011), a survey study which aggregated precedent studies that verified the capital asset pricing model (CAPM) in the Korean stock market, described that the numbers of average rate of returns in portfolios by firm size factor differ much by the sample period and result of such empirical analysis has the high possibility of sensitive changes from the selection of the sample period. Also, Sonu and Choi(2011) concluded that, with the precedent studies that found exceptional phenomena in Korean stock market combined, the size effect existed recently from the late 1990s to the early 2000s.

Also, similar to this study, there is An (2002), which conducted an empirical analysis with the 3 factor model of Fama and French(1993) regarding R&D expenditures. According to An, firm market value (M) has a difference of book value (B) to current value and of future abnormal return. Here, he insists that the future abnormal return occurs as a result of capitalization from competition or innovation by the firm. Against such a background, he analyzed how well a firm's innovation capital (proxy variable: research expenditure), which was suggested as the reason of B/M difference, explains the difference of B/M. His result indicates that R&D expenditure is the factor that effectively explains the stock return rate and in the firm where R&D expenditure are concentrated, the correlation with stock return rate was not very large. He insisted that in the Korean capital market, R&D expenditure occurs in accordance to the risk factors.

2.3 Contribution

Differentiations of this study from the precedent studies mentioned above are as follows. First, the research model is differentiated. The purpose of this study is to explore what effects R&D expenditures have on the firm value. Existing precedent studies mainly focus on Tobin's Q or management performance. In contrast, this study formed portfolios regarding R&D expenditures and tried an empirical analysis on how much excess return would be able to be acquired in the case of investing in the firm from the investor's perspective. This analysis differentiates this study from existing studies which only conducted a causal analysis.

Second, variables were subdivided. This study conducted an analysis on the volume of R&D expenditure change in addition to the volume of R&D expenditures in order to differentiate itself from precedent studies.

Third, the sample period is relatively longer. The sample period this study is based on is from 2000 to 2013. A longer sample period is advantageous in the sense that the bias in the estimation could be minimized. Hence, this study is meaningful in that it can minimize errors by securing a longer sample period.

3. Research Design

3.1 Hypothesis testing

One management strategy for firms to maximize the wealth of stockholders with limited resources is making decisions regarding investments on the basis of accumulated profit. Decision-making on investments is influenced by various aspects such as management structure or economic circumstance but we could say that for securing growth dynamic for the firm and sustainable growth, decision-making on the investment is a necessary condition. This study conducts an empirical analysis of how R&D expenditures are regarded in the capital market. For the example of firm's investment in intangible asset, the most representative one is R&D expenditure. R&D expenditures are regarded as an investment in an intangible asset, and existing studies insist that they have a positive effect on firm value. We can find many studies that reported that R&D expenditures have a positive effect on stock return rate, which is indicative of firm value (Lev and Sougiannis, 1996; Aboody and Lev, 1998; Cazavan-Jeny and Jeanjean, 2003; Han and Manry, 2004; Callimaci and Landry, 2004; Han, 2006).

There is a need to explore how investors recognize a firm's R&D expenditures. That is because the perspective of the investors determine the stock price. If R&D expenditures of the firm are regarded by the investors as the firm's investment for growth, demand for the firm's stock would

rise and the rate of return would be quite high. Through this, the value of stock would rise and firm value would also rise.

Most of the precedent studies report that a high level of R&D expenditures has a positive effect on firm value. Moreover, there are studies focused on the effect of R&D expenditures on the corresponding year's firm value (Hirschey, 1982; Hirschey and Weygandt, 1985; Kim and Kang, 2012) and a study which studied focused on the long-term effect R&D expenditure has on a firm's return improvement and value improvement (Jo and Jung, 2001; Choi, 2009).

Aboody and Lev (1998) examined what effects the capitalization of R&D expenditure would have on firm value. According to their analysis result, capitalized R&D expenditures provide useful information to investors and for that reason it has a correlation with firm value. However, they concluded that capitalized R&D expenditure is reflected later rather than immediately, and the post-investment excess return rate includes rewards for the risks of investment in R&D expenditures.

Foster (2003) empirically analyzed the effects R&D expenditure investments have on firm performance in 1,200 global firms. According to the results, studied firms raised R&D investments by 22% even during the economic recession in the 1990s, and firm performance was also far better than that of competitors in the same field. Eberhart et al. (2004) analyzed the correlation between R&D expenditures and firm performance with a sample of 8,313 firms and a fifty-year sample period from 1951 to 2001, and it was found that during the 5 years following the R&D investment period, not only operation profits but also abnormal return rates greatly rose.

Meanwhile, there are study results that show that R&D expenditure have a negative (-) effect on market value (Park and Kim, 2007; Tsolikas and Tsalavoutas, 2011). Their research focuses on the fact that R&D expenditure is influenced by discretionary investments by the executive. According to agent theory, risk preference of stockholders and that of the executives are not identical. That is because risk diversification mechanisms of the stockholder and the executive are different. Stockholders may diversify the investment risk of a certain firm through diversified investment on several firms and transfer their stock to others at a relatively low cost (Jensen and Meckling, 1976). In contrast, the executive cannot secure the means to effectively diversify the risk of unstable employment and decreased reward from the bankruptcy of a certain firm as easily as the stockholder does. Hence, the executive reduces R&D expenditures, which are discretionary investments and faces the under investment problem. This is expected to worsen the competitiveness of the firm in the long-term so that there could be a possible decrease in the stock return rate.

Coombs and Bierly(2006) researched technological capacity and performance of 201 U.S. firms, and the result indicated that R&D concentration is in a significant negative (-) correlation with,

among firm performance, return on sales (ROS) and return on assets(ROA), and no correlation with return on equity (ROE), respectively.

In the study of Tsovikas and Tsalavoutas (2011), since the United Kingdom began to enforce international accounting standards in 2005, the perspective of investors has clearly differed based on the capitalization or expense of R&D expenditures. That is, capitalized R&D expenditures show a positive correlation with firm value but expensed R&D expenditure had a negative effect on the firm value. This was interpreted as investors expecting future economic utility from capitalized R&D expenditure but seeing no future expected value in expensed R&D expenditure.

For a representative Korean study, there is Park and Kim (2007). They analyzed the effect of investment expenditures of Korean listed firms on firm value through firm management structure during the post-currency crisis period. The results suggested that while in a high-level firm management structure, facility investments and R&D investments enhanced the firm value, in a low-level firm management structure, facility investments may lead to decreased firm value. Such results report that improvement in the firm management structure is a necessary condition for the increase in the firm value. To summarize such existing studies, R&D expenditures are a part of decision-making on investments, and the investors focus on that to decide the demand.

From another perspective, according to Fama and French (1992, 1993), since firms with higher risks are exposed to financial risk, investors would demand higher stock return rates as a reward. R&D expenditures are interpreted as the risk premium from the increased cost so that firms with a high level of R&D expenditures would show a high excess return rate. Also, since R&D expenditures are expected to bring future economic utility through investment decision-making, the stock price is expected to rise. Hence, hypothesis 1 below was established.

Hypothesis 1 : As the R&D investments increase, the excess return rate also increases.

In addition, this study expands the hypothesis and conducts an empirical analysis of whether an excess return rate occurs by using an R&D investment growth rate. Investment policy of the firm could be a good signal for the investors. For example, a steep increase of R&D expenditure could be regarded as a sign of the firm having a causal factor for the profit enhancement of the firm. Hence, this study derives Hypothesis 2 below and conducts an empirical analysis on the perception of investors as R&D investments increase.

Hypothesis 2 : Excess return rates increase depending on the R&D investment growth rate.

3.2 Sample

This study conducts the effects R&D expenditures have on the excess return rate. For this, we set the research period from 2000 to 2013 (based on R&D expenditures). This took the stabilization of the capital market after the currency crisis and decided upon this research period in order to include the latest analysis results. This study used accounting data on firms listed in KOSPI provided by KIS-VALUE and excluded the following firms or data from the analysis considering the purpose of the study.

- 1) Firm whose accounting year did not end in December
- 2) Firms in the financial business such as banks
- 3) Administrative issue or firms without financial data
- 4) Firms without R&D expenditures

<Table 1> is the number of sample firms in this study after considering the items above. We could find that firms not with fluctuating expenditures but with constant expenditures are included. Ultimately, 452 firms and 4,260 samples were derived.

Table 1 Number of observations

Year	Firm Year
2000	265
2001	281
2002	304
2003	305
2004	288
2005	292
2006	306
2007	302
2008	313
2009	314
2010	329
2011	323
2012	319
2013	319
N	4,260

3.3 Model

This study conducts a time series regression through the 3 factor model of Fama and French (1993) and 4 factor model of Carhart (1997) in order to analyze whether investments on each portfolio group based on R&D expenditure volume results in an abnormal return.³⁾

3.3.1. Fama and French 3-Factor Model

Fama and French (1992) analyzed the cross-section of the average returns of listed stocks through beta, firm size, and BM ratio on the basis of stocks listed in the U.S. from 1963 to 1990 and found that only the firm size and BM ratio are significant variables. The asset price model, which uses the market size and log value of BM ratio as explanatory variables, and the market excess return rate were assessed to be excellent in the empirical sense since it effectively explains the cross-section of an average rate of return. However, it did not suggest any explanation on the significance of firm size, and BM ratio are the results of reflecting the risk factors. In order to solve such a problem, based on the research results of the previous year, Fama and French (1993) checked the common risk factor of the rate of return of stocks and bonds, and proposed a multi-factor model.

They created a factor portfolio based on the firm size, BM ratio, and 3 factor model which uses rate of return as a premium on the risk factors represented by the firm size and BM ratio. Formula (1) below refers to the equation of the 3 factor model of Fama and French(1993).

$$[E(R_i) - R_f]_t = \alpha_p + m_p[E(R_m) - R_f]_t + s_pSMB_t + h_pHML_t + \epsilon_{pt} \quad (1)$$

$E(R_i)$: Monthly average rate of return of the portfolio

$E(R_m)$: Monthly average market rate of return of portfolio

R_f : Risk free rate

SMB_t : Difference of rate of return of small firms to rate of return of larger firms

HML_t : Difference of rate of return of firms with a high BM ratio to rate of return of firms with a lower BM ratio

In formula (1), SMB_t and HML_t are variables to control the firm size and BM ratio. Here, SMB_t refers to the premium on the firm size, and the difference between the rate of return of a small firm

3) Existing studies conducted the analysis through excess return rate which excluded risk free rate from actual rate of return or CAPM, but the results were not very different. Hence, this study conduct the analysis through more detailed 3 factor or 4 factor model.

portfolio and a large firm portfolio. HML_t is the growth factor, and it refers to the difference between rate of returns of portfolio, which consists of stocks with a high BM ratio and a portfolio which consists of stocks with a low BM ratio.

Let's take a look at the method of forming SMB_t and HML_t in detail. In the portfolio categorization based on the firm size, sample firms in January year t were aligned according to the aggregated market price in late December year t and were divided into the upper 50% and lower 50%. The upper 50% was categorized into a large group and the lower 50% was categorized into a small group. Through the same method, based on the BM ratio, firms were categorized into the lower 30% (L), the middle 40% (M), and upper 30% (H). If we take the intersection of 2 firm size-based groups and 3 BM ratio-based groups, we get a 2x3 matrix as <Table 2>. And it is possible to derive the equally weighted average portfolios SL, SM, SH, BL, BM, and BH.

Table 2 Fama and French 3-factor

	BM Low	BM Median	BM High
SIZE Big	BL	BM	BH
SIZE Small	SL	SM	SH

SMB is calculated by the difference of the average rate of return of the small firm group portfolios (SL, SM, SH) to the average rate of return of the big firm group portfolios (BL, BM, BH) This was arranged into Formula (2) below.

$$SMB = (SL + SM + SH) / 3 - (BL + BM + BH) / 3 \quad (2)$$

The categorization of HML , the portfolios based on the BM ratio, is calculated by the difference of the average rate of return of the group with a high BM ratio (SH, BH) and the average return ratio of the group with a low BM ratio (SL, BL).

$$HML = (SH + BH) / 2 - (SL + BL) / 2 \quad (3)$$

3.3.2 Carhart(1997)'s 4-Factor Model

The 4 factor model of Carhart (1997) is a model where the winner minus loser (WML) is added to the 3 factor model of Fama and French (1993). For this, the winner portfolio, which consists of the winners of the top 30% rates of return, and the loser portfolio, which consists of the losers of the lowest 30% rates of return, based on the average rate of return in the last 12 months before the base month. And if we form 6 portfolios, which are the intersection between them, and portfolios based

on the firm size, we can arrange them into following <Table 3>.

Table 3 Fama and French 4-factor

	Loser	Median	Winner
SIZE Big	BL	BM	BW
SIZE Small	SL	SM	SW

Through this, we can refer to Formula (1) and derive Formula (4).

$$[E(R_i) - R_{f,t}] = \alpha_p + m_p[E(R_m) - R_{f,t}] + s_pSMB_t + h_pHML_t + w_pMOM + \epsilon_{pt} \quad (4)$$

$E(R_i)$: Monthly average rate of return of the portfolio

$E(R_m)$: Monthly average market rate of return of portfolio

R_f : Risk free rate

SMB_t : Difference of rate of return of small firm to rate of return of larger firm

HML_t : Difference of rate of return of firm with high BM ratio to rate of return of firm with lower BM ratio

MOM_t : Difference of rate of return of firm with high rate of return to rate of return of firm with lower rate of return

In formula (4), SMB and HML are variables to control the firm size and BM ratio. Here, SMB refers to the premium of the firm size and the difference between the rate of return of the small firm portfolio and the large firm portfolio. HML is the growth factor, and it refers to the difference between the rates of return of the portfolio that consists of stocks with a high BM ratio and the portfolio that consists of stocks with a low BM ratio. The new variable. MOM is, after calculating the average stock return rate of the stock in from -1 month to -11 months and dividing those into upper 30%, middle 40%, and lower 30%, the difference between the monthly average stock return rates of the upper 30% portfolio and the lower 30% portfolio. More specifically, as shown in Formula (5), it is calculated by deducting the loser stock with the big size from the winner stock with the big size.

$$MOM = (SW + BW) / 2 - (SL + BL) / 2 \quad (5)$$

3.4 Variable

3.4.1 R&D expense

This study conducts a test on where excess return rates by R&D expenditure could be presented. First of all, the definition of, among all variables, R&D expenditures is very important. According to the firm accounting criteria, R&D expenditures are divided into ordinary R&D expenditures and nonrecurring R&D expenditures. It could be explained as Formula (6) below.

$$\text{Total R\&D Expenditure (TRD) = Ordinary R\&D Expenditure + Nonrecurring R\&D Expenditure} \quad (6)$$

In short, total R&D expenditures (*TRD*) could be defined as the sum of ordinary R&D expenditure and nonrecurring R&D expenditure. Here, ordinary R&D expenditures are calculated as the sum of research expenditures in the income statement and research expenditures in the factory cost report. Nonrecurring R&D expenditures are calculated by deducting basic development expenditures from term-end development expenditure and summing up the repayments of development expenditures in the income statement and the factory cost report. This is described in Formula (7) below.

$$\text{Ordinary R\&D Expenditure} = \text{Research Expenditure Reported in the Income Statement (or Ordinary R\&D Expenditure, Ordinary Research Expenditure) + Research Expenditure in the Factory Cost Report(or Ordinary Development Expenditure)} \quad (7)$$

Nonrecurring Development Expenditure = End-term Development Expenditure Reported in the Statement of Financial Position(or R&D Expenditure) - Basic Development Expenditure Reported in the Statement of Financial Position(or R&D Expenditure) + Repayment of Development Expenditure Reported in the Income Statement(or Repayment of R&D Expenditure) + Repayment of Development Expenditure Reported in the Factory Cost Report

Then we divide the calculated number by the sales in order to control the size. Then the ratio of R&D expenditures to the sales volume is made.

$$TRD_t = \frac{RD_t}{S_t} \quad (8)$$

This study also conducts an analysis of the fluctuation of expenditures and how the cumulative expenditure is recognized in the capital market, as well as the ratio of R&D expenditures to the total

expenditures. For those, the fluctuation of R&D expenditures is calculated as following. ΔTRD

$$\Delta TRD_t = \frac{TRD_t}{TRD_{t-1}} - 1 \quad (9)$$

If ΔTRD is a positive number, this means that R&D expenditures increased compared to the previous term, and if it is a negative number, this means R&D expenditure decreased compared to the previous term.

3.4.2 Making the Portfolio

This study organizes portfolios based on R&D expenditure behaviors and analyzes the excess return rate. Therefore, the method of making a portfolio is very important. The method for making portfolios is as follows. Assuming the investment on individual stocks in the portfolio in the even proportion, the average excess return rate which is the average monthly rate of return with the risk free rate (monthly change rate of three-year treasury bond) deducted is used as the rate of return of the portfolio.

<Table 4> below refers to the values of portfolios by years. In the ratio of R&D expenditure, it was 2010 when most of the firms were included at 329 firms, and in 2000, 265 firms, which is slightly less, composed the portfolios.

Table 4 Number of firms belonging to portfolio by year

Portfolio	Year													
	00	01	02	03	04	05	06	07	08	09	10	11	12	13
1	66	70	76	76	72	73	76	75	78	78	82	80	79	79
2	66	70	76	76	72	73	77	76	78	79	82	81	80	80
3	66	70	76	76	72	73	76	75	78	78	82	81	80	80
4	67	71	76	77	72	73	77	76	79	79	83	81	80	80
Sum	265	281	304	305	288	292	306	302	313	314	329	323	319	319

3.4.3 Measure for variable

Assuming the investment on individual stocks in the portfolio in the even proportion, the average excess return rate, which is the average monthly rate of return with the risk free rate (monthly change rate of three-year treasury bond) deducted, is used as the dependent variable. As independent variables, RMRF, which means the market premium, firm size (*SIZE*), BM ratio (*BM*) are used. Calculations for each variable are as follows.

First, for RMRF, the value of the market rate of return with risk free rate deducted was used. KOSPI was used as the market rate of return, and the return rate of the three-year treasury bond was used as the risk free rate. Second, *SIZE*, which refers to the firm size, is calculated by the aggregated market value. It is calculated by multiplying the number of common stock by stock price with the year t-1 as the basis. Third, BM is the market to book ratio and the book value is total ownership interest with preferred capital stock deducted. Market value refers to the aggregated market value.

4. Results

This study conducts an empirical analysis on what effects R&D expenditures have on decision-making by the investors. In this chapter, we will discuss the result of the analysis, but first we will explore the analysis results on descriptive statistics.

4.1 Descriptive Analysis

4.1.1 R&D Expenditures

First, this study arranged descriptive statistics from the perspective of R&D expenditures in <Table 5>. Nonrecurring R&D expenditures were surveyed to be approximately 15.9 billion KRW on average, and ordinary R&D expenditures turned out to be 32.5 billion KRW on average, and total R&D expenditures were surveyed to be 32.8 billion KRW on average. R&D expenditures were found to consist largely of ordinary R&D expenditures.

TRD, which was based on the total R&D expenditures, was 1.19%. This means that R&D expenditures hold approximately 1% of the total sales volume. It is possible to compare *TRD* to that in the existing studies, and doing so did not show a significant difference. The next, ΔTRD , refers to the change rate of *TRD* in the current term compared to the previous term. On average, ΔTRD is used as an indicator. The reason for a slightly high number is that even the slightest change in the number may result in a great change in the change rate because the volume of *TRD* is small from the beginning.

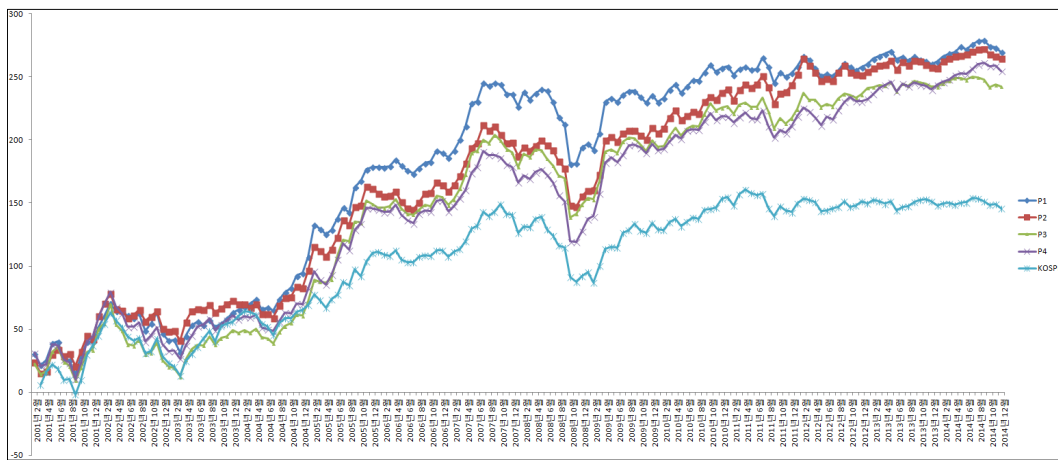
Table 5 Descriptive statistics for R&D(In millions of Korean won)

Variable	Mean	Med	Max	Min	SD	N
Non-contract R & D expenses	15,900	671	654,000	0.058	74,400	106
Current R & D expenses	32,500	857	12,800,000	0.005	358,000	4,254
Sum R&D	32,800	884	12,800,000	0.005	358,000	4,260
TRD	1.19	0.42	26.23	0.00	2.10	4,260
ΔTRD	116.36	1.02	83481.27	-99.99	1868.66	3,692

4.1.2 Rate of Return for R&D

This study largely indicates the rate of return by the R&D expenditures, and descriptive statistics regarding the rate of return was calculated. First, for the accumulated excess return rate on R&D expenditures, the trend of the accumulated rate of return is shown in <Figure 1> below. Most of the portfolio turned out to result in a higher rate of return than the market. Portfolios with the highest rate of return among them was P1, which consists of firms with less R&D expenditures. This shows that the capital market does not regard R&D expenditure positively in the short term.

Figure 1 Trend of Cumulated Abnormal Return



<Table 6> below describes the descriptive statistics regarding the rate of return. First, *TRD*, which refers to the ratio of R&D expenditures, was in the order of P1 (1.61%), P2 (1.58%), P4 (1.52%), P3 (1.44%). It was concluded that the portfolio with a lower R&D expenditure ratio results in the higher rate of return. Δ TRD, which refers to the change rate, was in the order of P2 (1.51), P3 (1.46), P1 (1.25), P4 (1.25). This could be interpreted as the excessive change in the R&D expenditure has a rather a negative effect on the stock price.

SMB, the control variable, turned out to be -0.29%, indicating that the firms with the larger size have the higher rate of return. *HML* was at 1.33%, and it seems that firms with a higher growth rate acquire more returns. *RMRF* was at 0.87%, indicating an average monthly return of 0.87% from the investment on the market. Lastly, *MOM* was observed to be at 0.94%.

Table 6 Descriptive statistics for R&D(%)

Category	Portfolio	Mean	Med	Max	Min	Sd	N
TRD	P1	1.61	2.14	25.55	-31.73	7.51	168
	P2	1.58	1.56	26.84	-29.44	7.19	
	P3	1.44	1.15	23.22	-30.97	7.49	
	P4	1.52	1.81	25.58	-31.71	7.52	
Δ TRD	P1	1.25	1.27	24.52	-30.04	6.93	156
	P2	1.51	1.54	23.82	-30.09	7.02	
	P3	1.46	1.59	23.10	-30.12	6.94	
	P4	1.25	1.77	24.84	-35.17	7.54	
Control Variable	SMB	-0.29	-0.33	22.29	-16.17	4.83	168
	HML	1.33	1.06	22.72	-20.15	6.35	
	RMRF	0.87	1.02	22.26	-23.28	6.51	
	MOM	0.94	0.86	14.48	-27.28	4.96	

4.2 Analytic Results on Hypothesis 1

The analytic results on determining which portfolio achieves an excess return rate are shown in <Table 7> below. 1-(1) to (4) refers to the analytic results based on the FF-3 factor model, while 1-(5)to (8) refer to the 4 factor model with momentum as the additional factor. First, α , which refers to the excess return showed a positive correlation with significance in all models, although the value of coefficients may vary. Firstly for the FF-3 factor model, P1 shows the highest value of 0.770, followed by P2, P4, and P3, each marking 0.762, 0.687, and 0.577, respectively.

It was analyzed that the rates of return are high for the firms with smaller R&D expenditures. The outcomes of R&D expenditures are uncertain, and the impacts are shown in the long-term, rather than short-term, as the expenditure itself is the decision made on long-term investments. It should also be noted that these stocks show higher variability and experience difficulties in securing profit stability. It is consequently considered that the trend of investors tending to invest in portfolios with less R&D expenditures was reflected in the result, as the investors seek capitalistic benefits and therefore prefer stable returns.

In the analysis results from 1-(5) to (8), which analyzed the 4 factor model, the same results were found. In all α s, which refer to the intercepts of the estimation model, a statistically significant positive (+) coefficient was found. The order of the larger alpha was the same as the result in the 3 factor model. More specifically, it was in the order of P1(0.65) > P2(0.64) > P4(0.63) > P3(0.37).

Table 7 Main Result

Model	1-(1)	1-(2)	1-(3)	1-(4)
Portfolio	P1	P2	P3	P4
α	0.770(3.53)***	0.762(3.94)***	0.577(2.76)***	0.687(3.59)***
RMRF	0.950(19.88)***	0.879(17.64)***	0.924(19.38)***	0.991(21.79)***
SMB	0.595(11.49)***	0.625(11.76)***	0.587(9.90)***	0.609(9.20)***
HML	0.137(2.90)**	0.175(3.79)***	0.177(3.67)***	0.110(2.12)***
F-stats	325.22***	386.58***	331.71***	450.98***
Adj R^2	0.853	0.873	0.855	0.890
N	168			
Model	1-(5)	1-(6)	1-(7)	1-(8)
Portfolio	P1	P2	P3	P4
α	0.649(3.11)***	0.635(3.14)***	0.366(1.72)*	0.626(3.02)***
RMRF	0.955(19.37)***	0.884(18.55)***	0.932(22.01)***	0.994(22.15)***
SMB	0.610(11.97)***	0.641(12.26)***	0.613(10.56)***	0.616(9.75)***
HML	0.153(3.04)***	0.191(4.20)***	0.204(4.56)***	0.118(2.21)**
MOM	0.107(1.59)	0.113(2.49)**	0.187(3.27)***	0.055(1.34)
F-stats	252.01***	304.02***	279.78***	340.44***
Adj R^2	0.857	0.878	0.869	0.890
N	168			

4.3 Analytic Results on Hypothesis 2

Hypothesis 2 makes a comparative analysis between the excess return rate of companies with stable R&D expenditures and those without. The results are seen in <Table 8> below. The majority of the variables show statistically significant results in every model. More specifically, the excess return rates are in the following order: P3(0.806) > P2(0.793) > P4(0.561) > P1(0.551). This means that P3 and P2 show higher rates of return, compared to P4 and P1, which show more fluctuation. And so the result can be translated into the statement that ‘firms with stable R&D expenditure are evaluated to be better than those with excessive fluctuations in R&D expenditure’.

Table 8 Analysis of Excess Return According to R & D Change

Model	2-(1)	2-(2)	2-(3)	2-(4)
Portfolio	P1	P2	P3	P4
α	0.551(2.82)**	0.793(3.80)***	0.806(4.25)***	0.561(2.81)**
RMRF	0.931(19.44)	0.943(20.75)***	0.970(18.55)***	1.041(21.15)***
SMB	0.562(8.29)***	0.562(8.50)***	0.565(10.89)***	0.700(10.67)***
HML	0.153(3.21)***	0.157(4.03)***	0.084(1.79)*	0.097(1.81)*
F-stats	323.14***	323.58***	305.15***	381.18***
Adj R^2	0.861	0.861	0.854	0.880
N	156			
Model	2-(5)	2-(6)	2-(7)	2-(8)
Portfolio	P1	P2	P3	P4
α	0.475(2.32)**	0.683(3.40)***	0.677(3.43)***	0.502(2.29)**
RMRF	0.926(17.46)***	0.935(20.08)***	0.961(16.65)***	1.037(19.51)***
SMB	0.574(8.86)***	0.580(8.91)***	0.585(11.76)***	0.709(11.67)***
HML	0.163(3.23)***	0.171(4.35)***	0.101(2.15)**	0.105(1.84)*
MOM	0.071(1.25)	0.103(1.44)	0.121(2.07)**	0.055(0.82)
F-stats	244.92***	249.65***	238.43***	286.81***
Adj R^2	0.862	0.865	0.859	0.880
N	156			

5. Conclusion

There exist various reasons for firms to invest in R&D expenditures, but the ultimate objective would lie in increasing the firm value. In this study, we conducted an empirical analysis of the impact of R&D expenditures on the firm value, which has not been used often in previous studies. The analysis aimed to show the amount of excess returns in the capital market, and for this purpose used the data on monthly return rates of stocks from 2000 to 2013.

The results are as follows: Firstly, through the estimation of the monthly rate of return based on portfolios based on the level of R&D expenditures, it was found that the rate of return was higher for the portfolios with less R&D expenditures than for those with more R&D expenditures. This implies that higher R&D expenditures do not necessarily lead to a higher rate of return. Also, this implies that the investors are likely to devalue the profitability and possibility of success of R&D expenditures, which leads to a fall in stock prices of the firm, and a denial of the positive impact of firm value.

Secondly, through analysis of excess return rates depending on the changes in R&D

expenditures, it was found that the rate of return was the highest in the very middle of the portfolio. This means that the investors do not show interest in portfolios in which the R&D expenditures increase or decrease in an excessive manner. On the contrary, it was found that investors would rather assign a bigger premium on firms spending constantly with less fluctuations in R&D. This implies that in the capital market, the firm value would become higher in situations when the firm's R&D expenditure fluctuates less. Relentless innovation is a mandatory virtue for the firms to survive and produce high returns in unforeseeable future environments with rapid technological developments. And so the adoption of technologies and adequate investments in R&D for the sustainment and development of the innovative capability of firms are considered mandatory. The research results suggest that the participants of the capital market may devalue the impact of R&D expenditures in the short term. This implies that the investors may consider an increase in R&D to be negative, as it may lead to a decrease in return from a short-term increase in cost. Also, it can be seen from a different perspective that the investors act sensitively toward excessive R&D expenditures, as they consider it be an investment of intangible assets based on the discretion of the executive. The systematic assessment and analysis of R&D expenditure's impact on firm value is much needed, not only from the academic perspective but also the business perspective of the firm. And it is determined that the research results will be able to provide several useful implications on the policymaking related to investments in R&D. The three restrictions of the study are: Firstly, selection bias may exist in constructing portfolios. For instance, the study divided the portfolio into 4 groups, but selection bias may exist in cases when the portfolio was divided into numbers other than four. Although there were 4 portfolios for effective interpretation of the analysis, the tentative results were found in cases when there were 10 or 3 portfolios, which may act as a major restriction to the study. Secondly, there were no detailed data on R&D research. The number of subject firms were very small despite the time range of data being 14 years, as a large number of companies was shown to spend small or even none on R&D. It is expected that the analysis will further be strengthened when more data are acquired afterward. Thirdly, the study should provide time-series analysis. Due to the limits on range of research only the analysis on short-term rates of return was conducted. However, it is expected that the analysis of long-term rates of return will also show significant implications, as R&D expenditures tend to show impact over a longer term. These details are to be covered in forthcoming studies.

Received 19. Dec. 2016, Accepted 27. Feb. 2017

Reference

- Aboody, D. and B. Lev, 1998, The value relevance of intangibles: The case of software capitalization, *Journal of Accounting Research* 36, 161-191.
- Ahn, H. B., 2002, Do R&D information can explain B/M phenomenon in Korean stock market?, *Korean Business Review* 31, 655-678. (In Korean)
- Ahn, Y. Y., H. H. Shin and J. H. Chang, 2005, The impact of R&D expenditures on financial analysts' forecast accuracy and forecast demands, *Korean Accounting Review* 30, 1-23. (In Korean).
- Bae, C. and D. Kim, 2003, The effect of R&D investments on market value of firms: evidence from the U.S., Germany, and Japan, *Multinational Business Review* 11, 51-75.
- Balkin D. B., G. D. Markma and L. R. Gomez-Mejia, 2000, Is CEO pay high-technology firms related to innovation?, *Academy of Management Journal* 43, 1118-1129.
- Branch, B., 1974, Research and development activity and profitability : A distributed lag analysis, *Journal of Political Economy* 82, 999-1011.
- Bublitz, B. and M. Ettredge, 1989, The information in discretionary outlays: Advertising, research, and development, *Accounting Review* 64, 108-124.
- Callimaci, A. and S. Landry, 2004, Market valuation of research and development spending under canadian GAAP, *Canadian Accounting Perspectives* 3, 33-53.
- Carhart, M., 1997, On Persistence in Mutual Fund Performance, *Journal of Finance* 52, 57-82.
- Cazavan-Jeny, A. and J. Thomas, 2003, Value relevance of R&D reporting: A signalling interpretation, Working Paper, University Paris IX Dauphine.
- Chan, S. H., J. D. Martin and J. W. Kensinger, 1990, Corporate research and development expenditures and share value, *Journal of Financial Economics* 26, 255-276.
- Chauvin, K. W. and M. Hirschey, 1993, Advertising, R&D expenditures and the market value of the firm, *Financial Management* 22, 128-140.
- Chen, S. S. and H. Kim, 1997, Market response to product-strategy and capital-expenditure announcements in Singapore: investment opportunities and free cash flow, *Financial Management* 26, 82-88.
- Cho, S., 1992, Agency costs, management stockholding, and research and development expenditures, *Seoul Journal of Economics* 5, 127 - 152.
- _____ and J. Y., Chung, 2001, The effect of R&D expenditures on subsequent earnings, *Korean Business Review* 30, 289-313. (In Korean).
- Choi, J. S., 2009, Time-series analysis on the lagged economic effects of R&D expenditures, *Korean accounting reviews* 34, 67-105. (In Korean)
- Coombs, J. E. and P. E. Bierly, 2006, Measuring technological capability and performance, *R&D Management* 36, 421-438.
- Connolly, R. A. and M. Hirschey, 1990, Firm size and R&D effectiveness: A value-based test, *Economic Letters* 32, 277-281.

- Doukas, J. and L. N. Switzer, 1992, The stock market's view of R&D spending and market concentration, *Journal of Economics and Business*, 44, 95-114.
- Eom, C. J., 2012, Re-examination on cross-section of expected stock returns under up/down market conditions, *Asian Review of Financial Research* 25, 599-639. (In Korean)
- Eberhart, A. C., W. F. Maxwell and A. R. Siddique, 2004, An examination of long - term abnormal stock return and operating performance following R&D increases, *Journal of Finance* 59, 623-649.
- Fama, E. F. and K. R. French, 1992, The cross-section of expected stock returns, *Journal of Financial Economics* 47, 427-465.
- _____, 1993, Common risk factors in the returns on bonds and stocks, *Journal of Financial Economics* 33, 3-56.
- Foster, R. N., 2003, Corporate performance and technological change through investor's eyes, *Research-Technology Management* 46, 36-43.
- Grabowski, H. G. and D. G. Mueller, 1978, Industrial research and development, intangible capital stocks, and firm profit rates, *Bell Journal of Economics* 9, 328 - 343.
- Han, B. H., 2001, The evaluation of value-relevance of R&D and advertising expenditures: Evidence from Korea. Winter Conference of Korean Accounting Association.
- _____ and M. David, 2004, The value-relevance of R&D and advertising expenditures: evidence from Korea, *International Journal of Accounting* 39, 155-173.
- _____, 2006, Market reaction to the Korean R&D accounting rule revision in accordance with the international accounting standards, *Korean Accounting Association* 31, 97-125. (In Korean)
- Hirschey, S. A., 1982, Intangible capital aspects of advertising and R&D expenditure, *Journal of Industrial Economics* 30, 375-390.
- Hirschey, M. and J. J. Weygandt, 1985, Amortization policy for advertising and research and development expenditures, *Journal of Accounting Research* 23, 326-335.
- Jung, J. H., H. Kim and J. E. Kwon, 2008, The effect of technology import and R&D investment on the value of the firm, *Journal of Technology Innovation* 16, 191-213. (In Korean).
- Kam, H. K. and Y. J. Shin, 2014, An empirical study on the relation between capital investments and stock returns in Korea, *Korean Corporation Management Review* 53, 67-84. (In Korean)
- Kho, B. C. and J. W. Kim, 2010, Mutual funds trading and its impact on stock prices, *Korean Journal of Financial Management* 27, 35-62. (In Korean)
- Kim, D. C., 2011, Asset pricing models in the Korean stock markets : A review for the period of 1980~2009, *Asian Review of Financial Research* 24, 167-229.
- Kim, H. K. and Y. Y. Song, 2004, A study on effects of the R&D expenses on business performance, *Tax Accounting Research* 14, 171-193. (In Korean)
- Kim, H. Z. and H. Y., Kang, 2012, A study on the R&D expenditure and corporate value relevance: IMF financial crisis and global crisis: comparison, *Korea Accounting Information* 30, 231-258. (In Korean)

- Kim, J. H., 2007, The impact of R&D accounting information on firm income and Value, *Korea International Accounting Review* 19, 139-156. (In Korean)
- Kim, J. K. and J. S., Seo, 2007, The effect of R&D expenditures on the firm's value, *Korea International Accounting Review* 20, 207-229. (In Korean)
- Kim, M. C. and H. H. Ki, 2009, The impact of the investment of R&D and tangible assets on the firm value: A case of small and medium enterprises, *Korean Small Business Review* 31, 121-137. (In Korean)
- Kim, S. H., 2009, Explaining the cross-section of stock returns: characteristics or risk factors, *Korean Journal of Financial Studies* 38, 289-323. (In Korean)
- Kim, T. H. and Y. T. Byun, 2011, The relationship between idiosyncratic volatility and expected returns in the Korea stock markets, *Korean Journal of Financial Studies* 40, 525-550. (In Korean)
- Kim, Y. Y. and G. K. Shin, 2006, The effect of alternative accounting policy for the R&D of the KOSDAQ venture firms on the value relevance of R&D, *Korean Small Business Review* 28, 157-180. (In Korean)
- Kwon, G. J., 2007, Value relevance of accounting earnings and book value according to R&D expenditure, *Journal of Taxation and Accounting* 8, 9-30. (In Korean)
- Kwon, H. J. and H. C. Lee, 2004, A empirical study of the venture business' R&D expenditure on the enterprise value, *Tax Accounting Research* 15, 85-101. (In Korean)
- Lev, B., 2001, Intangibles: management, measurement and reporting, Washington.
- Lev, B. and P. Zarowin, 1999, The boundaries of financial reporting and how to extend them, *Journal of Accounting Research* 37, 353-386.
- Lev, B. and T. Sougiannis, 1996, The capitalization, amortization, and value-relevance of R&D, *Journal of Accounting and Economics* 21, 107-138.
- Minasian, J. R., 1969, Research and development, production function, and rate of return, *American Review* 59, 80-85.
- Morck, R., A. Shleifer, and R. W. Vishny, 1988, Management ownership and market valuation: an empirical analysis, *Journal of Financial Economics* 20, 293-315.
- _____ and B. Yeung, 1991, Why investors value multinationality?, *Journal of Business* 64, 121-158.
- Park, Y. S. and N. G. Kim, 2007, Corporate governance and firm value : agency costs and efficiency of capital and R&D expenditures, *Korean Business Review* 36, 1203-1232. (In Korean)
- Sonu, S. H. and H. S. Choi, 2011, Capital market anomalies in Korea, *Asian Review of Financial Research* 24, 1231-1284.
- Sougiannis, T., 1994, The accounting based valuation of corporate R&D, *Accounting Review* 69, 44-68.
- Szewczyk, S. H., G. P. Tsetsekos and Z. Zantout, 1996, The valuation of corporate R&D expenditure; evidence from investment opportunities and free cash flow, *Financial Management* 25, 105-110.

Tsolikas, F. and I. Tsalavoutas, 2011, Value relevance of R&D in the UK after IFRS mandatory implementation, *Applied Financial Economics* 21, 957-967.

Weiss, L. W., 1969, Advertising, profits, and corporate taxes, *Review of Economics and Statistics* 51, 421 - 430.