Correlation of R&D Investment and Financial Ratios of Government-Invested Enterprises[1]

Gu Hwan Won *

Abstract: This study analyzes research and development (R&D) in government-invested enterprises and analyzes whether investment in R&D has a correlation with the financial ratios of these enterprises. First, investment and interest in R&D among government-invested enterprises is shown to be very weak; however, after the foreign currency crisis, government-invested enterprises increased their investment in R&D to a degree. Second, a positive correlation was found between R&D investment and CR and QR from the current ratio; NITA and OITA from the profitability ratio; and PC variables from the productivity ratio. The R&D investment in government-invested enterprises has a close correlation with monetary assets and total capital from the financial ratio. Third, quick assets that can be converted to cash must be established systematically for the financial operation plan to link with the long-term profit realization of government-invested enterprises, and the strategic plan to maximize the added value from the total capital has to be considered.

Keywords: government-invested enterprises, R&D investment, financial ratios

INTRODUCTION

Since 1980, as a result of strengthening protections on trade, advances in high-tech technology among developed countries, the rise of less developed countries, and deepening competition among emerging industrial countries, Korea's high growth, achieved by the qualitative increase of injected elements such as labor and capital, has encountered limitations. Therefore, the research and development (R&D) of new technology and products has become an important factor in economic growth. In determining the economic outcome of a country, the role of R&D on new technology and product development is very important. In particular, in order to structure a knowledge-based economy that accounts for environmental changes such as information technology and

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* Assistant Professor, Department of Public Administration, Hannam University.
He graduated with a PhD in public administration from Yonsei University in Korea. His research interests include public enterprise, local administration, and public management.

globalization, it is necessary to develop new and independent technologies and to accumulate fundamental knowledge. Already, the wave of the new information society, led by the computer, has accelerated change and innovation in technology, increasing the importance of R&D activities even more. Investment in R&D performs a remarkable service by absorbing the knowledge of the organization and heightening the operational capabilities of the organization (Cohen & Levinthal, 1990). A remarkable range of outcomes can be expected from investment in R&D (Finkelstein & Boyd, 1998).

However, R&D investment has aspects that make the realization of short-term gains difficult, that is, the significant time required for development and outcome recovery and the continuous funding requirements (Lee & O'Neil, 2003). Particularly, a public corporation that does not have the motivation to seek profits but undertakes R&D activities may see a decline in the efficiency of its R&D activities. Lack of enterprise incentive may bring inefficiency with the moral hazard of the R&D activities that accompany the uncertainty (Finkelstein & Boyd, 1998).

In other words, looking from the point of view of agent theory, chief executive officers (CEOs) of public corporations bring long-term profit to the companies, but they are reluctant to invest in R&D that requires a long recovery period (David, Hitt, & Gimeno, 2001), and the time from technology development to product development may be longer than the period some CEOs of public corporations are in office. Accordingly, CEOs of public corporations prefer to base their investments mainly on short-term performance, as opposed to investments that may reduce their compensation or interfere with labor stability (Coff, 2003). The CEOs of public corporations would rather pursue the realization of gradual profit than a significant investment in R&D. If the assessment of their performance worsens due to a decline in short-term gains, it is directly linked to a reduction of their compensation and an increase in the instability of labor. Consequently, one important method of resolving the inefficiency of public corporations is to raise their long-term outcomes by attracting hazardous investment, such as R&D.

The purpose of this study is to analyze the status of R&D investment in public corporations (particularly government-invested enterprises) and to analyze the correlation of R&D investment with the financial ratios of these enterprises. By looking into the correlation of R&D investment and the financial ratios of government-invested enterprises, we analyze whether the correlation hypothesis raised for private enterprises can also be applied in the public sector. The objective of this study is to provide an efficient financial management guideline for government-invested enterprises by establishing a new correlation between R&D investment and financial ratios that best suits such organizations. In particular, it aims to find out how the scarce resources of government-invested enterprises are distributed and how much R&D investment contributes to their financial performance. Furthermore, the study's purpose is to identify the current status of R&D investment among government-invested enterprises and to recommend alternative policies concerning their R&D investment.

THEORETICAL FRAMEWORKS

Classification of financial ratios is diverse depending on the scholar. Chen and Shimerda (1981) classify financial ratios as current ratio, leverage, profitability, turnover ratio, and ratio of cash flow, and Horne (1980) classifies them as current ratio, debt, profitability, and ratio of compensating financial cost. Bellemore and Ritchie (1974) classify them as current ratio, capitalization, and profitability ratio, and Altman (1968) classifies them as current ratio, profitability, leverage, payment capability, turnover ratio. Furthermore, the Korea Development Bank (2004) classifies them as growth, profitability, productivity, turnover, and stability ratio, and the Bank of Korea (2004) classifies them as profitability, finance-cost-related ratio, stability, growth, and productivity ratio. According to these research results, financial ratios can largely be classified into current ratio, stability, profitability, turnover, productivity, and growth. Accordingly, analyzing the R&D investment of government-invested enterprises to determine its correlation with various financial ratios would shed light on the financial information related to R&D investment.

First, according to the agent theory, CEOs are risk avoidance oriented. In other words, CEOs have a greater interest in realizing short-term gains rather than full-blown investment on R&D, for which outcomes are not immediately forthcoming and uncertainty is significant. Therefore, CEOs tend to increase the current ratio by reducing their expenditures, buying marketable securities, or depositing them in banks rather than investing in R&D (Lynn, Morone, & Paulson, 1997). The representative index of the current ratio is largely the current ratio (CR) and the quick ratio (QR) (Bank of Korea, 2004; Korea Development Bank, 2004). First, the CR index demonstrates how much the current asset ratio is appropriate to the short-term debt, which is also called the "banker's ratio." The higher the ratio, the better the short-term payment capability of a business. In addition, the QR is used to learn a business's payment capability on short-term debt by responding to quick assets on the current debt and excluding inventory assets, which are highly uncertain for cash conversion and slow for converting into cash. Therefore, the QR is also called the "prompt ratio." As the ratio gets higher, the more outstanding it is considered. However, raising the current ratio to excessively high rates would have the opportunity cost of waiving the profit that may be earned by investing in other profitable assets. Therefore, conservative enterprises would have more operation capital and a larger current ratio, but it has the trade-off that the profitability would decline compared to more aggressive enterprises. Consequently, this study defines an increase in the current ratio as having a negative correlation with R&D investment.

Second, companies with substantial debts have less room for investment on long-term projects with significant recovery terms. There are research results that show a negative correlation between the debt ratio and R&D investment (Baysinger & Hoskisson, 1989; Hoskisson, Hitt, Johnson, & Grossman, 2002; Kochhar & David, 1996; O'Brien, 2003). But according to some studies, the higher the debt ratio, the higher the R&D investment. In other words, as the debt ratio gets higher, risk preference and efforts increase, resulting in an expansion of investment in R&D (David et al., 2001). But the results of earlier research on the correlation of the debt ratio and R&D investment show a negative correlation

in general, which this study uses as a hypothesis. In other words, the debt ratio in general is defined as having a negative correlation with R&D investment. In order to verify such a hypothesis, this study selected the debt ratio (DR), which is generally utilized as the index in the stability ratio (Yang, 1989). The debt ratio is the most representative financial structure index and shows the relationship of other capital and equity capital for which less than 100% is deemed as the standard ratio in general.

Third, R&D investment has an uncertain outcome, showing results over long periods of time and reducing short-term gains by steady inputting of funds (Miozzo & Dewick, 2002; David et al., 2001, pp. 144–157). However, there are research reports that R&D investment is a source of growth and competitive advantage, controlling the organization from falling into mannerism and bringing long-term benefits in return (Lee & O'Neil, 2003; Stein, 1989). Accordingly, we may hypothesize that R&D investment has a positive relationship with profit on a long-term basis. In particular, this study considers financial ratios over 11 years in which the profit-related financial ratio had a positive correlation with R&D investment. The financial ratios that represent such a profit are important variables that measure the financial condition and results of a company; they can be classified into the sales yield of the statement of profit and loss and the capital profitability of balance sheet, two financial statements of a business. In this study, the net income/sales ratio (NIS), which represents sales profitability, is primarily selected, and the measured variables that display capital profitability are the net income/total assets (NITA), ordinary income/total assets (OITA), net income/stockholder's equity (NISE), and ordinary income/stockholder's equity (OISE) ratios. In particular, the NITA and the NISE have been proven to be very useful variables in forecasting the systematic risk of an enterprise and security of the profits (Beaver & Manegold, 1975, pp. 184–237).

Fourth, the turnover ratio shows how well the capital invested in an enterprise was actively operated. Companies continuously revolve the capital injected for the purpose of increasing profits, and the ensuing outcome is indicated in the sales amount. As the sales profitability increases, the financial resources for R&D investment are enlarged. Therefore, the turnover ratio in this study hypothesized to have a positive correlation with R&D investment. The variables considered to measure turnover in this study are total assets turnover (TAT) and stockholder's equity turnover (SET). The trade receivable turnover is a concept based on credit sales that would be difficult to apply to the government-invested enterprises. In particular, there is no indication that classifying sales by credit and sales by cash on the financial statements presents a problem for calculation. In addition, inventory asset turnover refers to the speed of inventory assets changing into the quick assets; this is an index of how efficiently inventory assets are managed, including the prevention of inventory loss of product and saving of deposit amount. However, the characteristics of business that government-invested enterprises provide are more meaningful as a service rather than monetary term that the consideration on the inventory asset is not effective.

Fifth, the index on productivity is a barometer of the management reasonableness and the standard of distribution on outcome earned from the improvement of productivity. In particular, R&D investment has a close relationship with how the rare resources of a business are distributed. If the resources of a company were sufficient, the availability of R&D investment

would be that much greater. In other words, the outcome of the improvement of productivity would be an important supply for R&D investment. Therefore, the outcome realized by a company has a positive correlation with R&D investment (David et al., 2001; Hoskisson et al., 2002). In order to prove the foregoing hypothesis, this study uses the gross value added to total assets or productivity of capital (PC) and the gross value added to property, plant and equipment (GVAP) indices selected by the Bank of Korea (2004, pp. 46–57) and the Korea Development Bank (2004, pp. 26–27).

Sixth, the size of the enterprise is an important factor for R&D investment. In other words, if the size is large, the efficiency of asset use is large (Acs & Audretsch, 1988; Baysinger & Hoskisson, 1989; Singh & Davidson, 2003) and the motivation for risky investments such as R&D is also greater (Kochhar & David, 1996). In addition, if the size gets larger, there will be more resources and greater ability to endure investments with long recovery periods, such as R&D (Cohen & Levinthal, 1990). Earlier studies on the relationship of size and R&D investment found that there is a negative relationship between them (Hoskisson et al., 2002), but a number of study results (Coff, 2003; Hill & Snell, 1988; Kochhar & David, 1996) assert that there is a positive relationship. Accordingly, in this study, the growth rate of sales (GRS) and the growth rate of total assets (GRTA) indices are used to indicate the increase of business size. The ratio related to the GRS and the GRTA is the index generally used to understand the size of a business (Hoskisson et al., 2002; Ramaswamy, Li, & Veliyah, 2002).

RESEARCH METHODS

The research method considers four areas in general: analysis focus, enterprise subject, time, and the measurement variable.

First, this study focuses on the correlation of R&D investment and financial ratios. Hypotheses with recently raised social-psychological system and cultural features (Gedajlovic & Shapiro, 1998, pp. 533–553) are excluded, and the analysis index on the situation and quality of R&D investment is controlled for as well. This study rules out hypotheses related to social-psychological and cultural aspects. The reason is that the objective data eligible for this study are not sufficiently discovered in the preceding studies. In addition, it has been reported that such data tend to have a great difference across regions. Another reason is the concern that emphasis on aspects other than the correlation between R&D investment and financial ratios may prevent us from evaluating financial performance on its own value.

Second is the consideration of enterprises as the subject for analysis. The range of public corporations is very diverse, and this study considers 13 government-invested enterprises in which the government provided at least 50% of the capital and that were controlled under the Frame Act of Government-Invested Enterprise Management. In particular, annual management assessment of these government-invested enterprises is undertaken. They are enterprises owned by the government with the incentives applied for different outcomes. The 13 government-invested enterprises are the Korea Electric Power Corporation (KEPCO), Korea Coal Corporation (KOCOAL), Korea Resources Corporation

(KORES), Korea National Tourism Organization (KNTO), Agricultural and Fishery Marketing Corporation (AFMC), Korea Agricultural and Rural Infrastructure Corporation (KARICO), Korea Minting and Security Printing Corporation (KOMSCO), Korea National Housing Corporation (KNHC), Korea Highway Corporation (KHC), Korea Water Resources Corporation (KOWACO), Korea Land Corporation (KLC), Korea Trade-Investment Promotion Agency (KOTRA), and Korea National Oil Corporation (KNOC). In the case of the Korea Electric Power Corporation, the government equity ratio is only 27%, but it was formed as a government-invested enterprise under the Frame Act of Government-Invested Enterprise Management.

Third is the time of analysis: Eleven years, from 1993 to 2003, are utilized. The time frame is near the foreign currency crisis of December 1997 and investigates how the R&D investment ratio has changed. Because the Korea Agricultural and Rural Infrastructure Corporation was established in 2000, only four years of data, from 2000 to 2003, are analyzed.

Fourth is the concept of R&D investment, a dependent variable for analyzing the correlation analysis. For the measured variable on R&D investment, the analysis indices of earlier studies (Chatterjee & Wernerfelt, 1991; Hill & Snell, 1988; Kochhar & David, 1996; Lee & O'Neil, 2003; Montgomery & Hariharan, 1991) are utilized as the analysis index. Namely, these earlier studies measure R&D investment and the intensity of R&D utilization. In this study, the R&D investment is measured as the R&D intensity (R&D cost / sales × 100) following this standard. In particular, the variables are all used for ratio indices so as to have unity of correlation analysis of R&D and financial ratios.

EMPIRICAL RESULTS

Status of R&D Investment

The average sales ratio on R&D investment in government-invested enterprises for the 11 years is around 1.18% (see Table 1). The sales ratio on R&D investment for KROES is 4.95%, a relatively higher ratio compared to the other government-invested enterprises. This is followed, in order, by KOMSCO, KEPCO, KOWACO, and KNOC. However, there are eight enterprises that had average R&D investment ratio below 1% for the 11 years. The R&D budget of the government in 2004 was 5675.1 billion won, representing 4.8% of the total government budget. R&D represented 2.64% of the gross domestic product (GDP) of Korea (2003), whereas it accounted for 2.62% in the United States (2003), 2.50% in Germany (2003), 3.12% in Japan (2002), and 2.20% in France (www.most.go.kr). Therefore, the investment ratio for R&D among government-invested enterprises has been very poor.

Table 1. R&D Ratio and Status of Government-Invested Enterprises

	R & D Intensity		Rank of 2003 Management Assessment	Capital (100 millions)		Government equity	
	Mean	Ranking		Authorized Capital	Paid Capital A	Amount (100 mil.) B	Equity Ratio B/A (%)
KORES	4.95%	1	6	3,000	2,793	2,766	99.0
KOMSCO	3.73%	2	13	150	66	66	100.0
KEPCO	2.43%	3	7	60,000	32,037	8,660	27.0
KOWACO	1.16%	4	3	100,000	56,775	51,411	90.6
KNOC	1.10%	5	8	50,000	32,079	32,079	100.0
KHC	0.80%	6	10	180,000	165,209	146,351	88.6
AFMC	0.39%	7	9	800	532	532	100.0
KNTO	0.32%	8	11	500	324	182	56.2
KOCOAL	0.25%	9	12	4,500	1,600	1,600	100.0
KLC	0.16%	10	4	50,000	18,024	13,199	73.2
KNHC	0.05%	11	2	80,000	56,035	46,111	82.3
KARICO	0.05%	12	5	50,000	12,000	12,000	100.0
KOTRA	0.00%	13	1	50	5	5	100.0
Mean	1.18%						

Source: Republic of Korea, Ministry of Finance and Economy (2004, p. 6).

For example, looking into the R&D investment ratio compared to the profit of public corporations in bio-industry in each country, the United States has 45.5%, Europe has 56.3%, Canada has 46.4%, the Asia Pacific region has 17.5%, and the overall figure is 47.1% (KOTRA, 2002, internal information). Therefore, the foregoing information demonstrates that R&D investment by world-class public corporations is very aggressive (see Table 2).

Table 2. R&D Expenditures of World-Class Public Corporations, Bioindustry

Classification		Total	U.S.	Europe	Canada	Asia Pacific Region
No. of enterprises	No. of public corporations	622	342	104	85	91
	No. of private enterprises	3,662	1,115	1,775	331	441
Public corporations	Profit (million US$)	34,874	25,319	7,533	1,021	1,001
	R&D expenditure (million US$)	16,427	11,532	4,244	474	175
	Net profit (million US$)	−5,933	−4,799	−608	−507	−19
	No. of employees	188,703	141,000	34,180	7,005	6,518

* Period: October 2000—September 2001 (KOTRA internal information).

Table 3 shows the basic statistics for each financial ratio of the government-invested enterprises. Namely, the average R&D investment ratio of government-invested enterprises from 1993 to 2003 was only 1.179%. This is not even up to the level of 1.9% of R&D ratio compared to the GDP of 1987.

Table 3. R&D Investment Ratio and Financial Ratios of Government-Invested Enterprises

Ratios	Mean	Std. Error of Mean	Std. Deviation	Variance	Skewness
R&D	1.179	0.124	1.448	2.097	1.640
CR	292.723	30.339	353.814	125184.587	2.796
QR	175.924	22.646	264.091	69743.923	3.402
DR	203.746	31.852	371.459	137981.704	7.697
NIS	0.057	1.456	16.985	288.477	-3.025
NITA	0.751	0.623	7.266	52.793	-1.849
OITA	1.737	0.657	7.662	58.711	-0.003
NISE	9.705	2.296	26.778	717.071	4.398
OISE	18.940	7.700	89.798	8063.756	9.386
TAT	6.618	1.817	21.185	448.794	3.268
SET	10.058	2.600	30.320	919.319	3.113
PC	24.607	3.719	43.370	1880.999	4.136
GVAP	266.478	45.186	526.957	277683.689	4.478
GRS	43.856	87.040	1015.047	1030321.030	8.882
GRTA	39.251	51.124	596.204	355459.445	7.093

Looking at the status of R&D investment of government-invested enterprises before and after the foreign currency crisis (December 1997), investment on R&D has expanded since the foreign currency crisis. The R&D investment ratio prior to the foreign currency crisis was 0.99% and the 1.24% after, an increase of 0.25% (see Table 4). In addition, looking at each government-invested enterprise, three enterprises — KEPCO, KOCOAL, and KNTO — reduced their R&D investment ratios after the foreign currency crisis, whereas the rest of the government-invested enterprises increased their R&D ratios.

Table 4. Change in R&D Ratio before and after the Foreign Currency Crisis

	Before Foreign Currency Crisis (1993–97)	After Foreign Currency Crisis (1998–2003)	Change (Percent)
KEPCO	2.30	2.22	–0.08
KOCOAL	0.40	0.28	–0.12
KORES	3.30	4.87	1.57
KNTO	1.00	0.00	–1.00
AFMC	0.11	0.53	0.42
KARICO	0.00	0.05	0.05
KOMSCO	3.23	3.50	0.27
KNHC	0.10	0.10	0.00
KHC	0.66	0.82	0.16
KOWACO	0.65	1.30	0.65

KLC	0.13	0.15	0.02
KNOC	0.00	1.03	1.03
Mean	0.99	1.24	0.25

Correlation Analysis of R&D Investment and Financial Ratio

Looking at the correlation of R&D investment in government-invested enterprises and the current ratio and stability ratio, the current ratio, comprising CR and QR, was found to have a positive correlation with R&D investment. However, the correlation of the debt ratio and R&D investment was found to have a negative relationship, but it is not statistically significant at the 0.05 level. From the theoretical hypothesis, the negative correlation is defined as derived from the current ratio and R&D investment, but the actual analysis result of the current ratio and R&D investment shows a high positive correlation. Particularly, QR was found to have a relatively higher correlation with R&D development than CR.

Table 5. Interrelationship of Financial Ratios and R&D Investment

	R&D	CR	QR	DR	NIS	NITA	OITA	NISE	OISE	TAT	SET	PC	GVAP	GRS	GRTA
R&D	1.000	0.477	0.578	-0.148	0.155	0.246	0.250	-0.186	-0.096	-0.059	-0.062	0.367	-0.067	-0.060	-0.023
(Sig.)	.	0.000	0.000	0.137	0.120	0.013	0.011	0.061	0.336	0.556	0.534	0.000	0.500	0.550	0.818
CR	0.477	1.000	0.958	-0.144	0.179	0.340	0.361	-0.121	-0.074	0.135	0.132	0.647	-0.038	-0.046	-0.020
(Sig.)	0.000	.	0.000	0.150	0.071	0.000	0.000	0.228	0.458	0.175	0.185	0.000	0.703	0.645	0.844
QR	0.578	0.958	1.000	-0.155	0.136	0.305	0.321	-0.123	-0.078	0.083	0.080	0.603	-0.087	-0.049	-0.017
(Sig.)	0.000	0.000	.	0.121	0.173	0.002	0.001	0.217	0.436	0.409	0.423	0.000	0.386	0.628	0.868
DR	-0.148	-0.144	-0.155	1.000	-0.373	-0.346	-0.631	0.859	0.953	-0.087	-0.124	0.093	0.055	0.156	0.151
(Sig.)	0.137	0.150	0.121	.	0.000	0.000	0.000	0.000	0.000	0.383	0.216	0.351	0.582	0.118	0.130
NIS	0.155	0.179	0.136	-0.373	1.000	0.903	0.788	-0.531	-0.226	0.076	0.096	-0.018	0.126	-0.036	-0.177
(Sig.)	0.120	0.071	0.173	0.000	.	0.000	0.000	0.000	0.022	0.447	0.336	0.854	0.208	0.722	0.075
NITA	0.246	0.340	0.305	-0.346	0.903	1.000	0.898	-0.470	-0.190	0.173	0.190	0.198	0.099	-0.117	-0.087
(Sig.)	0.013	0.000	0.002	0.000	0.000	.	0.000	0.000	0.056	0.082	0.056	0.046	0.323	0.242	0.384
OITA	0.250	0.361	0.321	-0.631	0.788	0.898	1.000	-0.642	-0.502	0.141	0.168	0.247	0.129	-0.152	-0.129
(Sig.)	0.011	0.000	0.001	0.000	0.000	0.000	.	0.000	0.000	0.159	0.092	0.012	0.195	0.128	0.195
NISE	-0.186	-0.121	-0.123	0.859	-0.531	-0.470	-0.642	1.000	0.837	-0.030	-0.069	0.231	-0.121	0.148	0.341
(Sig.)	0.061	0.228	0.217	0.000	0.000	0.000	0.000	.	0.000	0.761	0.491	0.020	0.226	0.138	0.000
OISE	-0.096	-0.074	-0.078	0.953	-0.226	-0.190	-0.502	0.837	1.000	-0.030	-0.066	0.172	-0.051	0.070	0.118
(Sig.)	0.336	0.458	0.436	0.000	0.022	0.056	0.000	0.000	.	0.765	0.511	0.083	0.613	0.485	0.239
TAT	-0.059	0.135	0.083	-0.087	0.076	0.173	0.141	-0.030	-0.030	1.000	0.998	0.187	-0.107	-0.017	-0.009
(Sig.)	0.556	0.175	0.409	0.383	0.447	0.082	0.159	0.761	0.765	.	0.000	0.060	0.283	0.867	0.925
SET	-0.062	0.132	0.080	-0.124	0.096	0.190	0.168	-0.069	-0.066	0.998	1.000	0.170	-0.099	-0.032	-0.015
(Sig.)	0.534	0.185	0.423	0.216	0.336	0.056	0.092	0.491	0.511	0.000	.	0.087	0.321	0.753	0.881
PC	0.367	0.647	0.603	0.093	-0.018	0.198	0.247	0.231	0.172	0.187	0.170	1.000	-0.123	0.137	0.046
(Sig.)	0.000	0.000	0.000	0.351	0.854	0.046	0.012	0.020	0.083	0.060	0.087	.	0.218	0.171	0.646

GVAP	-0.067	-0.038	-0.087	0.055	0.126	0.099	0.129	-0.121	-0.051	-0.107	-0.099	-0.123	1.000	-0.030	-0.013
(Sig.)	0.500	0.703	0.386	0.582	0.208	0.323	0.195	0.226	0.613	0.283	0.321	0.218	.	0.768	0.898
GRS	-0.060	-0.046	-0.049	0.156	-0.036	-0.117	-0.152	0.148	0.070	-0.017	-0.032	0.137	-0.030	1.000	-0.084
(Sig.)	0.550	0.645	0.628	0.118	0.722	0.242	0.128	0.138	0.485	0.867	0.753	0.171	0.768	.	0.402
GRTA	-0.023	-0.020	-0.017	0.151	-0.177	-0.087	-0.129	0.341	0.118	-0.009	-0.015	0.046	-0.013	-0.084	1.000
(Sig.)	0.818	0.844	0.868	0.130	0.075	0.384	0.195	0.000	0.239	0.925	0.881	0.646	0.898	0.402	.

Second, looking at the correlation of R&D investment in government-invested enterprises and the profitability financial ratio, the NITA and OITA variables were found to have a positive correlation with R&D investment. However, looking at the profitability ratio, the correlation of R&D investment and NIS, NISE, and OISE were found to have no meaningful implication. Therefore, the R&D investment ratio of the government-invested enterprises was found to have a positive correlation with profit related to the total capital within the profitability ratio.

Third, looking at the correlation of R&D investment in government-invested enterprises and the turnover ratio, the relationship is not statistically significant at the 0.05 level.

Fourth, looking at the correlation of R&D investment in government-invested enterprises and the productivity ratio, R&D investment and PC have a positive correlation at the 0.05 significance level. However, R&D investment does not have any meaningful interrelationship with GVAP.

Fifth, looking at the correlation of R&D investment in government-invested enterprises and the growth financial ratio, the relationship is not statistically significant at 0.05 level.

CONCLUSION

The conclusions obtained through the analysis in this study are as follows.

First, investment and interest in R&D among government-invested enterprises are very weak; however, after the foreign currency crisis, government-invested enterprises increased their R&D investment ratios &D. However, in light of the importance of R&D, R&D investment among government-invested enterprises has been very insignificant.

Second, there is a positive correlation between R&D investment and CR and QR from the current ratio; the NITA and OITA from the profitability ratio; and PC variables from the productivity ratio. In other words, R&D investment has a positive correlation with the current ratio, profitability ratio, and productivity ratio. From the theoretical research hypothesis, R&D investment was believed to have a negative correlation with the current ratio, but the results of the analysis showed a positive correlation compared to other the financial ratios. According to this analysis, R&D investment in government-invested enterprises has a close interrelationship with the monetary asset and total capital measures from the financial ratio.

The theoretical hypothesis that the current ratio and R&D investment have a negative correlation seems to be incorrect when it is applied to government-invested enterprises. In the hypothesis, corporations in the private

sector are regarded as paying attention to short-term profit realization rather than long-term, big-money investment. The approach does not appear to be appropriate for government-invested enterprises. The first reason that current ratio and R&D investment have a positive correlation is that, in case of public corporations, government policy is more valued in establishing a budget guideline. Guidelines for making budgets are prepared by the Ministry of Planning and Budget and determined by the committee. Thus, assets that can be easily transferred to cash are used more in distributing the government budget for public corporation than for debt or fixed assets. The second reason is that some enterprises, such as KORTA, AFMC and KARICO, are operated through the support of public finance. For example, KORTA is responsible for promoting international trades. AFMC controls the price of agricultural and marine products and builds infrastructure for facilitating the distribution of agricultural and marine products. And KARICO is engaged in government business for developing farming and fishing villages. In particular, KORTA uses government money to procure vehicles, merchandise, and intangible assets. All of three organizations maintain themselves through the financial support of the government, mainly composed of cash or cash equivalents. Therefore, R&D investment also has a close relationship with liquidity assets. The third reason is that in the case of government-invested enterprises, short-term profit realization is not a big deal. Their major concerns are related to the policies of government, and based on such polices, public finance is injected in the form of subsidies. Considering the context, it is thought to be inappropriate to manage all 13 organizations under the same standard. Taking into account that these enterprises perform duties that are commissioned by the government, it is reasonable to apply a different approach in analyzing the effects of R&D investment. The fourth reason is that public enterprises do not need to take risks. The products or services provided by government-invested enterprises have characteristics of exclusivity, so that long-term profit realization through R&D investment is not considered important.

Third, the hypothesis that the profitability ratio and R&D investment have a positive correlation was proved to be statistically significant. However, only the NITA and OITA variables have a positive relationship, whereas NISE and OISE were proved to be statistically insignificant. This finding implies that government-invested enterprises have a relatively low own-capital ratio. In fact, in the case of government-invested enterprises, the government owns more than 50% of their equity. Likewise, in analyzing the correlation between productivity ratio and R&D investment, a statistically insignificant relationship was found for the GVAP variable, whereas the PC variable was found to have a positive relationship. Thus, in order to properly analyze the correlation between financial ratios and R&D investment in government-invested enterprises, it is reasonable to consider total capital rather than the enterprise's own capital ratio against total capital. To achieve long-term profit realization, management needs to increase its interest in R&D investment. However, in reality, such interest is disregarded due to the exclusive characteristics of government-invested enterprises. Therefore, the involvement of government is discussed in terms of long-term profit realization.

Fourth, the study found that the correlation between the growth ratio and R&D investment is statistically insignificant. The reason for this result can be found in

the ways of dealing with profits. For example, in the case of KEPCO, any profits that are incurred by the business are used to make up for losses that are carried over from the last period, kept as earned surplus reserve, or provided as dividends to shareholders (Article 14, Law of KEPCO). And KOWACO and KHC deal with the money by making up for losses that are carried over from the last period, keeping it as earned surplus reserve, or accumulating business extension reserve (Article 12, Law of KOWACO, and Article 14, Law of KHC). KORTA uses the money to compensated for losses of the last period or saves it as earned surplus and other reserves (Article 12, Law of KORTA). This finding implies that government-invested enterprises have not established sufficient laws and regulations to ensure that any incurred profits are used for future R&D investment to facilitate the development of the organization. Thus, it is necessary to revise the laws and regulations so that some of profits are spent to promote future R&D investment in government-invested enterprises.

Therefore, quick assets that can be converted to cash must be established systematically for the financial operation plan to link with the long-term profit realization of government-invested enterprises, and the strategic plan to maximize the added value from total capital has to be considered. Particularly, increasing the current ratio assets would waive the profit earned by having the opportunity cost to invest in other profitable assets. Consequently, by sufficiently considering the trade-off between current ratio assets and profitability assets, it is necessary to expand R&D investment continuously to realize the long-term profit of government-invested enterprises. In addition, securing an original source of competitiveness and growing the businesses through the R&D investment would provide valuable instruction in resolving the agent issue of the government-invested enterprises.

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