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Impact of COVID-19 on R&D Cost Stickiness in IT industry

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Abstract

This study aims to examine whether there are some differences in the cost stickiness of R&D expenses of IT companies before and after the COVID-19 crisis. Before COVID-19, IT companies did not reduce R&D expenses even if sales decreased, resulting in cost stickiness. As a result, it appears that during the COVID-19, IT companies adjust R&D expenses in proportion to changes in sales. This is interpreted as a reduction in R&D investment, which takes a long time to create results, in case of a decrease in sales due to uncertainty in future management performance due to the COVID-19 pandemic. In other words, during the COVID-19 risk period, IT companies, like other companies, reduced R&D expenses as sales decreased, resulting in reduced cost stickiness. This study differs from existing literature in that it examines the impact of the COVID-19 pandemic on the R&D expenditure behavior of companies in the IT industry.

Keywords: *COVID-19, R&D, Cost stickiness, IT industry*

1. Introduction

Before the COVID-19 crisis, IT companies tend not to reduce R&D expenses even if sales decreased, which results in cost stickiness. However, during the COVID-19 pandemic period, IT companies also reduce R&D expenses if sales decreases. In other words, cost stickiness will disappear. Due to the COVID-19, future management performance is unpredictable and financial conditions such as liquidity crisis are poor.

Prior studies that have focused on the causes of cost asymmetry and show that resource adjustment costs, managers' incentives, and prospects affect cost asymmetry. This study differs from previous studies in that it examines the effect of the COVID-19 pandemic on the R&D expenditure behavior of companies in the IT industry.

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2. Review of Previous Studies and Hypotheses

Traditionally, it was assumed that cost changes symmetrically according to changes in the number of operations, but recent studies report the discovery of asymmetric cost behavior. Cooper and Kaplan (1998) and Noreen and Soderstrom (1997) argued that when the operating degree increases, the cost increase, but the cost does not decrease when the number of operations decreases [1-2]. Anderson et al. (2003) reported that the rate of decrease in sales and administrative expenses when sales decreases are smaller than the increase in sales and administrative expenses when sales increase in US companies, that is, there is a downward rigorous cost behavior of sales administration corruption [3]. Ahn et al. (2004) found that when the Anderson et al. (2003) model was applied to domestic manufacturing companies, there was downward rigidity in sales and management expenses and manufacturing expenses [4].

Since Anderson et al. (2013) reported that corporate characteristics such as adjustment cost and corporate financial environment are related to downward cost stickiness. If you immediately dispose of surplus resources when sales decrease and replenish them when sales increase in the future, then the downward cost stickiness may occur because the adjustment cost incurred for replenishment is higher.

Chang and Paik (2009) reported that financial and business conditions related to growth affect cost asymmetry [5]. Specifically, the higher the ratio of cash flows from operating activities to the net income, the higher the current ratio, the more rigid the R&D investment cost behavior, whereas the higher the debt ratio, the more cost stickiness. Koo et al. (2009) found that the cost stickiness was alleviated in the companies whose sales continued to decline compared to those whose sales temporarily decreased [6]. Ahn et al. (2004) found [4] that cost stickiness exists in sales and management expenses and manufacturing expenses when applying the Anderson et al. (2003) model to domestic manufacturing companies. On the other hand, managerial incentives also cause asymmetrical costs.

Managers' future outlook also causes asymmetric cost behavior. If we are optimistic about sales, even if sales decrease, we do not immediately reduce costs, but maintain idle resources, resulting in a downward cost stickiness. It was found that the more optimistic a manager had an error of expectation [7], and the manager had an overconfidence tendency [8], the stronger the downward cost stickiness. Before the Covid-19, even if future management performance declined, managers in the IT industry could reduce R&D expenses less than those in other industries (i.e. have higher downward cost stickiness). However, as the future business outlook is uncertain due to the Covid-19 [9] and faced with problems such as liquidity crisis, IT companies will appropriately reduce R&D investment when sales decrease (i.e. downward cost stickiness is expected to decrease).

Hypothesis: COVID-19 will affect the R&D spending behavior of companies in the IT industry.

3. Sample Selection and Research Method

This study aim to examine whether there is a difference in cost stickiness of R&D expenditures of IT companies before and after the COVID-19 crisis. The following equation (1) was established based on the models used in Anderson et al. (2003) [3] and Kwon et al. (2018) [10].

$$\begin{aligned} \ln(R\&D_t/R\&D_{t-1}) = {} & \beta_0 + \beta_1 \ln(SALES_t/SALES_{t-1}) + \beta_2 DEC_t \times \ln(SALES_t/SALES_{t-1}) \\ & + \beta_3 DEC_t \times \ln(SALES_t/SALES_{t-1}) \times IT_t \\ & + \beta_4 DEC_t \times \ln(SALES_t/SALES_{t-1}) \times \ln SIZE_t \\ & + \beta_5 DEC_t \times \ln(SALES_t/SALES_{t-1}) \times LEV_t \end{aligned} \quad (1)$$

$$+ \beta_6 DEC_t \times \ln(SALES_t/SALES_{t-1}) \times lnEMP_t$$
$$+ \beta_7 DEC_t \times \ln(SALES_t/SALES_{t-1}) \times lnAST_t$$
$$+ \beta_8 DEC_t \times \ln(SALES_t/SALES_{t-1}) \times DEC2_t$$
$$+ \beta_9 IT_t + \beta_{10} lnSIZE_t + \beta_{11} LEV_t + \beta_{12} lnEMP_t + \beta_{13} lnAST_t + \beta_{14} DEC2_t$$
$$+ \sum quarter + \varepsilon$$

In Equation (1) above, $\ln(R\&D_t/R\&D_{t-1})$ is the rate of change in R&D expenses, and $\ln(R\&D_t/R\&D_{t-1})$ is the rate of change in sales. To have a cost stickiness behavior, the regression coefficient β1 for the change in sales have a significantly positive (+) value, and β_2, which means the decrease in sales, and show a significant negative (-) value. Conversely, if you have an elastic cost stickiness behavior, β_1 will show a significant positive (+) value, and β_2 will also show a significantly positive (+) value. The variable of interest is $DEC_t \times \ln(SALES_t/SALES_{t-1}) \times IT_t$. If a company in the IT industry has a greater cost stickiness of R&D expenditure than a company that does not belong to the IT industry, β_3 is a significant negative value, If the cost stickiness elasticity is large, β_3 will have a significant positive value. According to prior research, the IT industry of Manufacture of electronic components, computer, visual, sounding, and communication equipment, Computer programming, consultancy, related activities, information service activities, software development, and software publishing [11], and companies in these industries give IT a value of 1, otherwise, a value of 0. In order to examine if there is a difference in R&D cost stickiness before and after the corona crisis, the sample was divided into the period before the COVID19 crisis and the period of the crisis. This study divided the 2nd-4th quarter of 2019 into the period before the COVID-19 and the 1-3th quarter of 2020 into the period of the COVID-19 crisis.This study divided the 2nd-4th quarter of 2019 into the period before the COVID-19 corona crisis, and the 1-3th quarter of 2020 into the period of the coronavirus crisis.

On the other hand, according to a study by Anderson et al. (2003) that the higher the asset concentration and the higher the employee concentration, the higher the cost stickiness, and according to the study of the employee concentration (lnEMP) and the asset concentration (lnAST) were included as control variables.

Corporate managers have incentives to reduce the cost according to the decrease in sales, as it is not highly likely that sales will increase in the future if sales continue to decrease [12]. Therefore, whether or not the sales decreases for the second consecutive quarter). DEC2 was added to the control variable due to examine whether managers of companies experiencing financial difficulties are expected to be active in reducing resources when sales decrease. Due to the problems such as immediate debt repayment are more urgent for the survival of the company [5].

In this study, we selected the companies listed on the securities market and the KOSDAQ market from the second quarter of 2019 to the third quarter of 2020. In the financial industry, since the format of the financial statements and accounting treatments are different, they were excluded for the homogeneity and limited to December year-end companies. And companies with capital impairment were excluded. According to prior research, companies with zero or zero sales and R&D expenses for the current and previous quarters are also excluded. Companies with R&D expenses greater than sales are also excluded. The observations that meet these conditions are a total of 5,971 firm-quarter data. To mitigate the effect of outliers, all continuous variables are truncated at the top and bottom 1 percent. Financial data obtained through KIS-VALUE. The sample selection process is presented in <Table 1>.

Table 1. Sample Selection

Sample selection procedure	Firm-quarters
Non-financial firms listed on the Korean stock market during 2019. 2Q to 2020. 3Q	12,392
(Less) Firms with non-December fiscal year-ends	(207)
(Less) Firms with impaired capital	(30)
(Less) Firms with zero or no R&D expenses for the previous quarter and the current quarters	(5,482)
(Less) Firms with R&D expenses greater than sales	(198)
(Less) Firms with missing data	(504)
Final sample	5,971

4. Research Results

<Table 2> shows descriptive statistics of variables used in this study. The average of IT_t is 0.256, which means that approximately 26% of the companies are in the IT industry. The average of $R\&D_t/SALE_t$ is 0.049, indicating that R&D expenditure accounts for about 5% of sales. The average of $\ln(R\&D_t/R\&D_{t-1})$ is -0.009. On average On average, companies' R&D expenditures are down 9%. The average of DEC_t is 0.475, which shows that companies whose sales for the current quarter were less than starch accounted for about 48% of the sample. The average of $DEC2_t$ is 0.182, indicating that about 18% of the samples are experiencing sales for the second consecutive quarter.

Table 2. Descriptive statistics

Variables	Mean	Median	STD	Min	Max
IT_t	0.256	0.000	0.436	0.000	1.000
$R\&D_t/SALE_t$	0.049	0.021	0.077	0.000	0.463
$\ln(R\&D_t/R\&D_{t-1})$	-0.009	0.004	0.606	-2.485	2.328
$\ln(SALES_t/SALES_{t-1})$	0.007	0.011	0.360	-1.207	1.263
DEC_t	0.475	0.000	0.499	0.000	1.000
$\ln SIZE_t$	25.968	25.665	1.391	23.785	30.998
LEV_t	0.371	0.369	0.197	0.038	0.838
$\ln EMP_t$	-11.571	-11.572	0.800	-13.504	-9.478
$\ln AST_t$	1.967	1.870	0.727	0.543	4.471
$DEC2_t$	0.182	0.000	0.386	0.000	1.000

Variable definitions: IT_t= indicator variable that takes the value of one if a company belongs to the IT industry; $R\&D_t/SALE_t$= research and development expenses divided by sales; $\ln(R\&D_t/R\&D_{t-1})$= the change of the log of R&D expenses in quarter t; $\ln(SALES_t/SALES_{t-1})$= the change of the log of sales in quarter t; DEC_t= indicator variable that takes the value of one when sales decreased from quarter t-1 to quarter t; $\ln SIZE_t$= logarithm of total assets; $\ln EMP_t$= logarithm of ratio of employees*1,000 to sales; $\ln AST_t$= logarithm of ratio of total assets to sales; $DEC2_t$= indicator variable that takes the value of one if sale had decreased in two consecutive quarters. All continuous variables are winsorized at the 1 percent and 99 percent levels.

<Table3> shows Pearson's correlation among the major variables. First, the correlation between

$\ln(R\&D_t/R\&D_{t-1})$ and $\ln(SALES_t/SALES_{t-1})$ was 0.068, showing a significant positive (+) correlation of 1%. This indicates that companies are spending R&D expenditures linked to the level of sales. And the correlation between IT_t and $R\&D_t/SALE_t$ was 0.133, showing a significantly positive (+) correlation. This means that companies in the IT industry have a higher ratio of R&D expenses to sales than companies in other industries. In addition, IT_t showed a significantly positive (+) correlation with $\ln EMP_t$. This means that companies in IT have more employees compared to their sales than companies in other industries, suggesting that the IT industry is a labor-intensive industry.

Table 3. Pearson Correlations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1)IT_t	1.000	0.133*	-0.009	0.011	-0.014	-0.198*	-0.089*	0.100*	0.019	0.013
(2)$R\&D_t/SALE_t$		1.000	0.094*	-0.125*	0.065*	-0.227*	-0.162*	0.461*	0.412*	0.042*
(3)$\ln(R\&D_t/R\&D_{t-1})$			1.000	0.068*	-0.050*	0.007	-0.010	-0.024	-0.025	-0.017
(4)$\ln(SALES_t/SALES_{t-1})$				1.000	-0.667*	-0.004	0.026	-0.236*	-0.268*	-0.276*
(5)DEC_t					1.000	-0.013	-0.004	0.151*	0.180*	0.496*
(6)$\ln SIZE_t$						1.000	0.171*	-0.466*	-0.094*	-0.011
(7)LEV_t							1.000	-0.132*	-0.212*	0.008
(8)$\ln EMP_t$								1.000	0.557*	0.115*
(9)$\ln AST_t$									1.000	0.132*
(10)$DEC2_t$										1.000

<Table 3> reports Pearson correlations. Variable definitions are in <Table 2>. * denotes statistical significance at the 1% levels.

Table 4. Regression results

Variables	PRE-COVID period		COVID period	
	coefficient	t-stat	coefficient	t-stat
Intercept	-0.086	-0.31	-0.073	-0.26
$\ln(SALES_t/SALES_{t-1})$	0.206	3.75***	0.012	0.22
$DEC_t \times \ln(SALES_t/SALES_{t-1})$	0.642	0.53	-0.424	-0.43
$DEC_t \times \ln(SALES_t/SALES_{t-1}) \times IT_t$	-0.309	-2.11**	0.017	0.17
$DEC_t \times \ln(SALES_t/SALES_{t-1}) \times \ln SIZE_t$	-0.101	-1.71*	0.010	0.23
$DEC_t \times \ln(SALES_t/SALES_{t1}) \times LEV_t$	0.098	0.34	0.338	1.58
$DEC_t \times \ln(SALES_t/SALES_{t-1}) \times \ln EMP_t$	-0.155	-1.38	0.011	0.15
$DEC_t \times \ln(SALES_t/SALES_{t-1}) \times \ln AST_t$	0.045	0.46	0.078	1.11
$DEC_t \times \ln(SALES_t/SALES_{t-1}) \times DEC2_t$	-0.001	-0.01	0.023	0.20
IT_t	-0.068	-2.35**	0.009	0.30
$\ln SIZE_t$	0.001	0.06	0.001	0.11
LEV_t	0.004	0.07	-0.031	-0.45
$\ln EMP_t$	-0.014	-0.66	0.001	0.01
$\ln AST_t$	-0.027	-1.22	0.022	0.97
$DEC2_t$	0.040	1.00	-0.026	-0.68
∑quarter	Included		Included	
Adj.R2	0.0069		0.0174	
N	2,808		3,163	

***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively. T-statistics are reported in the parentheses. All variables are defined in <Table 2>.

<Table 4> is the result of analyzing how Corona affects the R&D expenditure behavior of IT and non-IT companies. The first column of <Table 4> shows the R&D expenditure behavior from the second quarter of 2019 to the fourth quarter of 2019, the period before the COVID pandemic. As a result of the study, the regression coefficient of the variable of interest, $DEC_t \times \ln(SALES_t/SALES_{t-1}) \times IT_t$, was -0.309, which was statistically significant at the 5% level. This means that prior to the Corona Pandemic, companies in the IT industry have more rigid R&D expenditures than companies in other industries. In other words, it means that even if sales decreased before Corona, R&D expenses did not decrease in proportion to sales. On the other hand, the second column of <Table 4> shows the R&D expenditure behavior during the first quarter to the third quarter of 2020, which is the pandemic period. As a result of the analysis, the regression coefficient of $DEC_t \times \ln(SALES_t/SALES_{t-1}) \times IT_t$ was not significant. It appears that during the corona crisis, companies in the IT industry adjust R&D expenses in proportion to changes in sales, like other industries. This is interpreted as a reduction in R&D investment, which takes a long time to create results, in case of a decrease in sales due to uncertainty in future management performance due to the corona pandemic.

5. Conclusion

As a result of analyzing how COVID-19 affects the R&D expenditure behavior of IT and non-IT companies, it appears that during the coronavirus crisis, companies in the IT industry adjust R&D expenses in proportion to changes in sales, like other industries. The reduction in R&D investment, which takes a long time to create results, in case of a decrease in sales due to uncertainty in future management performance due to the Covid-19.

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