“Are capitalized R&D and expensed R&D costs “sticky”? Korean evidence”

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ARE CAPITALIZED R&D AND EXPENSED R&D COSTS "STICKY"? KOREAN EVIDENCE

Abstract

The purpose of this study is to investigate the cost behavior of research and development (R&D) expenditures. R&D costs can be divided into capitalized R&D expenditures and expensed R&D expenditures. The authors examine the cost behavior of total R&D expenditures, as well as the cost behavior of capitalized and expensed R&D expenditures. In addition, it is investigated how the cost behavior varies depending on company management performance. Research results document that the total cost of R&D and capitalized R&D expenditures are not affected by changes in sales. While the cost of expensed R&D has a positive relationship with sales changes, asymmetric cost behavior does not exist. However, when combined with such factors as successive declines in sales, performance, and economic growth as measured by gross domestic product (GDP), asymmetric cost behavior emerges. In addition, the authors found that companies with high management performance smooth their earnings by expensing R&D expenditures as incurred rather than capitalizing them. For firms with high earnings, cost behavior of total R&D expenditures and capitalized R&D expenditures moves in the opposite direction of sales. That is, companies with high performance have low capitalization ratio of R&D. The results of this study are significant in that they expand the understanding of managers' behaviors regarding R&D expenditures.

Keywords cost behavior, cost stickiness, R&D, agency problem

JEL Classification D24, D25, D82, M41, O32

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INTRODUCTION

R&D is a vital management activity that affects long-term value creation and company growth. As R&D capability is a core competitive edge that determines the future of a company in many industries, companies are making enormous investments in and spending substantial sums of money on R&D.

The level of R&D expenditures is also affected by firm's competitive environment, internal factors, corporate governance structure, and accounting standards. Internally, while financial variables are fundamental factors that determine R&D expenditure, there are also non-financial factors. For example, managers may adjust R&D expenditures as a means of beating their earnings benchmarks. The environments surrounding companies such as tax policies, managers' discretionary smoothing of R&D investments and expenditures, economic fluctuations, and management strategies also affect company's R&D expenditures.

Since R&D expenditures represent a critical investment decision that helps determine company's long-term performance, they are also known to be affected by external monitors such as institutional investors, foreign investors, outside directors and auditors, and governance

structure, including CEOs or managers. Nonetheless, there are few studies on how managers' R&D investments and expenditures change in terms of R&D cost behavior.

The asymmetric cost behavior is a result of various behaviors such as agency cost, earnings management and expectation of future sales increases (Anderson et al., 2003; Anderson et al., 2007; Banker & Chen, 2012; Kama & Weiss, 2013). This cost behavior includes important signal function to examine the manager's motivation. Therefore, this study examines how managers use R&D costs through cost behavior of R&D costs.

This study investigates managers' R&D spending decision-making behaviors by separating total R&D costs and expenditures into "capitalized R&D" expenditures and "expensed R&D" expenditures. "Expensed R&D" refers to R&D expenditures that are expensed as they are incurred rather than being capitalized and expensed through the amortization process, since the effects on firm profits or earnings for the period are different. In addition, analyzing the effects of the management environment on cost behavior of R&D investments and expenditures will broaden our understanding of managers' behaviors.

The results of the study show that total R&D costs and capitalized R&D expenditures were not affected by sales changes. However, expensed R&D expenditures were positively (+) associated with sales changes and asymmetric cost behavior did not exist. However, when combined with such factors as steady decline in sales, performance, and economic growth (GDP), asymmetric cost behavior emerged.

Although asymmetric cost behavior is a very important signal representing manager's motivation, there is no study yet on the cost behavior of R&D costs (Anderson & Lanen, 2009). This is because it is difficult to acquire the data, because the R&D costs are all expensed in many countries. We analyze the cost behavior of R&D costs using unique data from Korea. This study has significance, because it is the first research to analyze the cost behavior of R&D expenditures. The finding that capitalized R&D expenditures have no relationship with changes in sales, while expensed R&D expenditures have a positive relationship with sales can be interpreted as supporting the validity of current accounting standards in Korea where R&D expenditures are treated as intangible assets or expense. This study is also significant in that the asymmetric cost behavior of R&D in relation to successive decreases in sales and performance empirically verifies the association between R&D costs and management performance. We expect that research on the cost behavior of R&D expenditures will help us achieve better understanding of the behavior of R&D spending.

1. LITERATURE REVIEW AND HYPOTHESES

1.1. Literature review on research and development costs

To hit earnings targets, managers adjust their capital expenditures or expenses based on their business performance. R&D expenditures generally involve very large amounts and are perceived as discretionary expenditures, which reflect considerable subjective judgements by firm managers. Therefore, studies have been conducted to examine whether managers adjust R&D spending as a means of managing corporate earnings.

Considering adjustment of R&D expenditures as an alternative to discretionary earnings management, Baber et al. (1991) found that managers reduce R&D expenditures when they find it difficult to achieve a positive net profit or positive net profit growth rate, and that they make discretionary decisions about R&D spending to facilitate their own compensation arrangements.

Offering evidence that companies with higher than expected earnings (companies with earnings surprises) temporarily manage earnings downward by raising R&D spending, while companies with earnings below expected earnings do not manage earnings with R&D spending. Perry and Grinaker (1994) demonstrated that managers reduce R&D

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spending as a means of earnings management to match performance targets. In addition, managers reduce the scale of R&D spending to mitigate the pressure on them to achieve short-term earnings by beating established earnings benchmarks (Gunny, 2010; Osma & Young, 2009).

Studies on earnings management have also been conducted using R&D spending by newly listed companies with high probability of earnings management. Though some managers of newly listed companies reduce R&D spending (Darrough & Rangan, 2005), because investors are more interested in the company's current earnings than in R&D spending, the perception of R&D has an effect not only on short-term outcomes, but also on long-term management performance of newly listed companies (Guo et al., 2006).

As seen above, earnings management through R&D spending is conducted not only by adjusting actual expenditures, but also by manipulating the accounting treatment of R&D spending. For example, some managers in the 1980s used accounting methods for R&D expenditures that allowed room for discretionary intervention to make management performance and their companies' financial status appear sound. Cho (1997) argued that the higher the debt ratio and R&D expenditures of companies, the more they prefer capitalization of R&D expenditures, while companies under regulations prefer to partially expense R&D expenditures. Furthermore, the greater the debt ratio's growth rate, the smaller the profit than expected earnings, the lower the corporate tax burden, the bigger the growth rate of R&D expenditures, and the farther a company is from being a market dominator, the more managers of companies favor capitalization of R&D expenditures. In addition, preferences differed depending on technological characteristics as documented by Australian firms, which showed that the higher the technological competitiveness, the longer the technological cycles and the higher the level of intellectual property rights, the more they preferred capitalization (Wyatt, 2005).

As discussed above, accounting treatment of R&D spending is determined by various characteristics of companies, and companies make discretionary accounting choices as a tool for managing earnings.

1.2. Literature review on cost behavior

According to cost classifications based on traditional cost behaviors, variable costs refer to costs that increase or decrease in total amount in proportion to increases or decreases in levels of activity. Fixed costs are costs that are consistent in total amount irrespective of increases or decreases in activity level within the relevant range and assuming no fluctuations in external factors, such as price changes. That is, costs are classified as variable costs and fixed costs based only on changes in total cost caused by changes in activity level, and this classification method assumes that the level of increase/decrease in cost caused by the change in unit activity is the same. This concept is called a proportional cost model (Noreen & Soderstrom, 1997).

Asymmetric cost behavior can be explained both by "cost stickiness", which refers to the phenomenon that the cost reduction rate at the time of sales decrease is smaller than the cost increase rate at the time of sales increase, and by "cost anti-stickiness", where the cost reduction rate when sales decrease is larger than the cost increase rate when sales increase. This asymmetric cost behavior is caused by the fixed nature of costs, managers' failure to control costs, managers' economic decision-making regarding resource maintenance when sales decrease, and the relationship between adjusted costs and managers' decision-making (Anderson et al., 2003; Anderson et al., 2007; Banker & Chen, 2012; Kama & Weiss, 2013).

Anderson et al. (2003) defined this proportional cost model as symmetric cost behavior, which presumes that the cost increase rate at the time of sales increase is the same as the cost decrease rate at the time of sales decrease. Asymmetric cost behavior, which is the opposite of symmetric cost behavior, is divided into "sticky cost behavior", which refers to the phenomenon that the cost increase rate is larger when sales increase than the cost decrease rate when sales decrease, and "anti-sticky cost behavior", where the cost decrease rate when sales decrease is larger than the cost increase rate when sales increase.

Anderson et al. (2003) who identified asymmetric cost behavior argued that this asymmetry

stems from difference in the speed of managers' decision-making in adjusting corporate resources between increases and decreases of resources. Analyzing asymmetric cost behaviors of American, British, German, and French companies, Calleja et al. (2006) asserted that French and German companies show more sticky cost behaviors than their American and British counterparts due to differences in their corporate governance structures and management systems. In addition, they argued that corporate and industrial characteristics also affect cost stickiness.

Anderson and Lanen (2009) contended that the assumption in preceding studies that sticky cost behavior stems from managers' decision-making is theoretically weak, since sticky behavior of SG&A costs was statistically significant, although weak. As the grounds for their argument, the authors presented the fact that other types of cost items (e.g., labor costs, R&D costs, and costs related to tangible assets) affected by managers' decisions are not consistent in their cost stickiness.

Banker et al. (2014) pointed out the relationship between adjusted cost and managers' decision-making as the cause of asymmetric cost behavior. Here, the subject of managers' decision-making is sticky resources, which are resources that can be adjusted in the short term, but carry resource adjustment costs with the characteristics of neither fixed costs nor variable costs. They claimed that the factors affecting decisions about resource adjustment are sales for the term, previous level of resources influencing the resource adjustment cost of the current term, expected future sales influencing the future resource adjustment cost, agency problems, and behavioral factors.

If R&D investments and expenditures are adjustment costs, managers can maintain unused resources related to R&D that incur adjustment costs at the time of demand decrease. At the time of demand increase, however, managers can respond to demand only when they acquire the resources necessary for R&D. At the time of demand increase, managers may not increase resources if hefty R&D costs are required to secure labor and equipment resources. Thus, sales will increase at lower level than demand as sales growth will be limited by the capacity of R&D resources.

Like the theory of constraints, the theory of asymmetric cost behavior argues that resource capacity is composed of large number of implicit activity resources, including indirect labor resources, which can potentially cause bottlenecks, as well as problems of facility capacity. The difference between facility capacity and activity resources is that while facility capacity is often impossible to adjust in the short term owing to high adjustment cost, activity resources can be adjusted in the short term. The difference between the two theories is that while the theory of constraints focuses on efficient use of available resources by controlling bottlenecks at the current resource level, the theory of asymmetric cost behavior concentrates on efficient adjustment of resource levels in response to changes in activity.

2. HYPOTHESES

While increases or decreases in costs have traditionally been assumed to be symmetrical regardless of activity levels such as sales, Noreen and Soderstrom (1997) suggested the existence of asymmetric cost behavior. Finally, Anderson et al. (2007) demonstrate empirically that the asymmetric cost behavior exists using the SG&A costs. Since then, numerous studies have researched the cause of asymmetric cost behavior (Anderson et al., 2007; Chen et al., 2012; Kama & Weiss, 2013; Banker et al., 2014).

Researchers consider that there are three main causes of asymmetric cost behavior. The first cause is that, at the time of decrease in sales, managers try to reduce future committed resources by maintaining resources without reducing SG&A costs based on the expectation of future sales increases. The second cause is that asymmetric cost behavior is produced because of agency costs. The last cause is that asymmetric cost behavior is produced as a result of earnings management (Anderson et al., 2007; Kama & Weiss, 2013). R&D costs are key financial information that indicates expectations for future performance, agency costs, and earnings management (Roychowdhury, 2006).

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Research on the above has primarily focused on SG&A costs and their components. Roychowdhury (2006) argued that, among the items of SG&A costs, managers use the greatest level of discretion on R&D expenditures, which are often used to manage earnings. Thus, examining the cost behavior of R&D costs holds the potential to provide an in-depth understanding of managers' R&D spending.

If R&D expenditures are simply used as a form of earnings management, R&D costs will demonstrate anti-sticky behavior. In contrast, if R&D expenditures are consistently made regardless of sales, they will not respond to changes in sales. Further, if R&D expenditures respond to sales, but have low fixed factors, they are likely to be sticky.

In addition, R&D costs are divided into capitalized expenditures and expensed expenditures. Unlike the cost of sales and selling, general, and administrative (SG&A) expenses, R&D expenditures do not directly contribute to sales for the period, and these expenditures can be capitalized if certain requirements are met. R&D expenditures are not strongly tied to sales and spending on R&D can be adjusted by manager's discretionary decisions when sales are declining. While managers who focus on long-term value creation and company growth tend to maintain R&D spending, it may be difficult for managers to sustain R&D expenditures at the previous year's level in such difficult situations as when the survival of the company is seriously threatened. Thus, managers' decision-making behavior regarding R&D expenditures, which contribute to long-term management performance, may be different than their behavior in relation to other costs and expenses. Capitalizing R&D costs will increase profits, but expensed R&D expenditures will reduce earnings. Therefore, if R&D costs are used for earnings management, the cost behavior of expensed R&D costs is likely to be anti-sticky.

We disassemble each R&D expenditure and examine them in the form of an auxiliary hypothesis. Since this is an empirical question, we establish the null hypothesis as follows:

H1: R&D costs are not asymmetric cost behavior.

H1.1: Capitalized R&D expenditures are not asymmetric cost behavior.

H1.2: Expensed R&D expenditures are not asymmetric cost behavior.

As companies assume that operations will continue, even when sales are in decline, they are induced to make efforts to increase sales while maintaining committed resources rather than immediately reducing them (Anderson et al., 2003). Despite manager's judgment that sales will increase in the future, however, when the survival of the company is uncertain, the manager tends to choose survival of the company rather than maintenance of committed resources.

Specifically, when a company has poor performance, the company becomes short of cash for sales activities, which severely limits its investment activities, as well as normal business activities. Moreover, poor performance may lead to possible dismissal of the manager. In addition, lack of cash flow is highly likely to result in the reduction of resources available for the manager's discretionary use, which will in turn reduce the extent of decision-making ability for the manager's personal interests or future management performance, which further shrinks manager's discretion. Hence, manager's intervention in cost adjustment and decision-making is heavily influenced by management performance. As R&D costs are long-term investments, managers can take the action of actively reducing R&D costs to improve short-term performance. However, as capitalized R&D costs are not treated as expenses in calculating net profit for the period, managers may undertake a strategy of investing more resources in R&D to offset their low management performance. In other words, sticky cost behavior may appear in such cases. Therefore, we establish *H2* as follows:

H2: R&D cost behavior is not affected by the firm performance.

H2.1: Capitalized R&D cost behavior is not affected by the firm performance.

H2.2: Expensed R&D cost behavior is not affected by the firm performance.

3. RESEARCH DESIGN

3.1. Research model

To investigate the cost behavior of R&D costs, we first modify Anderson et al.'s (2003) equation and propose a basic model (equation 1), and then, by modifying the basic model, we establish research model 1 (equation 2) and research model 2 (equation 3) as follows:

Basic model

$$\begin{aligned}&\Delta R\&D_{i,t} = a_0 + a_1 \cdot \Delta SALE_{i,t} + \\ &+a_2 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} + \varepsilon_{i,t}, \\ &\Delta R\&D_{i,t} = b_0 + b_1 \cdot \Delta SALE_{i,t} + \\ &+b_2 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} + \\ &+b_3 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot ROA_{i,t} + \varepsilon_{i,t}.\end{aligned} \quad (1)$$

Research model 1

$$\begin{aligned}&\Delta R\&D_{i,t} = a_0 + a_1 \cdot \Delta SALE_{i,t} + \\ &+a_2 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} + \\ &+a_3 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot SUCCE_{i,t} + \\ &+a_4 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot ASSET_{i,t} + \\ &+a_5 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot EMP_{i,t} + \\ &+a_6 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot GDP_{k,t} + \\ &+\sum IND + \varepsilon_{i,t}.\end{aligned} \quad (2)$$

Research model 2

$$\begin{aligned}&\Delta R\&D_{i,t} = b_0 + b_1 \cdot \Delta SALE_{i,t} + \\ &+b_2 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} + \\ &+b_3 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot ROA_{i,t} + \\ &+b_3 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot SUCCE_{i,t} + \\ &+b_4 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot ASSET_{i,t} + \\ &+b_5 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot EMP_{i,t} + \\ &+b_6 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot GDP_{k,t} + \\ &+\sum IND + \varepsilon_{i,t}\ .\end{aligned} \quad (3)$$

Extended model

$$\begin{aligned}&\Delta R\&D_{i,t} = a_0 + a_1 \cdot \Delta SALE_{i,t} + \\ &+a_2 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} + \\ &+a_3 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot SUCCE_{i,t} + \\ &+a_4 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot ASSET_{i,t} + \\ &+a_5 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot EMP_{i,t} + \\ &+a_6 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot GDP_{k,t} + \\ &+a_7 \cdot SUCCE_{i,t} + a_8 \cdot ASSET_{i,t} + \\ &+a_9 \cdot EMP_{i,t} + a_{10} \cdot GDP_{k,t} + \\ &+b_j \cdot \sum IND + \varepsilon_{i,t},\end{aligned} \quad (H1) \quad (4)$$

$$\begin{aligned}&\Delta R\&D_{i,t} = b_0 + b_1 \cdot \Delta SALE_{i,t} + \\ &+b_2 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} + \\ &+b_3 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot ROA_{i,t} + \\ &+b_3 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot SUCCE_{i,t} + \\ &+b_4 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot ASSET_{i,t} + \\ &+b_5 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot EMP_{i,t} + \\ &+b_6 \cdot \Delta SALE_{i,t} \cdot DD_{i,t} \cdot GDP_{k,t} + \\ &+b_7 \cdot ROA_{i,t} + b_8 \cdot SUCCE_{i,t} + \\ &+b_9 \cdot ASSET_{i,t} + b_{10} \cdot EMP_{i,t} + \\ &+b_{11} \cdot GDP_{k,t} + b_j \cdot \sum IND + \varepsilon_{i,t},\end{aligned} \quad (H2) \quad (5)$$

where $\Delta R\&D_{i,t}$ is natural logarithm of change in R&D costs between year t and year t–1; $\Delta R\&DINT_{i,t}$ is natural logarithm of change in capitalized R&D costs between year t and year t–1; $\Delta R\&DEXP_{i,t}$ is natural logarithm of change in expensed R&D costs between year t and year t–1; $\Delta SALE_{i,t}$ is natural logarithm of change in sales between year t and year t–1; DD is 1 if sales of firm i for period t is less than that in the preceding period, otherwise 0; ROA is net income to assets; $SUCCE$ 1 if Sales t–2 > Sales t–1 > Sales t, otherwise 0; $ASSET$ is natural logarithm of ratio of assets to sales; EMP is natural logarithm of ratio of number of employees to sales; GDP is gross domestic product; IND is industry dummy.

In the above research model, the dependent variable is $\Delta R\&D$, which represents the change in research and development expenditures. The

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dependent variable uses both $\Delta R\&DCAP$ and $\Delta R\&DEXP$, which represent the change in capitalized R&D expenditures and expensed R&D expenditures, respectively. The variables of interest are $\Delta SALEi$ and $t{\cdot}DD$. The coefficient a_2 of the variable of interest is a variable representing asymmetric cost behavior. If a_2 has a positive (+) value, its cost behavior is anti-sticky, while if a_2 has a negative (–) value, its cost behavior is sticky. The value of a_2 is used to test hypothesis 1. In addition, the result of hypothesis 2 can be verified by the value of b_3. As in the case of a_2, b_3 has a positive (+) value if the cost behavior of R&D expenditure is anti-sticky and has a negative (–) value if the cost behavior of R&D expenditure is sticky. For control variables, the following variables were added by referring to the study by Anderson et al. (2003). The first variable is *SUCCE*, which represents successive decrease in sales. Anderson et al. (2003) argued that a continuous decrease in sales weakens cost stickiness, because managers are tempted to actively reduce costs. In addition, asset concentration, labor concentration, and the economic growth rate independently affect asymmetric cost behavior (Anderson et al., 2003). Thus, we establish the final model by adding these variables to the control variables. Moreover, Dierynck et al. (2012) mentioned that it is necessary to include lower degree of cost asymmetry in the model. Therefore, we conduct robustness analysis using the extended model.

3.2. Sample selection

The sample is selected from firms in Korea listed on the KSE and KOSDAQ from 2011 to 2016. We select companies that meet the following conditions:

1) companies listed in KOSPI from 2010 to 2016 (n = 14,886);
2) non-financial companies (n = 13,722);
3) companies that close their books in December (n = 13,527);
4) companies with data available for analysis of KIS-VALUE (n = 10,959);
5) companies with R&D cost data available (n = 1,106).

To compile our sample, we use all available firm-year observations from KIS-VALUE and firm's business report from firms in Korea listed on the KSE and KOSDAQ. We exclude firm-year observations from the financial industry and companies, which do not close their books in December, are excluded from the sample due to lack of comparability. In addition, companies for which financial data and R&D data cannot be collected and companies with impaired capital are excluded from the sample, since their management strategies may be different from those of ordinary companies. Our final sample covers the period 2012–2016 and consists of 1,106 firm-year observations with available one-year-ahead and dependence variables.

4. RESULTS

4.1. Descriptive statistics

Table 1 reports the descriptive statistics of the variables used in the research model. Some extreme values exist in the distribution of certain variables. Therefore, we use winsorized values at 1% and 99% for all variables except dummy variables to control for the effects of extreme values on the analysis.

The average value of $\Delta R\&D$, which indicates the change in R&D costs, is 0.0203. This shows that, on average, R&D expenditures of the companies are growing by 2% from the previous year. On the other hand, capitalized R&D expenditures are –0.0724 and expensed R&D are 0.0625, which shows that the capitalized ratio of R&D expenditure is decreasing, and the expensed ratio is increasing each year. Other variables show similar results to those of preceding studies.

Table 2 shows the correlations among the variables used in this study. Only R&D expenditures and expensed R&D costs are highly correlated. Expense treatment of R&D expenditures appears comparatively reasonable based on the principle of matching costs with revenues.

Tables 3, 4, and 5 show the cost behavior of R&D expenditures to evaluate hypothesis 1 of this study, and present regression results of the basic model, research model and extended model, respective-

Table 1. Descriptive statistics (n = 1,106)

Variables	Mean	Std.	Min	1Q	Median	3Q	Max
ΔR&D	0.0203	0.3841	–1.3161	–0.1366	0.0426	0.2095	1.2281
ΔR&DINT	–0.0724	0.9607	–3.5687	–0.4637	–0.0244	0.3582	2.9216
ΔR&DEXP	0.0625	0.6019	–2.0047	–0.1511	0.0715	0.2729	2.4883
ΔSALE	0.0111	0.2893	–1.0246	–0.1120	0.0222	0.1326	0.9732
ASSET	0.4796	0.6040	–0.6032	0.0421	0.3988	0.7917	2.4945
EMP	–19.6980	0.7394	–21.5255	–20.1895	–19.6838	–19.1906	–17.9155
DD	0.4485	0.4976	0.0000	0.0000	0.0000	1.0000	1.0000
SUCCE	0.2215	0.4155	0.0000	0.0000	0.0000	0.0000	1.0000
GDP	0.0280	0.0031	0.0230	0.0280	0.0280	0.0290	0.0330
ROA	–0.0087	0.1074	–0.4724	–0.0377	0.0161	0.0530	0.1580

Table 2. Correlation matrix (n = 1,106)

Variables	*ΔR&D*	*ΔR&DINT*	*ΔR&DEXP*	*ΔSALE*	*ASSET*	*EMP*	*DD*	*SUCCE*	*GDP*	*ROA*
ΔR&D	1.000	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–
ΔR&DINT	0.495	1.000	–	–	–	–	–	–	–	–
	< .0001	–	–	–	–	–	–	–	–	–
ΔR&DEXP	0.506	–0.091	1.000	–	–	–	–	–	–	–
	< .0001	0.002	–	–	–	–	–	–	–	–
ΔSALE	0.037	–0.047	0.130	1.000	–	–	–	–	–	–
	0.225	0.117	< .0001	–	–	–	–	–	–	–
ASSET	–0.044	0.012	–0.043	–0.178	1.000	–	–	–	–	–
	0.141	0.685	0.151	< .0001	–	–	–	–	–	–
EMP	–0.029	0.003	–0.025	–0.143	0.588	1.000	–	–	–	–
	0.337	0.916	0.401	< .0001	< .0001	–	–	–	–	–
DD	–0.067	0.012	–0.114	–0.675	0.095	0.061	1.000	–	–	–
	0.026	0.684	0.000	< .0001	0.002	0.042	–	–	–	–
SUCCE	–0.104	–0.025	–0.086	–0.386	0.073	0.026	0.592	1.000	–	–
	0.001	0.409	0.004	< .0001	0.015	0.383	< .0001	–	–	–
GDP	–0.027	0.034	–0.033	0.028	0.032	0.006	–0.034	0.024	1.000	–
	0.376	0.258	0.276	0.353	0.292	0.846	0.259	0.432	–	–
ROA	0.110	0.061	0.049	0.342	–0.301	–0.293	–0.318	–0.285	–0.019	1.000
	0.000	0.042	0.101	< .0001	< .0001	< .0001	< .0001	< .0001	0.536	–

ly. Total R&D expenditures and capitalized R&D expenditures are not related to sales. On the other hand, expensed R&D expenditures are highly related to sales, but do not exhibit asymmetric cost behavior. This suggests that managers expense R&D expenditures as incurred in proportion to increases and decreases in sales, which means that there is a relatively low tendency for earnings management and agency costs in R&D expenditures. On the other hand, by showing that capitalized R&D expenditures do not immediately contribute to sales, the tables demonstrate that accounting treatment is conducted in a relatively reasonable manner.

Tables 6, 7, and 8 show the cost behavior of R&D expenditures according to management performance, which is hypothesis 2 of this study, and presents regression results of the basic model, research model, and extended model, respectively. For companies with high management performance, cost behavior of total R&D expenditures and capitalized R&D expenditures moves in the opposite direction of sales. That is, companies with high management performance have low capitalization ratio of R&D. This shows that companies with high performance are less inclined to capitalize R&D expenditures, which seems to result from managers' efforts to lower tax burdens and smooth earnings by deferring future performance.

In Anderson et al.'s (2003) model, where the dependent variable is SG&A cost, the explanatory power of the regression equation (R-squared val-

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Table 3. Results of basic model (*H1*)

Variables	*ΔR&D*		*ΔR&DINT*		*ΔR&DEXP*	
	Coeff.	**(t-stat.)**	**Coeff.**	**(t-stat.)**	**Coeff.**	**(t-stat.)**
Intercept	0.0248	(1.58)	–0.0798	(–2.04)**	0.0542	(2.22)**
ΔSALE	0.0220	(0.32)	–0.1093	(–0.64)	0.2988	(2.83)***
ΔSALE·DD	0.0522	(0.48)	–0.0930	(–0.34)	–0.0543	(–0.32)
IND	No		No		No	
Adj. *R*-square	0.000		0.001		0.015	
Obs.	1,106		1,106		1,106	

Notes: *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively.

Table 4. Results of research model (*H1*)

Variables	*ΔR&D*		*ΔR&DINT*		*ΔR&DEXP*	
	Coeff.	**(t-stat.)**	**Coeff.**	**(t-stat.)**	**Coeff.**	**(t-stat.)**
Intercept	0.0178	(0.68)	–0.1241	(–1.90)*	0.0850	(2.10)**
ΔSALE	0.0219	(0.31)	–0.0814	(–0.46)	0.2932	(2.71)***
*ΔSALE·**DD***	–1.2181	(–0.59)	0.2775	(0.05)	–1.1662	(–0.36)
*ΔSALE·DD·**SUCCE***	0.3116	(2.64)***	0.3933	(1.32)	0.3295	(1.79)*
*ΔSALE·DD·**ASSET***	0.0136	(0.13)	0.0884	(0.34)	–0.0648	(–0.40)
*ΔSALE·DD·**EMP***	–0.0053	(–0.05)	0.1188	(0.48)	0.0614	(0.40)
*ΔSALE·DD·**GDP***	36.6408	(2.01)**	57.2055	(1.25)	80.3281	(2.83)***
IND	Yes		Yes		Yes	
Adj. *R*-square	0.004		0.000		0.019	
Obs.	1,106		1,106		1,106	

Notes: *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively.

Table 5. Results of extended research model (*H1*)

Variables	*ΔR&D*		*ΔR&DINT*		*ΔR&DEXP*	
	Coeff.	**(t-stat.)**	**Coeff.**	**(t-stat.)**	**Coeff.**	**(t-stat.)**
Intercept	0.1167	(0.24)	–0.3886	(–0.32)	0.5668	(0.76)
ΔSALE	–0.0104	(–0.14)	–0.1482	(–0.81)	0.3001	(2.65)***
*ΔSALE·**DD***	–0.7809	(–0.34)	–0.5395	(–0.09)	0.0928	(0.03)
*ΔSALE·DD·**SUCCE***	0.1009	(0.68)	0.1430	(0.38)	0.2763	(1.19)
*ΔSALE·DD·**ASSET***	–0.0516	(–0.44)	0.1118	(0.38)	–0.1819	(–1.00)
*ΔSALE·DD·**EMP***	0.0101	(0.09)	0.1394	(0.50)	0.1267	(0.73)
*ΔSALE·DD·**GDP***	35.1681	(1.70)*	104.5084	(2.01)**	83.1651	(2.58)**
SUCCE	–0.0824	(–2.13)**	–0.1223	(–1.25)	–0.0152	(–0.25)
ASSET	–0.0481	(–1.70)*	0.0120	(0.17)	–0.0698	(–1.58)
EMP	0.0039	(0.16)	0.0161	(0.27)	0.0254	(0.69)
GDP	0.6464	(0.15)	21.4309	(2.04)**	1.8514	(0.28)
IND	Yes		Yes		Yes	
Adj. *R*-square	0.009		0.000		0.018	
Obs.	1,106		1,106		1,106	

Notes: *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively.

ue) is 33-39%, but the explanatory power of the regression equation is lower in our research model, where the dependent variable is R&D expenditures. Low R-squared value supports the result of this study that R&D expenditures are proportionately expensed as sales increase, without asymmetric cost behavior. In addition, unlike Anderson et al.'s (2003) model, analysis using Dierynck et al.'s (2012) model including lower degrees provides partial support for the results of this study. Therefore, regarding the disappearance of the significance of Δ*SALE·DD·ROA* in Table 8 (*H2*), further study in the future is required regarding the validity of the research model.

Table 6. Results of basic model (*H2*)

Variables	*ΔR&D*		*ΔR&DINT*		*ΔR&DEXP*	
	Coeff.	**(t-stat.)**	**Coeff.**	**(t-stat.)**	**Coeff.**	**(t-stat.)**
Intercept	0.0197	(1.25)	–0.0933	(–2.37)**	0.0513	(2.09)**
ΔSALE	0.0344	(0.51)	–0.0762	(–0.45)	0.3058	(2.89)***
ΔSALE·DD	–0.0991	(–0.80)	–0.4948	(–1.59)	–0.1384	(–0.71)
ΔSALE·DD·ROA	–1.0382	(–2.44)**	–2.7580	(–2.59)***	–0.5774	(–0.87)
IND	No		No		No	
Adj. *R*-square	0.004		0.006		0.015	
Obs.	1,106		1,106		1,106	

Notes: **, *** represent significance at the 5%, and 1% levels, respectively. 5%, and 1% levels, respectively.

Table 7. Results of research model (*H2*)

Variables	*ΔR&D*		*ΔR&DINT*		*ΔR&DEXP*	
	Coeff.	**(t-stat.)**	**Coeff.**	**(t-stat.)**	**Coeff.**	**(t-stat.)**
Intercept	0.0142	(0.55)	–0.1356	(–2.07)**	0.0847	(2.09)**
ΔSALE	0.0301	(0.43)	–0.0549	(–0.31)	0.2940	(2.71)***
ΔSALE·DD	–1.3601	(–0.66)	–0.1814	(–0.03)	–1.1805	(–0.37)
ΔSALE·DD·ROA	–0.7712	(–1.74)*	–2.4933	(–2.24)**	–0.0775	(–0.11)
ΔSALE·DD·SUCCE	0.2698	(2.24)**	0.2582	(0.85)	0.3253	(1.73)*
ΔSALE·DD·ASSET	0.0061	(0.06)	0.0643	(0.24)	–0.0655	(–0.40)
ΔSALE·DD·EMP	–0.0144	(–0.14)	0.0893	(0.36)	0.0605	(0.39)
ΔSALE·DD·GDP	32.4197	(1.76)*	43.5596	(0.94)	79.9041	(2.79)***
IND	Yes		Yes		Yes	
Adj. *R*-square	0.006		0.000		0.018	
Obs.	1,106		1,106		1,106	

Notes: *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively.

Table 8. Results of extended research model (*H2*)

Variables	*ΔR&D*		*ΔR&DINT*		*ΔR&DEXP*	
	Coeff.	**(t-stat.)**	**Coeff.**	**(t-stat.)**	**Coeff.**	**(t-stat.)**
Intercept	0.2543	(0.52)	0.0095	(0.01)	0.4555	(0.60)
ΔSALE	–0.0081	(–0.11)	–0.1410	(–0.77)	0.3038	(2.68)***
ΔSALE·DD	–0.7986	(–0.34)	–0.6006	(–0.10)	–0.0235	(–0.01)
ΔSALE·DD·ROA	–0.4097	(–0.77)	–1.2480	(–0.93)	–0.5191	(–0.62)
ΔSALE·DD·SUCCE	0.0669	(0.44)	0.0398	(0.10)	0.2411	(1.01)
ΔSALE·DD·ASSET	–0.0365	(–0.31)	0.1547	(0.52)	–0.2037	(–1.11)
ΔSALE·DD·EMP	0.0065	(0.06)	0.1285	(0.46)	0.1200	(0.69)
ΔSALE·DD·GDP	29.8086	(1.43)	88.6388	(1.70)*	82.5923	(2.54)**
ROA	0.2436	(1.60)	0.7041	(1.84)*	–0.2080	(–0.87)
SUCCE	–0.0771	(–1.94)*	–0.1074	(–1.08)	–0.0270	(–0.44)
ASSET	–0.0407	(–1.42)	0.0333	(0.46)	–0.0768	(–1.71)*
EMP	0.0113	(0.47)	0.0376	(0.62)	0.0193	(0.52)
GDP	0.5079	(0.12)	21.0243	(2.01)**	1.8865	(0.29)
IND	Yes		Yes		Yes	
Adj. *R*-square	0.013		0.002		0.016	
Obs.	1,106		1,106		1,106	

Notes: *, **, *** represent significance at the 10%, 5%, and 1% levels, respectively.

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SUMMARY AND CONCLUSION

Research and development is a vital management activity that affects long-term value creation and company growth, and a key indicator of management strategy. A close look at the expenditure behavior of R&D may provide clear understanding of manager's management intentions. A typical method for examining expenditure behavior is to investigate cost behavior. However, no studies have been conducted on the cost behavior of R&D expenditures. Therefore, this study investigated the intention of managers' R&D expenditures by looking into the cost behavior of R&D expenditures. The results of this study are as follows. Total R&D expenditures and capitalized R&D expenditures were not related to sales, while expensed R&D expenditures were highly related to sales.

However, no measure of R&D expenditures demonstrated asymmetric cost behavior. This suggests that managers expense R&D expenditures as incurred in proportion to increases and decreases in sales, which means that there is a relatively low tendency for earnings management and agency costs in R&D expenditures.

However, cost behavior of total R&D costs and capitalized R&D expenditures decreases earnings if the company has strong management performance. In other words, companies with strong management performance have lower rate of capitalized R&D expenditures in accordance with changes in sales. This shows that companies with strong management performance are smoothing their earnings by expensing R&D expenditures as incurred instead of capitalizing them. The results of this study make significant contribution to broader understanding of R&D spending behaviors based on the management performance of companies.

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