

Method for Composing a Portfolio for REITs Investment Using Markowitz's Portfolio Model

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Abstract: Domestic construction companies are suffering from financing difficulties in the wake of the economic slump in Korea and abroad. During this economic slump, real estate investment trusts (REITs), facilitators for improving financing and stimulating construction businesses, have increasingly expanded since their introduction in 2001. However, in terms of growth speed and marketing size, Korean REITs are falling behind those of other nations. The purpose of this study is to suggest a method for composing a portfolio using the Markowitz portfolio selection model to stimulate REITs. The main contents are as follows. First, a comparative analysis was conducted of increased REIT profit with the application of the Markowitz model and the average REIT profit rate from July 3, 2007, to July 21, 2008, during the investment analysis periods. The results showed that the total profit rate from the Markowitz model was about 10% higher than the average REIT profit rate. Second, the sensitivity was analyzed according to the portfolio's data-gathering and replacement cycle to measure the optimum cycle and yield. The six-month profit data collection period showed about 16% higher profits with the Markowitz model than with the REITs. The two-week portfolio change period resulted in about 11% higher profits with the Markowitz model than with the REITs

Keywords: Real Estate Investment Trusts (REITs), Markowitz's portfolio model, Minimum Attractive Rate of Return (MARR), Replacement cycle of portfolio

I. INTRODUCTION

A. Research Background and Purpose

The domestic economy and the construction economy, as well as the real estate economy, are facing a recession due to the effects of the American sub-prime mortgage crisis, because construction companies are experiencing difficulties in obtaining funds. Small and medium-sized construction businesses are in an especially serious situation in the reality of financial institutions' dependence on corporate credit for loans. This economic recession is widening, reducing the number of goods ordered in the construction industry, and is affecting the liquidity of construction companies obtaining funds based on construction orders.

REITs (real estate investment trusts), which were first implemented in Korea in 2001, promote the sale of real estate during economic recessions to support the securitization of owned real estate. REITs have the advantage of being used to finance new real estate development (Park 2003a). The current REITs market accounts for only 0.7% of the capital market, and listed REITs remain at 0.3%, thereby making them unable to reach more than 1-7% of the capital market, as predicted in the early stages of their implementation. Furthermore, Japan and Australia, which implemented REITs during a recession, show a market size of 25% and 4%, respectively, and REIT growth is much slower in Korea than in other Asian countries.

Perhaps because Korea's policies differ from those of other countries, the total number of current publicly subscribed REITs remains at 15%, the scale of funds does not reach 10% of the total scale of REITs, and the trading amount and stock prices are low, thus hindering investors from making active investments (Jung et al. 2008). If a scientific REITs investment portfolio composition method could enhance the profit rate of REIT investors, a large amount of funds could be inputted into the real estate and construction industries with active investments.

This study proposes a Markowitz portfolio selection model that applies a nonlinear programming method as the composition method for a portfolio that was established to enhance REITs' investment profit rate. Furthermore, this study verifies the efficiency and analyzes the results of the investments that apply the Markowitz model, and thereby contribute to enhancing liquidity and financing in the construction industry and the activation of REITs.

B. Study Flow and Method

This study applied the Markowitz portfolio selection model that has verified the efficiency of diversified investments to enhance the efficiency of the profit rate of REITs investments, and analyzes the applicability of the Markowitz model in the construction industry,

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which is sensitive to economic fluctuations. The flow and method of this study are as follows.

First, the theoretical aspects of REITs and of the Markowitz portfolio selection model, the methodology, are considered.

Second, the subject of research related to this study, REITs and real estate predictions, is considered. In addition, the research trends for the portfolio and the Markowitz portfolio selection model, which is the methodology of this study, are considered.

Third, the comparative subject is selected based on the investment subjects, investment results, and the term of analysis that considers the analysis method, and an investment method is proposed.

Fourth, the predicted investment results that apply the Markowitz model are compared with the actual profit rate of the same REITs to verify the efficiency of the method proposed in this study.

Fifth, a sensitivity test is conducted on the changes in the portfolio replacement cycle and the collection term of the profit rate data, to deduce the optimum portfolio replacement cycle and the collection term of the profit rate data.

II. BACKGROUND

A. Real Estate Investment Trusts (REITs)

REITs are based on an indirect investment policy that collects funds from organizations and the investing public for investment in real estate, returns the amount that corresponds to the profit rate in the form of dividends, and applies the Real Estate Investment Company Law. Domestic REITs were launched in the Korean market in 2002, after they were enacted into law in 2001. Figure 1, Figure 2, and Figure 3 display the annual REIT establishment trends. In 2002, REITs held 364.5 billion won in capital, total assets worth 558.4 billion won, and four funds, but they grew approximately 10 times to hold capital of 3,066.4 billion won, total assets worth 5,860.6 billion won, and 27 funds (Jung et al. 2008). Such an increase in scale was slow, however, compared to the market scale and speed of growth in Japan and other Asian countries that started at a similar period of time.

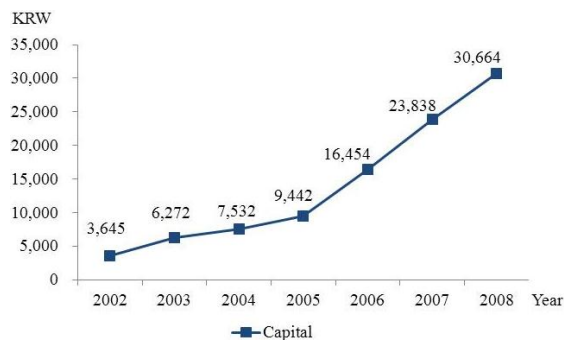


FIGURE I
ANNUAL REITs ESTABLISHMENT TRENDS: CAPITAL

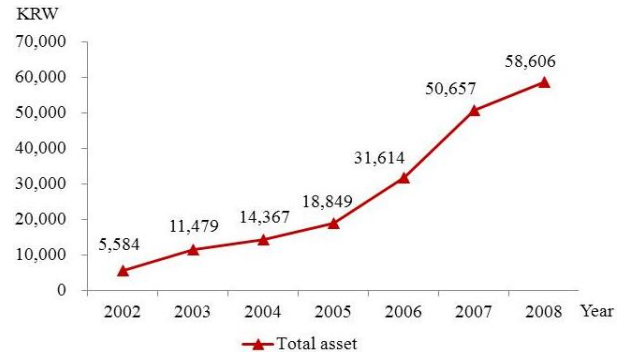


FIGURE II
ANNUAL REITs ESTABLISHMENT TRENDS: TOTAL ASSETS

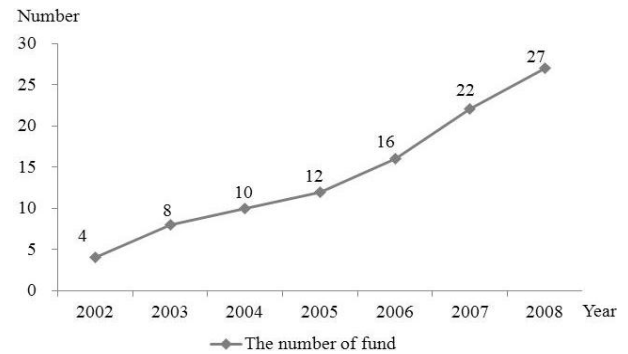


FIGURE III
ANNUAL REITs ESTABLISHMENT TRENDS: THE NUMBER OF FUNDS

REITs have the following advantages. First, most investment shares that can be categorized as company stocks and trust-based beneficiary shares are distributed and listed on the stock exchange, thus facilitating expanding opportunities for small investors as well as their liquidity and financing. Moreover, relatively stable investment returns are guaranteed by the tax reduction effect of corporate taxes. Furthermore, tenant- and tax-related tasks can vicariously be executed by a juridical member, even for owners of large buildings, exempting them from direct management responsibilities.

The types of REITs adopted in Korea can be categorized as REITs and corporate restructuring (CR) REITs, and REITs can be further categorized into self-managed REITs and externally managed REITs. Self-managed REITs take the form of internal assets, which apply only to asset management subsidiaries; and externally managed REITs take the form of externally executed asset management duties. The greatest difference is that between an actual company and a paper company. CR REITs refer to funds that supply returns obtained by investing in real estate or buildings, which are corporate restructuring articles for sale, after collecting investment funds by issuing shares.

In real estate indirect investment products such as REITs, there are products such as REFs (real estate funds), PFVs (project financing vehicles), and ABSs (asset-backed securities). Table 1 displays the main differences between REITs and real estate indirect

investment products.

TABLE I
THE DIFFERENCES BETWEEN REITs AND OVERHEAD REAL ESTATE INVESTMENT PRODUCTS

Type	Difference with REITs
Real Estate Funds (REFs)	REITs can be sold and purchased in the stock market, but real estate funds generally cannot be resold or repurchased. Institutions that sell real estate funds, such as banks and security companies, do not take responsibility for managing the funds. Real estate funds do not impose the responsibility of listing and subscription. Subscription refers to obtaining applicants by issuing shares to multiple unspecified persons, and private placement refers to collecting funds from a small number of investors.
Asset-Backed Securities (ABSs)	ABSs are bond-type securities that collect fixed interest as predetermined by the investor, and REITs invest in real estate and related securities with funds collected through share sales. An SPC (special purpose company) separate from the credit of issuing organizations executes the duties, and asset-backed securities can be increased with the agreement of the creditor.
Project Financing Vehicles (PFVs)	Specific businesses are targeted, and their subjects, and completed buildings, members-only resorts, and golf courses, are excluded from the subject businesses. There is no responsibility for listing and subscription.

Real estate funds are based on the Indirect Investment Asset Management Business Law and the law related to the Capital Market and Finance Investment Businesses, which refer to companies or entrusted parties that collect funds from investment organizations, including personal investors and organizational investors, for investment in real estate and financial products. Asset-backed securities are based on the Law Related to Asset Liquidation and refer to the payment of returns of asset-backed securities from profits or loans based on managing, operating, or disposing relevant asset-backed securities by transferring securities from asset holders with money entrusted from the investor when asset-backed securities are issued. Project financing vehicles are based on the Corporate Tax Law and are temporary (more than two years) paper companies that invest in specific development projects, which consume considerable time and funds, such as facility investments, social infrastructures, and residential and plant construction projects, by collecting funds from investors.

B. Markowitz's portfolio selection model

Markowitz's portfolio selection model is a theory that determines investment opportunities, which combine profits and optimum risks among all investment

opportunities. This theory involves diversified investments using only previous data on covariance between average profit rates, shares, and individual shares. The core content of this theory concerns the decrease in the total portfolio risk, which results in a decrease in the risk of individual assets, as the number of assets that compose the portfolio increases, and such risk is determined by the size of the covariance between the assets (Kim 2006). Markowitz's portfolio model and the variables and constants used in this study are as follows (Kim and Kim 2008).

$$\text{Minimize } V = \sum_{i=1}^N \sum_{j=1}^N \sigma_{ij} w_i w_j$$

(1)

$$\text{Subject to } \sum_{j=1}^N \mu_j \mu_i \geq K$$

(2)

$$\sum_{j=1}^N w_j = 1$$

$$w_j \geq 0 \text{ for } j = 1, 2, \dots, N$$

Where, *N*: The number of types of shares to be invested in that can be included in the portfolio

w_j: Ratio invested in share *j* in the portfolio (*j* = 1, 2, ..., *N*)

μ_j: Average profit rate of share *j* (*j* = 1, 2, ..., *N*)

s_{jj}: Variance based on the profit rate of share *j* (*j* = 1, 2, ..., *N*)

s_{ij}: Covariance based on the profit rate of shares *i* and *j*, for *i* ≠ *j*

K: Minimum expected profit rate required by the portfolio

V: Variance based on the profit rate of the portfolio

The Markowitz model determines the minimization of the variance (*V*) that displays the degree of risk based on the return of the portfolio as the objective function. This nonlinear programming model has the following three restrictions. First, the minimum expected profit rate required by the investor must be reached. Second, the entire amount available for investment must be invested in the portfolio. Third, there must be no short stock selling.

This study aims to find the optimum investment weight (*w*₁, *w*₂, *w*₃,..., and *w*_{*N*}) that minimizes the variance (*V*), which is the portfolio risk, while satisfying the three aforementioned conditions. This study analyzed the profit rate by composing an optimum portfolio using the solver table and the solution finder.

III. LITERATURE REVIEW

Previous studies can be categorized as studies of predictions for REITs and real estate, with respect to the research subject, as seen in Table 2, and as studies related to the portfolio and the Markowitz model, with respect to the research methodology, as seen in Table 3.

TABLE II
RESEARCH TRENDS WITH RESPECT TO
THE RESEARCH SUBJECTS

Type	Author	Main Content
REITs	Kim (2007a)	Analysis of the dynamic compositional relationship and long-term balanced relationship of REITs and stock prices
	Kim (2004)	Deduction of the performance measurement value that most proficiently reflected the REIT stock prices by comparing the performance measurement values with the American REITs as the subject
	Park (2003b)	Analysis of the REITs profit rate in Korea and the USA, and the effects of the implementation of REITs on the real estate industry and the finance industry
	Lim (2004)	Analysis of the effects of real estate portfolios such as REITs, shares, and bonds
	Jang and Shim (2007)	Comparative analysis of the influence of the macroeconomic variables based on the profit rate of REITs and analysis of the relationship among the REITs, stock, and real estate markets
	Choi (2005)	Construction of the Korean REITs profit rate prediction model that uses the Vector autoregressive (VAR) model
	Kim (2007b)	Construction of an effective asset portfolio by predicting real estate fluctuations and profit rate
Real Estate Price	Kwak and Lee (2006)	Analysis of the fluctuations in residential prices following the real estate policy and the fluctuation of the residential market based on changes in the economic variables
	Seo (2005)	Construction of a combined prediction mechanism that considers the existing prediction method and the development of a leading index for predicting fluctuations in real estate prices
	Sohn et al. (2003)	Evaluation of the importance of the basic market value before and after the international monetary fund (IMF) and the construction of a real estate price prediction model that applies the VAR model
	Yoo (2008)	Analysis of the influence of adopting governmental policies on the residential market during the government participation period
	Lim (2005)	Analysis of a regression model of the relationship between the profit rate and the asymmetric risk measurement value during the distribution of the real estate profit rate
	Jung (1999)	Analysis of the mutual relationship between each asset price and over-sensitivity, and analysis of the fluctuation in real estate prices as is the subject of the covariance hypothesis
	Jung and Lee (2007)	Application of establishing policies and predicting the real estate economy, and determining an artificial neural network model with a real estate index and a macroeconomic index

In studies related to REITs, Kim (2007a) analyzed the long-term relationship between, and the dynamic

structure of, stock prices and REITs. Kim (2004) deduced the achievement measurement value that reflects REITs' stock price. Park (2003b) and Park and Park (2000) analyzed the properties of profits and the effects of REITs on real estate and the finance industry. Lim (2004) analyzed the effects of a portfolio composed of REITs, stock prices, and bonds. Jang and Shim (2007) analyzed the influence of macroeconomic variables and the relationship among REITs, stocks, and the real estate market. Choi (2005) constructed a profit rate prediction model through the VAR model.

In studies related to real estate prices, Kim (2007b) constructed a portfolio by predicting fluctuations and profits. Kwak and Lee (2006) analyzed the fluctuations in market and residential prices based on changes in real estate policies and economic variables. Seo (2005) analyzed the relationship between the profit rate and prediction methods by developing a leading index of real estate prices. Jung (1999) analyzed the mutual relationship between asset prices and fluctuations in real estate prices as a covariant hypothesis. Jung and Lee (2007) constructed an artificial nerve network model with macroeconomic indicators and a real estate index, and applied the model to predict the real estate economy.

TABLE III
RESEARCH TRENDS CONCERNING STUDY METHODOLOGY

Type	Author	Main Content
Portfolio	Kim (2005)	Analysis of the profit rate of the portfolios of each region/form and comparison of the combined portfolio and profit rate of offices, residential complexes, and apartments
	Seo (1999)	Analysis of the performance of diversified investments through transference of real estate to the portfolios for each region, form, and number of levels
	Lee (2000)	Deduction of the optimum portfolio by measuring the risk capital and the expected profit rate for each investment portfolio using the VAR model
	Ji (1999)	Analysis of the circulatory relationship of the stock, bond, and real estate markets based on fluctuations in the economy
	Hong and Lee (2003)	Analysis of the effects of portfolios in each region with apartments in Seoul, Busan and Daegu as the subjects
	Markowitz Model	Kim and Kim (2008)
Um (2003)		Comparison of the performance of investments in only one asset and of diverse investments
Lee and Jin (2000)		Analysis of investment performance by reinvesting during the same period based on data from a predetermined period in the past

In studies related to portfolios, Kim (2005) analyzed the combined portfolio profit rate of offices, residential complexes, and apartments in regional and categorical classifications. Seo (1999) analyzed real estate investment performance according to region, size, and number of levels by composing a portfolio. Lee (2000) deduced the optimum portfolio by measuring the risk capital and the expected profit rate using the VAR model. Ji (1999) analyzed the circulatory relationship of the stock, bond, and real estate markets. Hong and Lee (2003) analyzed the effects of regional portfolios, with apartments as the subject.

In studies related to the Markowitz model, Kim and Kim (2008) analyzed the investment performance not of the construction industry, which is sensitive to economic fluctuations, but of the funds of the owner of the Samsung Group as the subject of the investment and analysis. Um (2003) analyzed the efficiency of diversified investments by comparing the investment path of diversified investments and investments concentrated on a single asset. Lee and Jin (2000) analyzed the profit rate by reinvesting for the same amount of time as before, based on data from a set period of time in the past; and thus, they could not analyze the validity of future predictions.

REITs are important in securing liquidity and obtaining funds in the construction industry. Studies related to solutions that enhance the profit rate of REIT investments and solutions for activating REITs are insufficient, however, unlike studies related to predicting real estate costs, REIT profits, and the portfolio effects of REITs and real estate, as seen in Table 2 and Table 3. This study contributes to securing liquidity and funds for the construction industry by contributing to activating REITs through the inputs of numerous investors and investment funds by enhancing investors' profit rate.

IV. EMPIRICAL ANALYSIS

A. Analysis Period

In this study, the analysis period was set as approximately one year from July 3, 2007, with the combined stock price index of 1,805.50 until July 21, 2008, and 1,562.92, as shown in Figure 4.

This investment analysis period was selected because it is considered a difficult time for increasing investors' profit rate, as it is when fluctuations related to the declining trend of the combined stock price index is severe, and thus, predicting stock prices is difficult. Accordingly, the period proposed in this study is meant to efficiently judge the validity of the investment results, when the predicted investment results and the actual profit rate of the relevant REITs based on the Markowitz model are compared within this period set as the time limit.

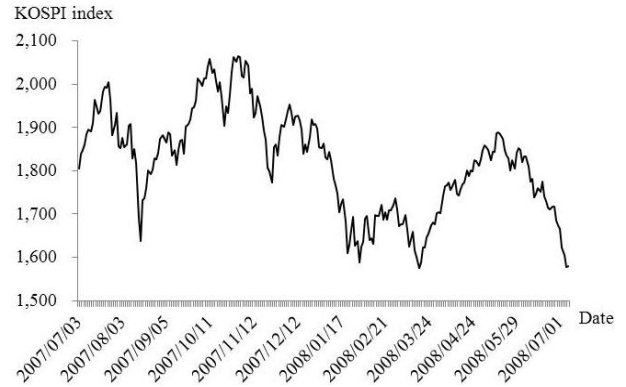


FIGURE IV
THE DEGREE OF FLUCTUATION OF THE COMBINED STOCK PRICE INDEX

B. Investment Candidate

This study analyzed the profit rates of five types of REITs, including the data-gathering period and the investment period in this study, among the REITs listed on the stock market through stock for public subscription. The main contents are shown in Table 4. The REITs collected through private placement are not publicized to the investing public and are not traded on the stock market; thus, those REITs were excluded from this study, as they are inappropriate for executing investment strategies according to the portfolio composition of the Markowitz model.

TABLE IV
RESEARCH TRENDS CONCERNIGN STUDY METHODOLOGY

Term of Data Collection	Jul. 4, 2006 - Jul. 2, 2007
Investment Term	Jul. 3, 2007 - Jul. 21, 2008
REITs Type	Euresmerits No. 1, Kocreb No. 3, Kocreb No. 7, Kocreb No. 8, McQuarry Central Office

The REITs that were not liquidated as of 2009 are Kocreb No. 7 and 8, McQuarry Central Office, and KR No. 2 listed in 2008, as shown in Table 4. If liquidated REITs are included in the study analysis period, they will display their past profit rate, so they were included among the analysis subjects in this study. KR No. 2 was excluded because it was not included during the analysis period and the data-gathering period in this study, as this REIT was listed in 2008. If REITs are activated in the future, results that are more useful will be obtained, as analyses can be conducted on more REITs. Table 5 displays the outline of the REITs selected as the investment subjects in this study.

TABLE V
OUTLINE OF INVESTMENT CANDIDATE REITS

REITs Name	Asset Management Company	Principal Stockholder	Main Investing Real Estate
Eures1 (Aug. 20, 2003)	KayRitz & Pearce Partners	Liquidation (Jul. 29, 2008)	<ul style="list-style-type: none"> • Save Zone (Seongnam, Nowon, Daejun branch) • Hanshin Sports Center • Jangyou Aquawave
Kocreb 3 (Dec. 23, 2003)	Koramco	Liquidation (Aug. 5, 2008)	<ul style="list-style-type: none"> • Hanhwa Securities Building • I-Ville Hill Town
Kocreb 7 (Oct. 25, 2005)	Koramco	Woori Bank Local Administration-Cooperation	<ul style="list-style-type: none"> • DSME Building (Dadong) • GwacheonKolon Annex
Kocreb8 (May 17, 2006)	Koramco	Samsung, Kyobo, Daehan, Shinhan Life, etc.	<ul style="list-style-type: none"> • Geoyang Building • Central Tower
McQuarry (Dec. 23, 2003)	McQuarry Property Adviser	McQuarry Bank, Samsung Life, Schroeder Asia	<ul style="list-style-type: none"> • Geukdong Building

C. Investment and Analysis Method

The investment method in this study involved analyzing the profit rate by composing a portfolio for each expected profit rate, and analyzing the covariance between the variances and REITs and the annual average profit rate of the REITs by collecting profit rate data for the first year since the initial investment date.

First, the one-year profit rate data were collected, with the absolute profit rate provided by the KIS-value library database of the Korea Investors Service as the standard. Through such data, the average profit rate of the REITs and the covariance between each REIT and variance were analyzed, as were the annual average profit rate, annual average risk, and annual covariance.

Second, an investment was made by composing a portfolio for each expected investor profit rate. When determining investments, sometimes investors want a high profit rate regardless of the high risk, and sometimes they want a stable profit rate with low risk. This study deduced the optimum portfolio with the highest profit rate using the Markowitz model after categorizing investors' minimum expected profit rate as 10%, 20%, 30%, 40%, and 50%.

Third, the profit rate based on the deduced portfolio was analyzed, and the lowest commission of 0.015% and a transfer tax of 0.315% were applied.

Fourth, investments at regular intervals were made with the deduced portfolio. The actual profit rate of the

combined stock price index continually fluctuated during the investment period of approximately one year, from July 3, 2007, to July 21, 2008; and thus, the portfolio set up in the early stages of the investment could not be consistently maintained for the year. This study made an investment by setting the period of portfolio investment in four-week units, as seen in Figure 5; when the four-week investment period ended, the oldest four-week profit rate data from the past year were replaced with the most recent four-week profit rate data, and a new portfolio was deduced by applying the Markowitz model after re-analyzing the covariance, variance, and average profit rate of the most recent year based on the replaced data. Using this method, reinvestments were made with constant changes in the portfolio; after the one-year investment period, the actual profit rate of the REITs and the final predicted profit rate were compared, and the efficiency of the proposed investment methods was verified.

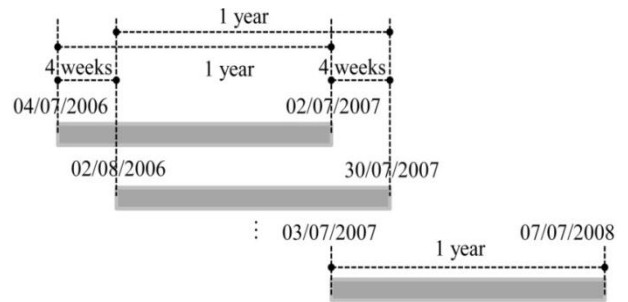


FIGURE V
PROFIT RATE DATA COLLECTION AND INVESTMENT METHODS

D. Investment Results

The profit rates of the relevant REITs for the comparison of the predicted investment results during the investment period are shown in Table 6. Among the REITs, McQuarry Central Office had the highest average profit rate at 148.81%, with 111.24% for Kocreb No. 8, 107.15% for Kocreb No. 7, 43.28% for Kocreb No. 3, and 72.12% for Euromerits No. 1. The actual average profit rate of the relevant REITs was 97.54%. The highest profit rate during the investment period was 5.44% for Euromerits No. 1, 15.07% for Kocreb No. 3, 5.95% for Kocreb No. 7, 10.37% for Kocreb No. 8, and 13.18% with McQuarry Central Office; and the lowest profit rate was -18.57% for Euromerits No. 1, -42.55% for Kocreb No. 3, -4.95% for Kocreb No. 7, -6.05% for Kocreb No. 8., and -2.45% for McQuarry Central Office.

A phenomenon that displays fluctuations and differences in profit rate according to the type of REIT gives investors relatively high risk, which may make the investors passive toward the investment and can lead to a reduction in investment fund inputs in REITs.

TABLE VI
ACTUAL PROFIT RATES OF REITS

Date of Investment	Eures1	Kocreb 3	Kocreb 7	Kocreb 8	McQuarry
Jul. 3, 2007	-1.09%	-2.02%	-0.31%	-0.86%	-2.45%
Jul. 31, 2007	-0.10%	8.36%	-1.54%	0.35%	-1.06%
Aug. 28, 2007	1.61%	0.00%	1.56%	-1.04%	5.91%
Sep. 25, 2007	-8.15%	-0.47%	-0.46%	-0.35%	-0.77%
Oct. 23, 2007	0.33%	2.37%	-4.95%	-0.88%	-0.52%
Nov. 20, 2007	-3.13%	0.46%	2.44%	-0.71%	3.90%
Dec. 18, 2007	5.44%	2.32%	-1.28%	-6.05%	-0.69%
Jan. 15, 2008	0.63%	15.07%	1.12%	-0.19%	3.08%
Feb. 12, 2008	0.52%	0.40%	0.32%	2.47%	6.97%
Mar. 11, 2008	2.19%	5.93%	3.63%	10.37%	4.42%
Apr. 8, 2008	-0.20%	4.86%	3.80%	4.73%	8.81%
May 6, 2008	-18.57%	-40.42%	1.32%	3.73%	0.81%
Jun. 3, 2008	-7.77%	-42.55%	5.95%	4.69%	0.00%
Jul. 1, 2008	-1.50%	-0.93%	-4.11%	-4.48%	13.18%
Total	72.12%	48.38%	107.15%	111.24%	148.81%
Average	97.54%				

The investment results for the year in which the Markowitz model was applied to the profit rate data of the past year, the method proposed in this study, are shown in Table 7.

When the minimum expected profit rate was 30%, the actual profit rate was highest at 120.89%. When the minimum expected profit rate was 40%, the actual profit rate was 109.20%, and 108.88% at 20%, 103.99% at 10%, and 93.61% at 50%.

During the investment period, the highest profit rate was 4.39% with the minimum expected profit rate of 10%, and 6.18% at 20%, 13.18% at 30%, 13.29% at 40%, and 15.04% at 6.18%; and the lowest profit rate was -8.90% with the minimum expected profit rate of 10%, -12.75% at 20%, -17.56% at 30%, -28.55% at 40%, and -40.42% at 50%. Among the actual REITs studied, the profit rate of McQuarry Central Office was higher than that of the investment strategy that followed the proposed Markowitz model, but the total profit rates that followed the change in the minimum expected profit rate increased, as seen in Table 7.

TABLE VII
PROFIT RATES BASED ON THE MARKOWITZ'S MODEL

Date of Investment	10%	20%	30%	40%	50%
Jul. 3, 2007	-1.33%	-1.46%	-1.58%	-1.68%	-1.77%
Jul. 31, 2007	-0.56%	0.41%	2.08%	4.17%	7.40%
Aug. 28, 2007	2.53%	2.04%	1.49%	0.41%	0.15%
Sep. 25, 2007	-3.55%	-2.03%	-0.59%	-0.60%	-0.55%
Oct. 23, 2007	-1.01%	-1.00%	-0.66%	0.07%	0.79%
Nov. 20, 2007	0.86%	1.63%	1.46%	0.89%	0.52%
Dec. 18, 2007	0.31%	-0.69%	0.25%	1.19%	1.99%
Jan. 15, 2008	3.55%	6.18%	9.65%	13.29%	15.04%
Feb. 12, 2008	2.80%	3.33%	3.68%	2.08%	0.40%
Mar. 11, 2008	4.39%	4.57%	5.19%	5.83%	5.93%
Apr. 8, 2008	3.81%	5.04%	5.99%	5.86%	4.86%
May 6, 2008	-8.90%	-12.75%	-17.56%	-28.55%	-40.42%
Jun. 3, 2008	1.97%	1.44%	-0.18%	-0.20%	-0.33%
Jul. 1, 2008	-0.14%	3.28%	13.18%	13.18%	13.18%
Total	103.99%	108.88%	120.89%	109.20%	93.61%
Average	107.31%				

When the minimum expected profit rate was 50%, the actual profit rate was -93.61%, but the total average profit rate was 107.31% with the Markowitz model, higher than the average profit rate of relevant REITs, at 97.54% as seen in Figure 6. The other expected profit rates also showed more than a 10% profit rate than the average profit rate of the REITs. The efficiency of the profit rate can be adjudged as high if the average profit rate of relevant REITs at 97.54% from July 3, 2007, to July 21, 2008, is considered, with the profit rate at 120.89%, when the expected profit rate is 30%.

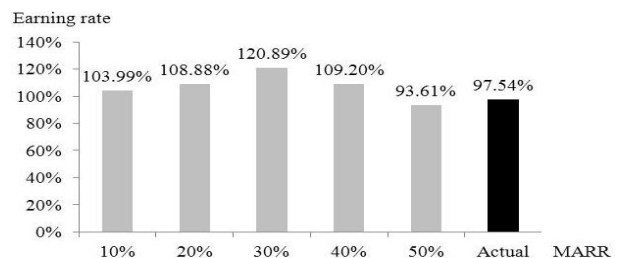


FIGURE VI
ACTUAL EARNING RATE OF REITS AND THE EARNING RATE OF THE MARKOWITZ'S MODEL

V. SENSITIVITY ANALYSIS

A sensitivity analysis was conducted on the profit rate data-gathering period and the portfolio replacement cycle to optimize the efficiency of the REITs investment strategies that follow the proposed Markowitz model. Through this, the optimum profit rate data-gathering period and the portfolio replacement cycle were deduced for applying the Markowitz model.

A. Analysis following the collection term of return rate data

The investment method analyzed in Chapter 4 analyzed the profit rate by restricting the period of gathering the existing profit rate data to one year. If the profit rate data-gathering period changes, however, the covariance, variance, and average profit rate of the REITs changes, as well as the investment portfolio compositional proportion of the Markowitz model; thus, the profit rate of the investment results will also change. Accordingly, this chapter analyzes the degree of the profit rate data-gathering period from which the optimum profit rate can be deduced.

A short-term profit rate data-gathering period has the advantage of being able to proficiently reflect the recent domestic economy, shares, and REITs trends, but has the disadvantage of being affected by external fluctuations, overlooking the essential properties of relevant REITs. The period from July 3, 2007, to July 21, 2008, which was set as the analysis period in this study, is unstable, with a pattern of increases and decreases within the declining trend, as seen in Figure 4. Therefore, the short-term data collection cannot be concluded as having produced excellent investment results that proficiently reflect recent trends. On the other hand, a long-term profit rate data-gathering period has the disadvantage of not being able to reflect recent trends. Accordingly, this chapter analyzed the profit rates following the minimum expected profit rate by changing the data-gathering period into three months, six months, nine months, and 12 months, as shown in Table 8.

Table 8 shows the highest profit rate of 109.43% with the expected profit rate of 40% at the data-gathering period of three months, and the lowest profit rate of 35.61% with the expected profit rate of 20%. At six months, the highest profit rate was 120.63% with the expected profit rate of 20%, and the lowest profit rate was 106.56% at 30%. At nine months, the highest profit rate was 110.68% at the expected profit rate of 30%, and the lowest was 81.66% at 40%. At 12 months, the highest profit rate was 122.65% with the expected profit rate of 30%, and the lowest was 82.81% at 50%.

TABLE VIII
PROFIT RATES BASED ON THE MARKOWITZ'S MODEL

MARR	3 Months	6 Months	9 Months	12 Months
10%	64.40%	111.32%	105.18%	101.84%
20%	35.61%	120.63%	103.54%	111.88%
30%	76.17%	106.56%	110.68%	122.65%
40%	109.43%	120.42%	81.66%	113.72%
50%	108.83%	110.95%	84.50%	82.81%
Total	78.89%	113.98%	97.11%	106.58%
Average	99.14%			

The average profit rate based on the data-gathering period for each profit rate and the average profit rate of the REITs was compared during the same analysis period, as shown in Figure 7. The average profit rate that applied the Markowitz model was highest at 113.98% for the six-month data-gathering period, followed by 106.58% at 12 months, 97.11% at nine months, and 78.89% at three months. The average profit rate of the REITs during the same period showed a profit rate of 97.54%, and this value at six months and 12 months was higher than the actual profit rate of the REITs, but was lower than the actual profit rate of the REITs at three months and nine months, which showed negative profit rates. The average profit rate for nine months was 97.11%, however, showing no significant difference from the actual average profit rate of the REITs at 97.54%. The three-month data-gathering period showed approximately 20% lower values than the actual average profit rates, and can be seen as showing the risk of short-term data gathering during rapid fluctuations in shares.

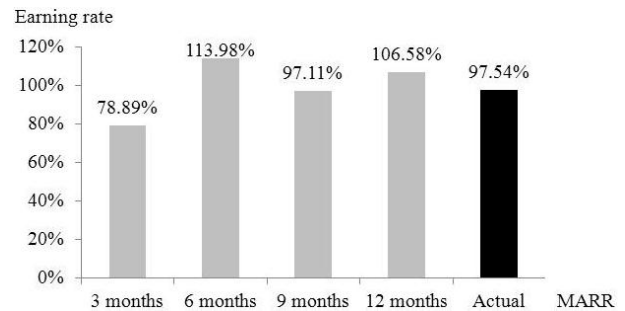


FIGURE VII
THE EARNING RATE ACCORDING TO CHANGE IN THE DATA COLLECTION TERM

B. Analysis following the portfolio replacement period

The investment method in Chapter 4 executed investments by determining the portfolio replacement cycle in four-week units. In this chapter, the profit rate will be analyzed by changing the portfolio replacement cycle in two-week, four-week, six-week, eight-week, and 10-week units. This will reflect recent REITs trends if investments are made by setting the portfolio replacement cycles as short-term, similar to the sensitivity analysis following the profit rate data-gathering period in Chapter 5.1. The investment

analysis result is influenced more by the essential value of REITs than by recent trends if investments are made by setting the replacement cycles long-term. Table 9 shows the profit rate results after the portfolio replacement cycle is changed to two-week, four-week, six-week, eight-week, and 10-week units.

TABLE VIII
SENSITIVITY ANALYSIS FOLLOWING THE PORTFOLIO REPLACEMENT CYCLE

MARR	2 Weeks	4 Weeks	6 Weeks	8 Weeks	10 Weeks
10%	101.01%	103.99%	106.37%	101.84%	99.76%
20%	111.93%	108.88%	114.60%	111.88%	98.80%
30%	127.24%	120.89%	118.35%	122.65%	99.90%
40%	110.46%	109.20%	99.94%	113.75%	77.11%
50%	93.65%	93.61%	82.17%	82.81%	50.86%
Total	108.86%	107.32%	104.29%	106.58%	85.29%
Average	102.47%				

The two-week, four-week, six-week, eight-week, and 10-week profit rate replacement cycle showed the highest profit rates of 127.24%, 120.89%, 118.35%, 122.65%, and 99.90% when the minimum expected profit rate was 30%, and showed the lowest profit rates of 93.65%, 93.61%, 82.17%, 82.81%, and 50.86% when the minimum expected profit rate was 50%. The domestic stock market manifests great fluctuations, as seen in Figure 4; and thus, it is adjudged that the profit rate of a high expected profit rate of 50% would be low, with a high effect of risk. This confirms the basic rule in investments, that the risk is high with a high expected profit rate.

Figure 8 compares the average profit rate of REITs and the average profit values following the changes in the portfolio replacement cycle. First, the profit rate of the Markowitz model, as applied in this study, showed the highest average profit rate at 108.86% when the replacement cycle was two weeks, followed by 107.32% at four weeks, 106.58% at eight weeks, 104.29% at six weeks, and 85.29% at 10 weeks. Excluding the 10-week portfolio replacement cycle, the profit rates were higher than the 97.54% actual average profit rate of all the relevant REITs. Unlike with the profit rate data-gathering period, the short-term portfolio replacement cycle was more advantageous than the long-term cycle.

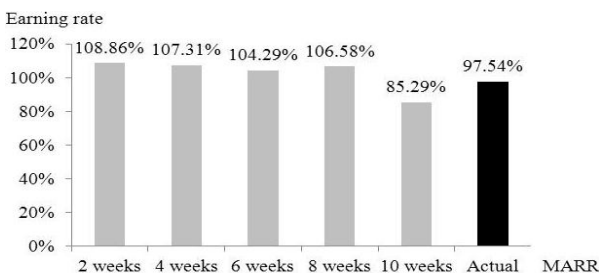


FIGURE VIII
THE EARNING RATE ACCORDING TO CHANGES IN THE PORFOLIO REPLACEMENT CYCLE

VI. CONCLUSION

This study was analyzed to contribute to expanding investments and to raise investors' interest in REITs by proposing the Markowitz portfolio selection model that can increase the profit rate of REITs to revitalize the construction economy and increase the liquidity of construction funds. The three main conclusions of this study are as follows.

First, the covariance between the REITs, and the variances and annual average profit rate of the REITs based on the profit rate data obtained within one year from July 4, 2006, to July 2, 2007, were calculated, and the profit rate was analyzed by composing portfolios for each expected profit rate with a replacement cycle in four-week units during the one-year investment period from July 3, 2007, to July 21, 2008. Five stocks for public subscription REITs—Euomerits No. 1, Kocreb No. 3, Kocreb No. 7, Kocreb No. 8, and McQuarry Central Office—were selected for analysis, and the investment results showed an average profit rate of 107.32%, which is approximately 10% higher than the actual average profit rate of 97.54%.

Second, the investment results were analyzed by changing the profit rate data-gathering period into three-month, six-month, nine-month, and 12-month periods. The highest average profit rate was 113.98% at the six-month profit data-gathering period, and 106.58% at 12 months, 97.11% at nine months, and 78.89% at three months. Compared with the actual average profit rate of REITs during the same period of 97.54%, an approximate 16% profit rate increase was shown at the six-month period, and approximately 9% at 12 months. The low profit rate was manifested due to the three-month data-gathering period, which reflected only the recent data within the unstable market where increases and decreases frequently occur during the investment period.

Third, the investment results were analyzed by changing the portfolio replacement period into two-week, four-week, six-week, eight-week, and 10-week periods. The average profit rate was highest at 108.86% at a two-week replacement period, and was 107.32% at a four-week period, 106.58% at eight weeks, 104.29% at six weeks, and 85.29% at 10 weeks. The profit rate of the replacement periods other than the 10-week period showed higher values than the actual average profit rate of the REITs, and the four-week replacement period showed an increase of approximately 10% from the actual average profit rate of the REITs.

This study contributes to the activation of REITs by increasing investment funds in the REITs market; this will contribute to revitalizing the construction economy and the overall domestic economy by contributing to the number of loans from financial organizations and an increase in liquidity for financing in the construction industry. There were limitations, however, in the efficient display of the effect of portfolios, as the types of stock for public subscription REITs in Korea

remained few. If there were more types of REITs than the five analyzed in this study, investment results with higher profit rates could have been displayed and could have magnified the advantages of portfolio investments. The investment results based on the degree of the effect of portfolios in the construction market and the real estate market will be analyzed in future studies by analyzing the mutual relationship of the real estate market and the construction market.

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