

Strategy for Portfolio Management using Inventory Control Approach

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Abstract

This paper proposes an efficient strategy for portfolio management named SPM with consideration of risk and required return. SPM employs Markowitz's portfolio model to select securities and adopts inventory control scheme (ICS) that is a well-known technique in the inventory control area to revise the current portfolio. Computational experiments using virtual stock prices generated by Monte Carlo simulation method as well as real stock ones of KOSPI for recent 4 years are conducted to show the excellence of the portfolio management under ICS framework. The result shows that SPM is remarkably superior to both 6 or 12 months based periodic portfolio revision method and market (KOSPI index).

Keywords: ICS, Markowitz, Portfolio Management, SPM, Systematic Framework

1. Introduction

Large domestic and foreign fund management institutions operate pension funds, mutual funds, or trillions of dollars invested from other foundations, they indeed have a great deal of responsibility. Therefore, it can be said that way of portfolio management for efficiently operating invested money is essential to fund management. Portfolio management is largely divided into two decision making problems through securities selection: asset allocation and portfolio revision, and portfolio revision is then divided into rebalance and upgrade¹. In the matter of operating portfolio's risk and profit, portfolio rebalance is for recovering its originally intended qualities, that it sells the profited shares and buys shares which the price fell so it can be said as the act of distribution of invested money. Also, through individual assets' relative chance in price, it is a strategy for making equal ratio with the original portfolio formation by buying shares with lowered portfolio formation. On the other hand, Portfolio is upgrade is a revision in

order to either decrease portfolio's risk or increase its expected profit, and it buys or sells stocks reflected on new information.

Generally if the investment period is passed and new information is spread, then the expectations for its systematic risk and unsystematic risk are changed, so the original portfolio formations must be changed in aspects of expected profit and allowed risk. However, during the process of making the revision strategy for portfolio, huge losses occur as the problem in making earnest decisions depending on psychological matters. Also, the ways of portfolio management operated in the manual method have the limit of always being exposed to the change in market situations. Therefore, the introduction of efficient portfolio revision way is required based on determinate system.

In this study, the portfolio selection model with operating principle for traditional Inventory Control Scheme (ICS), that is employed for solving the limitation that portfolio management methods have². For examining its methods' practical usage and excellence which this

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study presented, based on the KOSPI listed stocks during the period of July, 2010 through September, 2010, the research tries to compare and analyze the profits between the portfolio and the market based on the fixed period (6, 12 months) of revision method. Also, the by applying the presented methods to the one thousand imagined items made from Monte Carlo simulation and by actually practicing it, the study tries to verify the capacity for diverse market changes.

2. Existing Research

The representative method for organizing the portfolio, there is the Markowitz MV (mean variance) model, and this single model is for selecting items that show the designated average earnings by decreasing its risks. Through this model, it was theoretically explained that diverse assets must be combined then invested rather than investing in single assets only for increasing the profit. Also, it can be said that the investment strategy depended on past stock files is the most general way, Reference³ presented the actual result of monthly receiving 2% of extra profit due to the strategy of buying stocks based on past month's profit then investing reversely the next month's stocks according to investors' overreactions. On the other hand, Reference⁴ insisted that there is a limit on achieving profit from reverse investment unless one quickly handles the information on investing items. In order to analyze the strategic efficiency on reverse investment, References^{5,6} analyzed their own investment profit after certain period after their investment. As result, based on the period of investment, it proved that earnings for shares with high profit in the past actually decreased, but earnings for shares with low profit in the past actually increased.

Reference⁷, by analyzing the investment strategies based on the past earnings, proved that momentum strategy is efficient for the mid-year investment and that reverse investment strategy is efficient for the long-term investment. The primary factor for such profit is said to be caused from divergence of each share's crossing average profit which organize the portfolio. Especially, it proved that its average profit examined during other examination period can be extracted from the momentum strategy that applied in the mid-year⁸.

Compared to previously presented study on portfolio formation, study on portfolio revision is actually imperfect. Generally, periodical portfolio revision method is largely used and not the revision method based on fixed

strategy. During the process of examining the efficiency on Markowitz model's investment results, Reference⁹ experimented by fixing the revision period to 1, 4, 8, 12 weeks. Reference¹⁰ used Markowitz selection method while organizing the REITs (real estate investment trusts) portfolio, and managed them in fixed cycle (2, 4, 6, 8, 10 weeks). As result, it showed that the profit through the proposed portfolio management method is approximately 10% higher than the average profit from REITs' individual profit. However, the periodic portfolio revision method connotes the limit that it cannot quickly react to the quickly changing market risk. Related to this, Reference[1] applied SPC (statistical process control) chart, which is used in the quality management field, in the portfolio revision problem, and proved that, based on the actual stock data that are in transaction in KRX, AMEX, NYSE, the portfolio revision using the SSPC chart is better than the profit from stock index. In this research, for the portfolio selection model, MAD (mean absolute deviation) was used by changing the model from risk-minimizing to profit-maximizing model, and this was for reflecting SPC chart's management limit to the risk measuring limit. But this profit-maximizing model has a weak point in selecting only a few items when choosing the portfolio items only if appropriate risk measuring limit is satisfied. In order to solve such problem, this study presents the efficient portfolio management method in the basis of the inventory control technique, ICS.

In the third chapter of this research, Markowitz portfolio selection model for its formation will be explained, and in fourth chapter, the ICS and portfolio revision framework will be discussed. In fifth chapter, experiment plan and result analysis, and portfolio management efficiency that used ICS framework will be inspected, and lastly in sixth chapter, the conclusion of this study will be prepared.

3. Markowitz Portfolio Selection Model

Markowitz portfolio selection model, as nonlinear programming model, and by including items that has low relationship between assets under some profit limit, it has a concept of forming a safe and efficient portfolio³. The Markowitz model makes decreasing the dispersion among each item's profit the objective function. Moreover, based on 'the public sale does not exist', it must accomplish the maximum earning rate that investor demands, and it follows a limit of investing all of the available amounts into

portfolio. The Markowitz models used in this research are following.

<Symbols>

N Number of entire items

μ_j Stock j 's average earning rate ($j = 1, 2, \dots, N$),

σ_{ij} Dispersion between stock i earning rate and stock j earning rate,

K Minimum expected earning rate in portfolio,

w_j Stock j 's formation ratio in portfolio ($0 \leq w_j \leq 1$),

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

$$\text{Subject to} \quad \sum_{j=1}^N \mu_j w_j \geq K \quad (2)$$

$$\sum_{j=1}^N w_j = 1 \quad (3)$$

Equation (1), as the objective function, is for minimizing the earning rate's dispersion among items which will organize the portfolio. At the same time of including its items, in Equation (2), the expected earning rate is limited to greater than K . Equation (3) is for investing the entire amount into portfolio.

4. Systematic Portfolio Management

4.1 Inventory Control Scheme (ICS)

ICS is one of the management techniques for inventory control in the manufacturing and its field, and since its operating principles are simple, there is an advantage where the managers' intuitive understanding is possible. Also, since it is possible to efficiently react to resource supply/demand due to unexpected demand, it is widely used in the manufacturing companies. The basic concept of ICS is that if the inventory level falls under the safety stock (s) level, then the orders are placed; here, the number of orders is the amount where the inventory level becomes S by estimating the demand between period of the lead time (L), which is the period between order placed and replenishment. Therefore, ICS starts with defining the safety stock (s) level, order point, and order amount. Especially, ICS has two forms, continuous review and periodic review, according to this stock level monitoring method.

In this study, the ICS, which is for managing the portfolio and its continuous observation, its operating principle is straightforward. When the current stock level reaches the safety stock level, s , ICS order starts and after the period of lead time, L , the stock is filled as much as S amount.

4.2 Systematic Portfolio Management with ICS

In this study, for quantitatively solving the decision making problems related to portfolio selection and revision point, Systematic Portfolio Management (SPM) is proposed by using the method of continuous observation, ICS. For applying ICS for portfolio decision making, ICS's main parts, s and S must be redefined into its management problems. SPM's s defines the minimum demanded earning rate related to portfolio, p , and this is the security market line from capital asset pricing model; CAPM, in other words, it is expressed as the sum of no-risk earning rate and portfolio expected risk premium. s is set up as objective earning rate which the forming portfolio pursues. Also, the current inventory level from the inventory control falls under p 's current earning rate (r_p). Table 1 explains the comparisons of operating principles between ICS and SPM and detailed definitions for SPM's s and S are the following.

Table 1. Comparisons of operating principles between ICS and SPM

Compared Items	ICS	SPM
Monitoring Period	Continuous observation	Continuous observation (daily)
Monitored Items	Inventory Level	Portfolio earning rate(r_p)
Triggering (order/reorganization) condition	Inventory level $\leq$ Safety stock (S)	$r_p \leq$ minimum demanded earning rate(S)
Adjustment methods for Inventory level/ aimed earning rate	Calculating order amount and placing order (Inventory level when warehousing = S)	Markowitz model calculation (aimed earning rate = S)

<Symbols>

N_p	Amount of items included in portfolio p
i	Item index included in portfolio p ($i = 1, \dots, N_p$)
I_m	Market earning rate
R_f	Risk free earning rate
b_p	Portfolio beta
b_p	Amount of beta in stock item i
S_t^i	Price of item i at current time t
$S_{t_0}^i$	Price of item i during recent portfolio formation
E	Security market line
r_p	Portfolio earning rate
r_i	Individual item's earning rate included in portfolio

[SPM]

$$s = \begin{cases} E & \text{if } r_p < s \\ \max(E, 0.7 * \max(r_p)) & \text{otherwise} \end{cases} \quad (4)$$

$$S = \max(I_m + R_f, R_f) \quad (5)$$

$$\text{Here, } r_p = \sum_{i=1}^{N_p} w_i \frac{S_t^i - S_{t_0}^i}{S_{t_0}^i} \quad (6)$$

$$E = R_f + b_p (I_m - R_f) \quad (7)$$

$$b_p = \sum_{i=1}^{N_p} w_i b_i \quad (8)$$

$$b_i = \text{Cov}(r_i, I_m) / \text{Var}(I_m) \quad (9)$$

By continuously observing if the earning rate, r_p , which is the observation target for SPM, decrease below the demanded earning rate, s , at point of $r_p \leq s$, reorganizes the portfolio by using the Markowitz model introduced in chapter three. At then, Markowitz model demand earning rate K is used after substituting it with earning rate s , Equation 5. Equation 4 is in the security market line E (Equation 7) where the portfolio earning rate is lower than the aimed earning rate, but if not, then it is the larger of E and $0.7 * r_p$. By making the s to chase r_p in certain range, portfolio earning rate could be maximized, and especially in examination, it has the effect of preventing the chance of portfolio profit because E is also lowered together. The number used here, 0.7, was decided through pretest of trial and error. The aimed earning rate, S from Equation 5, is the sum of I_m and R_f but noting that the market earning rate at the point of portfolio formation can fall below 0, the minimum demanded expected earning rate was made higher than no-risk interest rate.

Along with s , r_p gets renewed with a new value, and $S_{t_0}^i$ is the unchanging value during the Time Between Update (TBU), from Equation 6, the price of formed items at the point of recently organized portfolio, and S_t^i is the current price where identical items went through daily monitoring. For effective portfolio management, the tradeoff between transaction cost, coming from portfolio earning rate and its revision, must be considered. Therefore, in order to prevent repetitive and unnecessary changes, SPM prevents portfolio reformation within one month of its formation, and this period is defined as FL (Frozen Lead time).

Table 2. Number of shares generated

Starting market price range (unit: Korean Won)	Amount of stock formation
110~1,000	300
1,000~10,000	300
10,000~100,000	300
100,000~1,000,000	80
1,000,000~1,200,000	20
Total	1,000

5. Experimental Results and Analysis

5.1 Experimental Data

In this study, four stock-periodical data are used for examining the effects of SPM. One of them is as the actual stock-periodical data, it is the 759 KOSPI listed stocks and this has a strong relationship with the economy at that time. Another one is 1,000 item's assumed stock generated through Monte Carlo simulation, and has neutral characteristics with the economic situation. The other two data are as the reverse time series of the two data mentioned above, the SPM functions were made to be examined through stock-periodical data. The period for all the stock-periodical data is approximately four years (1,049 business days), and the actual analysis period for KOSPI stocks is from July 6th, 2006 through September 24th, 2010. Because the data used to form portfolio is for one year by using the Markowitz model, the actual data used to manage portfolio is approximately for three years.

In order to form a stock process using Monte Carlo simulation, first, the amount of stock forming is periodically defined, similar to Table 2. In order to make more than two stock processes, one must use Monte Carlo simulation based on Cholesky decomposition.

5.2 Alternative Comparison

In this study, two periodic revisions (P-Revision) were used for analyzing the functions of SPM, and the each revision period is 6 months and 12 months, respectively. P-Revision method also uses Markowitz model in selecting the portfolio items. If we set the KOSPI stock data as S_{KO}^r , Monte Carlo simulated data as S_M , and each reverse-periodical data as S_{KO}^r and S_M^r , then this research summarizes to Table 3. The number of portfolio revision times during the three year period is arranged with comparing alternatives, as it is shown in Table 4. Looking S_M stock

Table 3. Experimental features

Experiment Factor	Type
Experiment data	S_{KO} , S_M , S_{KO}^r , S_M^r
Periodical section	4year (2006.07.06~2010.09.24)
Method for managing portfolio	SPM, P-Revision(6M), P-Revision(12M)
Standard earning rate	Market earning rate (KOSPI Index)

Table 4. Performance comparison

Stock data	Method for managing portfolio	Final earning rate (accumulated)	Revision times (Period: 3 years)	Market earning rate (KOSPI)
S_K	SPM	419%	8times	-5%
	P-Revision(6M)	-15%	6 times	
	P-Revision(12M)	-16%	3 times	
S_M	SPM	134%	4 times	-2%
	P-Revision(6M)	10%	6 times	
	P-Revision(12M)	4%	3 times	
S_{KO}^r	SPM	126%	12 times	8%
	P-Revision(6M)	-16%	6 times	
	P-Revision(12M)	-17%	3 times	
S_M^r	SPM	216%	6 times	3%
	P-Revision(6M)	9%	6 times	
	P-Revision(12M)	3%	3 times	

data in this chart, SPM and P-Revision(6M) recorded same number of revision times (6 times) during the same period, but in the final earning rate, SPM shows more than approximately 13 times better result than P-Revision(6M). This means that, even though item selection for efficient portfolio management is important, setting the time period of its revision is much more important.

6. Conclusion

One of the most difficulties in managing the portfolio was portfolio revision that it is done generally or through investor's intuition. This not only brings huge risk via diverse finance market changes but it also has problems that brings side effects on its revisions that seek after short-term earning rates. In this study, portfolio was organized through Markowitz model, and in order to set the revision point as quantitative way, a well-known inventory control technique, ICS, imported SPM portfolio management method was introduced. The SPM's function proved its excellence with four types of stock periodical data by comparing the periodical portfolio revision method, P-Revision (6M & 12M), and the market earning rate. Other than its excellence, we believe it has significance in showing the possibility of making the manufacturing management or management science field's existing decision-making method to become successful in the finance and its management fields.

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8. References

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