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Article

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Global Business & Finance Review (GBFR)

Provided in Cooperation with:
People & Global Business Association (P&GBA), Seoul

Suggested Citation: Cheong, Mun-Kyung; Kim, Yong-Hyeon; Kim, Kyoung-Ha (2023) : Management of the pension fund in Korea: Sharpe ratio as a measurement, Global Business & Finance Review (GBFR), ISSN 2384-1648, People & Global Business Association (P&GBA), Seoul, Vol. 28, Iss. 6, pp. 95-111,
https://doi.org/10.17549/gbfr.2023.28.6.95

This Version is available at:
https://hdl.handle.net/10419/305929

GLOBAL BUSINESS & FINANCE REVIEW, Volume. 28 Issue. 6 (NOVEMBER 2023), 95-111
pISSN 1088-6931 / eISSN 2384-1648 | Https://doi.org/10.17549/gbfr.2023.28.6.95

GLOBAL BUSINESS & FINANCE REVIEW

www.gbfrjournal.org

Management of the Pension Fund in Korea: Sharpe Ratio as a Measurement

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A B S T R A C T

Purpose: This study criticizes the existing benchmarks of the national equity fund specified by the National Pension Service and proposes alternative benchmarks.
Design/methodology/approach: First, this study investigates whether the existing benchmarks returns are affected by the value and momentum factors. Second, we examine the effects of different factors on the benchmark returns of internal and outsourcing investments. Third, we propose three benchmarks by including the value factor and/or momentum factor. Finally, the Sharpe ratios of return-to-risk are used to measure these proposed benchmarks compared to the existing benchmarks.
Findings: First, the existing benchmarks of internal and outsourcing investments are associated with value and momentum factors, which have been observed in many other countries. Second, the Sharpe ratios of the three proposed benchmarks - value oriented, momentum oriented, and value & momentum oriented - are always better than the existing benchmarks. Third, the Sharpe ratio of the value oriented benchmark is better than that of the momentum oriented and value & momentum oriented benchmarks. Finally, the Sharpe ratios are better with increased investment weights of value and/or momentum.
Research limitations/implications: This study uses the Sharpe ratio to measure the return-to-risk relationship. There could be other measures to capture the relationship.
Originality/value: This is the first research to analyze the national pension equity fund with proposed benchmarks in the Korean market.

Keywords: National pension fund, Benchmark, Factor investing, Sharpe ratio

I. Introduction

The size of domestic stocks in the National Pension Fund's is about 96.86 trillion Korean won as of the end of 2014. The size is rapidly increasing, and half of it is entrusted to outsourcing (or external) management companies, as of the end of 2014[1]).

Barberis and Schleiffer (2003) theoretically demonstrates that fund performance varies when a fund is invested with a different goal. The National Pension Investment Guidelines established by the fund management committee in Korea specify that internal (or direct) investment should be aimed at passive management, whereas outsourcing (or external) investment must be aimed at active investment. The committee also specified that the benchmark of

Received: Jul. 24, 2023; Revised: Sep. 1, 2023; Accepted: Sep. 8, 2023

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1) The National Pension Service has been reluctant to release the recent data. Due to this limitation, the latest data is from 2014.

domestic stocks is the KOSPI, that of internal investment is the KOSPI200, and that of outsourcing investment is the composite index of KOSPI and KOSDAQ100, respectively[2].

The purpose of this study is to analyze both the appropriateness of the existing internal investment and outsourcing investment benchmark through return-to-risk analysis and to propose enhanced benchmarks. For this, we research a literature study on the theoretical basis of internal and outsourcing investments. We then analyze both the existing benchmarks of internal and outsourcing investment of domestic stocks while discussing the need to improve benchmarks. Finally, we propose the new benchmarks, and show that these are superior to the existing benchmarks.

The rest of this paper proceeds as follows. Section II reviews the previous literature. In Section III, we present data and methodology. We report empirical results for proposed benchmarks in Section IV. Section V concludes this paper.

II. Literature Review

A. Agency Problem in Outsourcing Fund

Pension funds generally operate pension assets by hiring outsourcing (or external) fund managers. External management has an agency problem with the owner, where the principal is the asset owner who entrusts the asset to the fund manager, and the agent is the fund manager who has been entrusted with the asset management. Since the National Pension Service (NPS) entrusts the management of stocks, bonds and alternative assets to fund managers, the NPS becomes the owner and external fund managers become agents.

The role of NPS is to select asset managers who are specialized in a single asset class of stocks, bonds, or alternatives. Thus, asset allocation decisions are made in two stages. Specifically, after the NPS allocates funds to the different asset classes, managers of these different asset classes decide how to allocate the capital given to them. The two-stage process could generate the agency problem in the investment horizon. The investment horizon of the fund managers is relatively short since they are compensated on an annual basis. The NPS, in contrast, has a longer investment horizon. The agency problem arises because the NPS acts in the best interests of the beneficiaries, while the managers wish to maximize their own annual compensation.

Binsbergen, Brandt, and Koijenn (hereafter BBK, 2008) show that an optimally designed benchmark improves the alignment of incentives between the principal and the agent, and mitigates the agency problem of two-stage decentralized investment management.

The design of an investment mandate could be very important to solve the agency problem. Specifically, Ang (2014) argued that the agency problem can be alleviated through the design of appropriate benchmarks. He advocates that factor benchmarks can induce fund managers to perform better than benchmarks by appropriately changing the weight of factors (market timing) or exercising their ability to select stocks depending on the economy. The factor benchmarks also play a role in risk sharing between fund managers and asset owners. It is known that the fund managers' skill can be divided into two dimensions of market timing and stock selection (e.g., Kacperczyk et al. (2014); Shin et al. (2021)). The risks of the market and factors are allocated to the owner, and the risks of stock selection and market timing are allocated to the fund manager, and hence the portfolio risks can be distributed between the owner and the agent.

This argument strongly indicates that stock market indexes cannot be appropriate benchmarks for investment management, and the market indexes must be replaced by factor benchmarks or rebalancing benchmarks. In conclusion, benchmarks such as market indexes are not appropriate for alleviating the agency problems related to external (or outsourcing) investment

2) KOSPI stands for Korea Stock Price Index, and KOSDAQ stands for Korean Securities Dealers Automated Quotations.

management. Instead, factor benchmarks containing management strategies and directions can be better benchmarks that align the interests of fund managers and asset owners.

We argue that the existing benchmarks should be modified to style benchmarks which can obtain both the value premium and momentum premium and propose three benchmarks. We then analyze the return-to-risk analysis of the proposed benchmarks for internal and outsourcing investments of the national pension assets in Korea. With our proposed benchmarks, we show higher returns and lower risks, and hence improved Sharpe's ratio.

BBK (2008) presents a theoretical model that analyzes the difference between internal investment and outsourcing investment. Internal investment can form an optimal portfolio by considering the expected return of all assets and the covariance between assets at the same time; while outsourcing investment first considers strategic asset allocation (equity/bond or asset allocation of stock and bonds) and then forms an optimal portfolio for each asset. Therefore, outsourcing investment creates a diversification loss that does not exist in internal investment; so outsourcing investment forms a portfolio with lower performance for risk than internal investment does from the perspective of overall funds.

In addition, the interests of the principal (the committee) and agent (outsourcing fund managers) are different. The committee prioritizes the interests of the fund, while the outsourcing investment managers develop a portfolio in the interests of their own compensation. Moreover, since the risk propensity and investment horizon of the committee and the fund managers are different, the agency problem occurs, resulting in diversification losses.

Benchmarks restrict the investment behavior of outsourcing fund managers and induce the managers to invest in accordance with the goals of owners. Specifically, in the absence of benchmarks, the fund manager's goal is to maximize the absolute value of the outsourcing fund. Whereas, when benchmarks are given, the goal becomes to maximize the relative value compared to the benchmark. In other words, when benchmarks are not given, the fund managers value absolute returns on assets whereas when benchmarks are given, they value relative returns compared to given benchmarks.

In addition, the composition of the portfolio varies greatly depending on the risk aversion tendency of the fund manager, in the absence of benchmarks. Specifically, if the fund manager of bonds is risk tolerant, he tends to increase the weights of bonds with credit ratings BBB or lower in the bond portfolio in the absence of bond benchmarks. On the other hand, if the fund manager is risk averse, she tends to increase the weights of bonds with a high credit ratings AA or higher in the bond portfolio. This is not a desirable investment pattern from the perspective of the principal. In contrast, if a bond benchmark exists, the risk of a bond portfolio is measured as risk relative to the benchmark (active risk or tracking error), and hence fund managers form the same weights as the benchmark to avoid the risk. In other words, the fund manager tries to constitute a portfolio in accordance with the owner's interests.

Even if bond managers pursue active risk, bonds are invested in accordance with the weights of bond benchmarks. Therefore, the fund managers are more likely to make decisions that match the interests of the principal (i.e., benchmark-oriented decisions) in the presence of benchmarks. BBB (2008) compares the objective function and optimal investment weights without a benchmark to those of with a benchmark.

1. Objective function and optimal investment weights without a benchmark

- Objective Function: $max\ E(\frac{1}{1-\gamma_i} W_T^{1-\gamma_i})$
- Optimal Investment Weights:

$$x_i^{NB} = \frac{1}{\gamma_i} x_i + \left(1 - \frac{x_i' l}{\gamma_i}\right) x_i^{MV}$$

where

γ_i : the coefficient of relative risk aversion.

i : the asset managers 1, 2, and principal.

W_{T_i} : the portfolio value at the end of the investment

horizon.

x_i^{NB} : the weights of asset manager i (value stock and growth stock for stock manager; AA bond, BBB bond and government bond for bonds manager).

x_i : the (myoptic) weights of asset managers.

x_i^{MV} : the minimum-variance weights.

Due to the two-stage decision-making process described earlier, the optimal portfolio of outsourcing investment is an inefficient portfolio with higher risks and lower returns than internal investment. In internal investment, the number of assets is 2k+1 (the number of stocks, bonds, and cash), and investments are made in consideration of their covariance. However, in outsourcing investment, each asset manager invests in the number of k assets. Therefore, the portfolio risk of outsourcing investment is greater than that of internal investment.

2. Objective function and optimal investment weights with a benchmark

- Objective Function: $max\ E\left(\frac{1}{1-\gamma_i}\left(\frac{W_{i,T}}{B_{i,T}}\right)^{(1-\gamma_i)}\right)$
- Optimal Investment Weights :

$$x_i^{NB}=\frac{1}{\gamma_i}x_i+\left(1-\frac{1}{\gamma_i}\right)\beta_i+\frac{1}{\gamma_i}(1-x'_i l)x_i^{MV}$$

where

β_i : the weights of benchmark i (value stock and growth stock for stock benchmark; AA bond, BBB bond and government bond for bonds benchmark)

The committee can minimize diversification losses of outsourcing investment by constructing optimal benchmark β_i. The fund manager's investment weights can be matched with the committee's optimal investment weights by evaluating performance related to benchmark and paying performance-based compensation. In other words, by designing outsourcing investment benchmarks appropriately, the committee can match the pension fund's investment strategy with the fund manager's investment goals. In conclusion, appropriate benchmarks of outsourcing investment play an important role as a means to align the pension fund's long-term goals with the fund manager's short-term investment goals.

B. Factor Investing

1. CAPM

Factor investing is investment into stocks considering risk factors, and factor explains the return-to-risk relationship of an asset. Therefore, factor investing is a stock investment that reflects the characteristics of risk factors which affect returns. The first factor model can be the capital asset pricing model (CAPM).

Stock returns are determined by the risk premium for stock risk, which in CAPM refers to the relationship between market portfolio and stock movements, and is measured in beta. Stocks with higher beta than market beta can expect higher returns than market returns, while stocks with lower beta than market beta can expect more stable returns than market returns. Therefore, in CAPM, a factor to consider is market beta, and factor investing is an investment strategy that obtains a market risk premium by associating a portfolio with a market beta. The CAPM can be said to be a one-factor model.

2. Fama and French (1993) three factor model

Fama and French (1993) explains stock returns have three factors: market, size, and value/growth. They introduced the size factor. Small-capitalization stocks tend to achieve higher returns than large-capitalization stocks, even after eliminating other risk factors. Therefore, investors who invest in small-cap. stocks gain a size premium. This phenomenon was discovered by Banz (1981), and Fama and French include this effect in their model. This represents the difference in returns between small-capitalization and large-capitalization companies and is expressed as Small stocks Minus Big stocks (SMB). The SMB factor is, in general, the stock performance of small-cap. stocks is superior to that of large-cap. stocks.

In the meanwhile, Berk, Green and Naik (1999) argued that firm value is determined by the company's current assets and investment options, and CAPM does not sufficiently reflect the value of the second corporate investment option. When managers exercise investment options, firm value increases, so the value stock factor acts as a separate risk factor from market risk of the CAPM.

Zhang (2005) advocates that value companies possessing a large proportion of buildings and machinery cannot properly dispose of them when the economy suffers, while growth companies possess low corporate restructuring costs because they consist of mostly software and young people. Thus, value companies are riskier compared to growth companies, and higher risk premiums are required for the stocks. The scholars argued that value stock investors should be long-term investors waiting for the recovery of the economy, and short-term investors are less likely to make profits using the value premium for this reason.

Fama and French (1993) also introduce High book-to-market stocks Minus Low book-to-market stocks (HML), which represents the difference between the portfolio return of companies with large book value to market capitalization and that of companies with small book value to market capitalization. It refers to a strategy of purchasing value stocks and selling growth stocks. The HML factor is that, in general, value stocks perform better than growth stocks. The Fama and French (1993) three factor model[3] is as follows.

$$E(r_i) = r_f + \beta_{i,mkt}E(r_m - r_f) + \beta_{i,SMB}E(SMB) + \beta_{i,HML}E(HML)$$

3. Carhart (1997) four factor model

Carhart (1997) developed a four-factor model by adding momentum factors to the Fama and French (1993) three factor model described earlier. The momentum strategy is an investment strategy that purchases stocks which have risen in the past six or twelve months (winners) and sells stocks which have fallen in the past six or twelve months (losers). The momentum strategy predicts performance by comparing winners with losers at a specific point in time. It advocates that stocks which have risen in the past are relatively more likely to increase in the future than stocks which have fallen. This momentum premium was discovered by Jegadesh and Titman (1993). Carhart (1997) four factor model[4] is as follows.

$$E(r_i) = r_f + \beta_{i,mkt}E(r_m - r_f) + \beta_{i,SMB}E(SMB) + \beta_{i,HML}E(HML) + \beta_{i,UMD}E(UMD)$$

Daniel and Moskowitz (2013) compare the returns of winners, losers, market portfolio, and risk-free bonds, and find a momentum effect showing performance in the order of winners, market portfolio, risk-free bonds and losers. They also find that momentum strategies often have short-term reversals.

In general, the size (SMB) premium is much less than the value (HML) and momentum (UMD) premiums in almost every country nowadays, so the size premium has disappeared. It is believed that the size premium effect may be the result of data mining (Alquist et al.(2018)).

The excess return on stock investment (alpha, α) can be decomposed into the fund manager's ability, SMB, HML, and UMD factor premiums. However, since the benchmark of internal investment is simply designated as a composite index of KOSPI200 and that of outsourcing investment is designated as a composite index of KOSPI and KOSDAQ100, factor premiums could not be properly reflected in the internal and outsourcing investment benchmarks. The reason is that the composite indexes of the KOSPI200, KOSPI, and KOSDAQ100 are market indexes which do not reflect factor premiums. Ou-Yang (2003) advocates that the market index benchmarks do not

3) Yun & Kim (2022) also used the Fama and Frecnch model to analyze the relationship between distress risk and the stock returns of firms.

4) The Carhart model was also used to investigate national pension fund performance (e.g., Cheong et al. (2020)).

induce the fund managers to act in the interests of asset owners. Ang (2014) also argues that the fund's operational reference portfolio needs to be established, and this reference benchmark should be an index reflecting factor premium. Therefore, fund managers should take a stock trading strategy that exceeds the reference benchmark and should be evaluated based on that benchmark. To this end, the fund committee should reflect the factor premium in the benchmark by determining the market beta, size factor beta, value beta, and momentum beta in the reference benchmark.

C. Factor Investing, Passive Investing, and Active Management

Factor investing can be represented as an intermediate stage between market index investment and active management as shown in Figure 1. It is invested by fund managers with the aim of achieving more excess return than the factor benchmarks do. Factor investing is similar to index funds in that it can be passively invested around the style index. Factor investing also could be a part of active management in that it analyzes and invests into new factors.

The differences between active management and factor investing are as follows. The active management seeks diversification of management by hiring fund managers with stock selection and market timing capabilities. The committee uses investment strategies through strategic asset allocation and the selection of fund managers. It also pursues more excess return (alpha) compared to the benchmarks, which relies on fund managers' stock selection and market timing capabilities to achieve alpha. In addition, it employs many outside experts as fund managers to contribute to diversity.

In the meanwhile, factor investing pursues investment diversification through designing various factor indexes. The committee presents a factor index to the fund manager to achieve higher returns and lower risks than the market portfolio. Factor investing could be a part of active management because the excess return compared to the factor benchmark is considered active investment return. In addition, the committee can hire internal fund managers at a lower cost than external fund managers, and can also hire outsourcing fund managers.

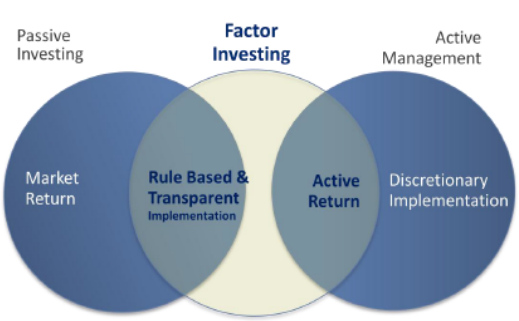


Figure 1. Factor investing,k passive investing, and active management

III. Data and Methodology

A. Data

According to the National Pension Investment Guidelines, domestic stock investment is classified as internal (or direct) investment and outsourcing (or external) investment. The former is for a passive style while the latter is for an active style.

The following data were used to analyze whether the internal investment benchmark and outsourcing investment benchmarks of the NPS were effectively designed to the intended characteristics of fund management: daily and monthly data of the benchmark indexes of internal investment and outsourcing investment from 2002 to 2014 as well as the SMB, HML, and UMD indices of FnGuide.

The stock data set is provided by Fn-Guide, a financial data provider in Korea. According to the Fama-French method, stocks listed on the KOSPI and KOSDAQ markets are ranked at 50%/50% based on market capitalization at the end of June of each year during the sample period. We created three groups of 30%/40%/30% of stocks in each market

size group based on the book value of net assets divided by the market value at the end of December of the last year. For the six portfolios in total, the weighted average returns for each portfolio are calculated by holding one year. The SML (small minus big) portfolio returns are the differences in average returns for the three small and three large portfolios, and the HML (high minus low) portfolio returns are the differences in average returns for the two small and two large book-to-market portfolios, based on the return data of the six portfolios. We calculated the return of momentum factors following Carhart's methodology. Three groups of 30%/40%/30% were generated based on the stock returns over the past 11 months between t-12 month and t-2 month. The equally weighted returns for each portfolio were calculated by holding one month t. The momentum factor of the month t is the difference between the average return of the top 30% portfolio with high past performance and that of the bottom 30% portfolio with low past performance (Cheong et al.(2020)).

As explained earlier, the committee of NPS specified that the benchmarks used were domestic stocks as the KOSPI, internal investment as the KOSPI 200, and outsourcing investment as the composite index of KOSPI + KOSDAQ 100, respectively. This is shown in Table 1.

B. Excess Returns of Internal Investment and Outsourcing Investment Benchmarks

Table 2 shows the excess returns of internal investment and outsourcing investment benchmarks (BMs) compared to the KOSPI, respectively. Since outsourcing investment began in 2007, the internal investment period was divided into overall periods starting with 2007 to compare outsourcing investment.

The average excess return of the internal investment benchmark is 0.01% per month and the standard deviation is 0.584% per month for overall periods from January of 2002 to December of 2014. The average excess return of the outsourcing investment benchmark is -0.021% per month and the standard deviation is 0.187% per month, while the average excess return of the internal investment benchmark is -0.018% per month and the standard deviation is 0.640% for periods from January 2007 to December 2014.

As a graphical presentation of Table 2, Figure

Table 1. Stock benchmark Index specified by the fund management committee

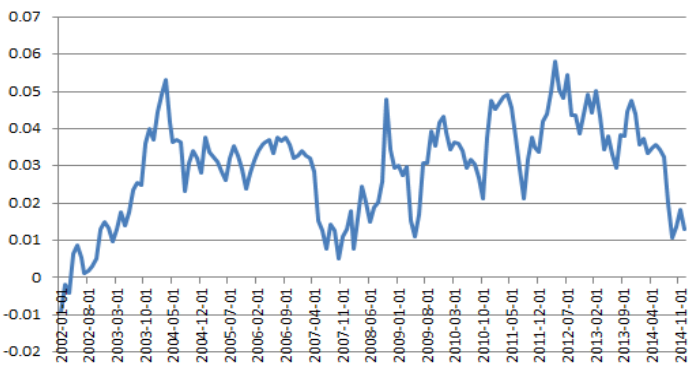
Category	Benchmark index	Remarks
Domestic stock (total)	KOSPI (including dividends)	
Internal investment	KOSPI200 (including dividends)	
Outsourcing investment	Composite index of KOSPI (including dividends) and KOSDAQ100	Weighted average by market capitalization

Table 2. Excess return of internal investment benchmark and outsourcing investment benchmark compared to domestic stock benchmark

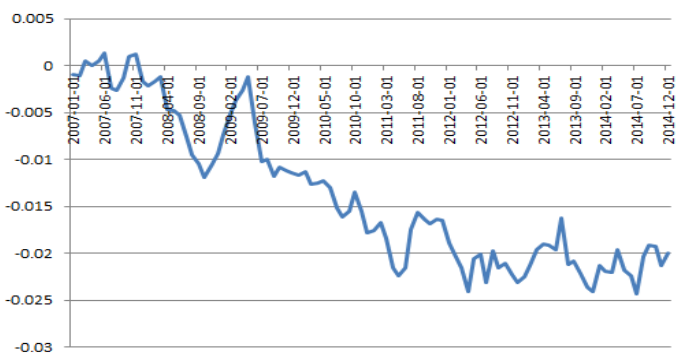
	Internal investment BM minus KOSPI (Jan. 2002~Dec. 2014)	Outsourcing investment BM minus KOSPI (Jan. 2007~Dec. 2014)	Internal investment BM minus KOSPI (Jan. 2007~Dec. 2014)
Average	0.010%	-0.021%	-0.018%
Median	-0.008%	-0.015%	-0.052%
Maximum	2.174%	0.416%	2.174%
Minimum	-1.425%	-0.499%	-1.425%
Std. dev.	0.584%	0.187%	0.640%
No. of obs.	156	96	96

2 presents the cumulative returns of internal and outsourcing investment benchmarks compared to domestic stock benchmarks of KOSPI for different periods, respectively.

Panel A. Cumulative excess returns of internal investment benchmark (Jan. 2002~Dec.2014)



Panel B. Cumulative excess returns of outsourcing investment benchmark (Jan. 2007~Dec.2014)



Panel C. Cumulative excess returns of internal investment benchmark (Jan. 2007~Dec.2014)

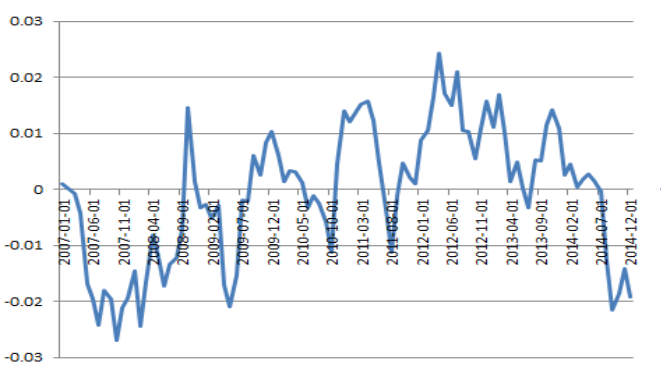


Figure 2. Cumulative excess returns of internal investment benchmark and outsourcing investment benchmark compared to domestic stock benchmark

The cumulative excess return of the outsourcing investment benchmark has steadily declined, while that of the internal investment benchmark has declined in the second half of 2006 after showing an upward trend from 2002 to 2004. After that, it fell sharply during the financial crisis from late 2008 to early 2009, and then showed an upward trend before falling sharply again in the second half of 2013. This could be attributed to the KOSPI200 index moving similarly to large-capitalization stocks. However, the cumulative excess return of the outsourcing investment benchmark has continued to decline since 2007. Both internal investment benchmark and outsourcing investment benchmark have performed worse than domestic stock benchmark since 2007.

C. Factor Analysis of Internal and Outsourcing Investment Benchmarks

An analysis of the internal investment and the outsourcing investment benchmarks is needed to understand the investment direction of the committee. By doing so, we figure out which risk factor premiums the committee is concerned with. We analyze how the internal and outsourcing investment benchmarks change against the market, size, value, and momentum factors using the Carhart's model.

$$R_{i,t} - R_{F,t} = \alpha_i + b_i(R_{M,t} - R_{F,t}) + s_i SMB_t + h_i HML_t + m_i UMD_t + e_{i,t}$$

where

$R_{i,t}$: the return of the internal and outsourcing investment benchmarks.

$R_{F,t}$: the risk-free return.

$R_{M,t}$: the return of KOSPI.

SMB_t : size factor (small-cap. return minus large-capt. return).

HML_t : book-to-market factor (value style of high book-to-market return minus growth style of low book-to-market return).

UMD_t : momentum factor (high past eleven-months return minus low past eleven-months return).

IV. Empirical Results

A. Analysis of Diversification Effect

In summary, the committee divided the national pension domestic stock investment into internal investment and outsourcing investment for diversification. It sets KOSPI200 and KOSPI+KOSDAQ100 as benchmarks for internal investment and outsourcing investment, respectively. Since the KOSPI200 consists of only the biggest 200 stocks among KOSPI, over 500 stocks in the KOSPI are excluded. Excluding 500 stocks can increase risk and decrease returns. In contrast, the combination index of KOSPI + KOSDAQ100 has more than 100 stocks compared to KOSPI, resulting in a risk reduction and return increase.

Panel A of Table 3 shows the descriptive statistics of benchmarks for domestic stock, internal investment, and outsourcing investment.

The return, standard deviation, and return to risk of domestic stock benchmarks are similar to those of internal and outsourcing benchmarks. The benchmarks of internal investment show increased return and risk compared to domestic stock, while outsourcing investment benchmarks show decreased return and risk, resulting in a similar return to standard deviation. Panel B of Table 3 shows the correlation coefficients of benchmarks for domestic stock, internal investment, and outsourcing investment.

The correlation coefficient between the benchmark of domestic stocks and internal investment is 0.9938, and the correlation coefficient between the benchmark of domestic stocks and outsourcing investment is 0.9995, showing a high degree of correlation. Therefore, the risk diversification effect of the benchmark index of internal investment and outsourcing investment could not be significant.

Table 4 shows the average return and risk of the portfolio when investing in the internal investment and outsourcing investment benchmarks, with weights of (50%/50%), (60%/40%), and (40%/60%).

The table shows that the average returns of the portfolios across all different investment weights are

Table 3. Descriptive statistics of benchmark indexes

Panel A. Return and standard deviation of existing benchmarks

	Returns (month)	Std. dev. (month)	Return / Std. dev.
Domestic stock	0.958%	6.572%	0.146
Internal investment	0.984%	6.807%	0.145
Outsourcing investment	0.946%	6.556%	0.144

Panel B. Correlation coefficients of existing benchmarks

	Domestic stock	Internal investment
Domestic stock	1.0000	-
Internal investment	0.9938	1.0000
Outsourcing investment	0.9995	0.9910

Table 4. Return and risk to different weights for internal investment benchmark and outsourcing investment benchmark

	Domestic stock benchmark	Internal and outsourcing weights		
		50%/50%	60%/40%	40%/60%
Average return (month)	0.958%	0.965%	0.969%	0.961%
Standard deviation (month)	6.572%	6.670%	6.696%	6.646%
Return to risk	0.146	0.145	0.145	0.145

higher than those of the domestic stock benchmark. Therefore, both the internal investment benchmark and outsourcing investment benchmark could be inferior to the domestic stock benchmark. This could be attributed to the correlation coefficient between internal and outsourcing investment benchmarks being very high at 0.9910, and failing to achieve the diversification effect of the portfolio.

B. Factor Analysis of Internal and Outsourcing Investment Benchmarks

Table 5 shows the statistics of SMB, HML, and UMD factors, respectively, from 2002 to 2014.

The factors of size (SMB), book-to-market (HML) and momentum (UMD) increase by 0.350%, 1.359%, and 0.873%, respectively, during the period. The HML and UMD are statistically significant, but SMB is not significant. The significant results of this paper are consistent with many overseas papers, as mentioned in the literature review section.

Table 5. Statistics of SMB, HML, and UMD factors

	SMB	HML	UMD
Average	0.350%	1.359%	0.873%
Std. dev.	4.561%	3.395%	4.608%
t-statistics	0.840	4.385	2.076

As mentioned in the introduction section, fund performance varies when a fund is invested with a different goal. The committee specified that internal investment should perform passive management, while outsourcing investment must perform active investment. Therefore, we need to analyze how internal investment and outsourcing investment benchmarks respond to risk factors around Market, SMB, HML, and UMD. For this, Carhart's four factor regression is performed. The monthly return of internal investment and outsourcing investment benchmarks are the dependent variables and the monthly return of the market (KOSPI), SMB, HML, and UMD are the explanatory variables. The beta of each month was estimated using monthly data

Table 6. Regression results of Carhart's four factor model for internal investment and outsourcing investment benchmarks

Panel A. Alpha and beta estimates for internal investment benchmark

	Alpha	Market	SMB	HML	UMD
Average	0.126%	1.001	-0.0638	-0.0138	-0.0163
Std. dev	0.717%	0.030	0.0382	0.0322	0.0187
t-stat.	1.919	0.396	-18.3145	-4.7030	-9.5748

Panel B. Alpha and beta estimates for outsourcing investment benchmark

	Alpha	Market	SMB	HML	UMD
Average	-0.058%	0.994	0.026	-0.015	0.002
Std. dev.	0.770%	0.005	0.005	0.007	0.004
t-stat.	-0.581	-8.582	38.826	-15.589	3.645

from the past 3 years (36 months). Based on this, the alpha of the next month was estimated. Alpha and beta were estimated by rolling over in this way until December 2014.

Panel A and Panel B of Table 6 are the regression results of Carhart's four factor model for internal investment and outsourcing investment benchmarks, respectively.

As shown in Panel A, the internal investment benchmark has a market beta of 1.001 which is the same level as the market beta of 1. The betas of SMB, HML and UMD are -0.0638, -0.0138, and -0.0163, respectively, which are statistically significant. Therefore, the internal investment benchmark (KOSPI200) has the same market beta as KOSPI. It is also a benchmark composed mainly of large-cap., growth, and low-momentum stocks. Alpha return of 0.126% is the excess return of the internal investment benchmark which is not explained by Carhart's four-factor model.

As shown in Panel B, the outsourcing investment benchmark has a market beta of 0.994 which is lower than the market beta of 1. The betas of SMB, HML and UD are 0.026, -0.015, and 0.002, respectively, which are statistically significant. Therefore, the outsourcing investment benchmark (KOSPI+KOSDAQ100) has a market beta lower than KOSPI. It is also a benchmark composed mainly of small-cap., growth, and high-momentum stocks. Alpha of -0.058% is not statistically significant.

In a nutshell, the benchmark return of internal and outsourcing investments is affected by different factors. Specifically, internal investment benchmarks are affected by large-cap, growth, and low momentum stocks, while outsourcing investment benchmarks are affected by small-cap., growth, and high momentum stocks.

C. Proposed Benchmarks

Now we can argue that internal and outsourcing investment benchmarks should be modified to style benchmarks which can obtain value premium (HML) and momentum premium (UMD). Since the HML and UMD are statistically significant in this paper and similar results have been found in many other papers (e.g., Fama and French (1993 & 2015); Carhart (1997)), the internal and outsourcing investment benchmarks should be designed in a way that utilizes them.

This section designs two ways to propose enhanced benchmarks. The first enhanced benchmark is to include the value and momentum factors into the domestic stock benchmark (KOSPI). The second enhanced benchmark is to include the value and momentum factors into the internal investment benchmark (KOSPI200) and outsourcing investment benchmark (KOSPI+KOSDAQ100). Afterwards, the return-to-risk analysis of three proposed benchmarks are performed.

1. Including the value and momentum factors into the domestic stock benchmark of KOSPI

As an alternative to the existing internal investment and outsourcing investment benchmarks, three new enhanced benchmarks of value index and momentum index are proposed. The new benchmarks are simulated based on KOSPI, a domestic stock benchmark, which was designated by the committee.

More specifically, first, the value stock oriented benchmark consists of investment weights of the KOSPI and the value stock (HML) index of (95%/5%), (90%/10%), (80%/20%), (70%/30%), and (60%/40%). The benchmark with these five investment weights is named as the value stock oriented benchmark (KOSPI_Value). Second, the momentum oriented benchmark is composed of the investment weights of the KOSPI and the momentum (UMD) index of (95%/5%), (90%/10%), (80%/20%), (70%/30%), and (60%/40%). The benchmark with these five investment weights is named as the momentum oriented benchmark (KOSPI_Momentum). Third, a value-momentum oriented benchmark consists of the investment weights of value and momentum indices by 50%. That is, the value-momentum oriented benchmark consists of the investment ratio of the KOSPI, value (HML), and momentum (UMD) index of (95%/2.5%/2.5%), (90%/5%/5%), (80%/10%/10%), (70%/15%/15%), and (60%/20%/20%). The benchmark with these five investment weights is named as the value-momentum oriented benchmark (KOSPI_Val_Mom). And then, we analyze the validity as a benchmark through return-to-risk analysis to these three proposed benchmarks of KOSPI_Value, KOSPI_Mom and KOSPI_Val_Mom.

Table 7 shows the diversification effect and risk analysis to the three proposed benchmarks of KOSPI_Value, KOSPI_Mom and KOSPI_Val_Mom compared to the existing benchmark of KOSPI. We present the results for investment weights of 95%/5% solely for parsimony. The abridged results for investment weights of (90%/10%), (80%/20%), (70%/30%), and (60%/40%) are presented in Table 10.

The average return of the KOSPI_Value, KOSPI_Mom and KOSPI_Val_Mom indices is 0.806%, 0.776%, and 0.791%, respectively, which are higher than the existing KOSPI of 0.755%. The standard deviation is 5.698%, 5.696%, and 5.696%, respectively, which are lower than the existing KOSPI of 5.988%. As a result, the Sharpe ratio is 0.121, 0.116, and 0.119, respectively, which are higher than the existing KOSPI of 0.110. Therefore, the results indicate that our proposed indexes are decisively better than the existing benchmark. In addition, the active returns of the KOSPI_Value, KOSPI_Mom, and KOSPI_Val_Mom indices are 0.033%, 0.003%, and 0.018%, respectively. The tracking errors of the KOSPI_Value, KOSPI_Mom, and KOSPI_Val_Mom indices are 0.0342%, 0.371%, and 0.335%, respectively. As a result, the information ratios of the KOSPI_Value, KOSPI_Mom, and KOSPI_Val_Mom indices are 0.098, 0.008, and 0.054, respectively.

Table 7. Diversification effect and risk analysis of KOSPI_Value, KOSPI_Moment and KOSPI_Val_Mom to KOSPI for investment weights of 95%/5%

	KOSPI	KOSPI_Value	KOSPI_Moment	KOSPI_Val_Mom
Average	0.755%	0.806%	0.776%	0.791%
Std. dev	5.988%	5.698%	5.696%	5.696%
Excess return to risk-free rate	0.657%	0.691%	0.660%	0.675%
Sharpe Ratio	0.110	0.121	0.116	0.119
Active return	-	0.033%	0.003%	0.018%
Tracking error	-	0.342%	0.371%	0.335%
Information ratio	-	0.096	0.008	0.054

2. Including the value and momentum factors into the internal investment benchmark of KOSPI and outsourcing investment benchmark of KOSPI+KOSDAQ100

The previous methodology was applied. As an alternative to the existing internal investment benchmark of KOSPI200, three new enhanced benchmarks of value index and momentum index are proposed. The proposed benchmarks are value oriented benchmark (KOSPI200_Val), momentum oriented benchmark (KOSPI200_Mom), and value and momentum oriented by 50% benchmark (KOSPI200_Val_Mom). These new benchmarks are simulated based on KOSPI200, an internal investment benchmark, which was designated by the committee.

Likewise, as an alternative to the existing outsourcing investment benchmark of KOSPI+ KOSDAQ100, three enhanced benchmarks with value index and momentum index are proposed as new benchmarks. The proposed benchmarks are the value oriented benchmark (KOSPI+KOSDAQ100_Val), momentum oriented benchmark (KOSPI+KOSDAQ100_ Mom), and value and momentum oriented by 50% benchmark (KOSPI+KOSDAQ100_Val_Mom). The new benchmarks are simulated based on KOSPI+ KOSDAQ100, an outsourcing investment benchmark, which was designated by the committee.

For simulation, the value stock oriented benchmark consists of the investment weights of the existing benchmarks and the value stock (HML) index of (95%/5%), (90%/10%), (80%/20%), (70%/30%), and (60%/40%). The benchmark with these five investment weights is named the value stock oriented benchmark. In addition, the momentum oriented benchmark is composed of the investment weights of the existing benchmarks and the momentum (UMD) index of (95%/5%), (90%/10%), (80%/20%), (70%/30%), and (60%/40%). The benchmark with these five investment weights is named as the momentum oriented benchmark. Here, the effects of the three proposed benchmarks on diversification and risk factors are analyzed.

Table 8 represents the diversification effect and risk analysis to the three proposed benchmarks of KOSPI_Value, KOSPI_Mom and KOSPI_Val_Mom compared to the existing internal investment benchmark of KOSPI200 for investment weights of 95%/5%.

The average return of the KOSPI200_Value, KOSPI200_Mom, and KOSPI200_Val_Mom indices is 0.816%, 0.785%, and 0.801%, respectively; these are higher than the existing KOSPI200 of 0.765%. The standard deviation is 5.714%, 5.710%, and 5.711%, respectively, lower than the existing KOPSI200 of 6.005%. As a result, the Sharpe ratio is 0.123, 0.117, and 0.120, respectively to the KOSPI200_Value, KOSPI200_Mom, and KOSPI200_Val_Mom indices, which are higher than the existing KOSPI200 of 0.111. Therefore, the results indicate that our proposed indexes are better than the existing benchmark. In addition, the active returns of the KOSPI200_Value, KOSPI200_Mom, and KOSPI200_Val_Mom indices are 0.043%, 0.013%, and 0.028%, respectively. The tracking errors of the KOSPI200_Value, KOSPI200_ Mom, and KOSPI200_Val_Mom indices are 0.343%, 0.373%, and 0.337%, respectively. As a result, the

Table 8. Diversification effect and risk analysis of KOSPI_Value, KOSPI_Moment and KOSPI_Val_Mom to KOSPI200 for investment weights of 95%/5%

	KOSPI200	KO200_Value	KO200_Moment	KO200_Val_Mom
Average	0.765%	0.816%	0.785%	0.801%
Std. dev.	6.005%	5.714%	5.710%	5.711%
Excess return to risk-free rate	0.667%	0.700%	0.670%	0.685%
Sharpe Ratio	0.111	0.123	0.117	0.120
Active return		0.043%	0.013%	0.028%
Tracking error		0.343%	0.373%	0.337%
Information ratio		0.066	0.019	0.043

information ratios of the KOSPI200_Value, KOSPI200_Mom, and KOSPI200_Val_Mom indices are 0.066, 0.019, and 0.043, respectively.

Table 9 shows the diversification effect and risk analysis for the three proposed benchmarks of KOSPI_Value, KOSPI_Mom, and KOSPI_Val_Mom compared to the existing outsourcing investment benchmark of KOSPI+KOSDAQ100 for the 95%/5% investment weights.

The average return of the KOSPI+KOSDAQ100_Value, KOSPI+KOSDAQ100_Mom, and KOSPI+KOSDAQ100_Val_Mom indices is 0.452%, 0.436%, and 0.444%, respectively, higher than the existing KOSPI+KOSDAQ100 of 0.404%. The respective corresponding standard deviations are 5.465%, 5.443%, and 5.453%, which are lower than the existing KOSPI+KOSDAQ100 of 5.733%. As a result, the Sharpe ratio is 0.061, 0.064, and 0.061, respectively, which are higher than the existing KOSPI of 0.055. Therefore, the results definitely indicate that our proposed indexes are better than the existing benchmark. In addition, the active returns of the KOSPI+KOSDAQ100_Value, KOSPI+KOSDAQ100_Mom, and KOSPI+KOSDAQ100_Val_Mom indices are 0.012%, -0.006%, and 0.003%, respectively. The tracking errors of the KOSPI+KOSDAQ100_Value, KOSPI+KOSDAQ100_Mom, and KOSPI+KOSDAQ100_Val_Mom indices are 0.307%, 0.375%, and 0.316%, respectively. As a result, the information ratios of the KOSPI+KOSDAQ100_Value, KOSPI+KOSDAQ100_Mom, and KOSPI+KOSDAQ100_Val_Mom indices are 0.033, -0.013, and 0.008, respectively.

Now, we summarize the Sharpe ratio of our proposed benchmarks against the existing correspondent benchmarks. Panel A of Table 10 shows the Sharpe ratios of the proposed benchmark compared to the existing domestic stock benchmark of KOSPI with changing investment ratios from 95%/5% to 60%/40%.

We find three notable results from Panel A. First, the Sharpe ratio of the three proposed benchmarks (value oriented, momentum oriented, and value and momentum oriented) is an improvement from the existing benchmark's Sharpe ratio of 0.110. Second, the most improvement in Sharpe ratio was observed in the value oriented benchmark amongst the proposed benchmarks. Third, the Sharpe ratios improved more with increasing investment weights of value and/or momentum.

Panel B of Table 10 compares the Sharpe ratios of the proposed benchmark to the existing internal investment benchmark of KOSPI200 with changing investment ratios from 95%/5% to 60%/40%.

Note that the results of Panel B follow the same pattern as those of Panel A. Specifically, first, the three proposed benchmarks have enhanced Sharpe ratios compared to the existing benchmark's Sharpe ratio of 0.111. Second, the Sharpe ratio for the value oriented benchmarks is most enhanced among the proposed benchmarks. Third, increasing investment weights of value and/or momentum enhance the Sharpe ratio.

Panel C of Table 10 compares the Sharpe ratio of the proposed benchmark and the existing outsourcing investment benchmark of KOSPI+

Table 9. Diversification effect and risk analysis of KOSPI_Value, KOSPI_Moment, and KOSPI_Val_Mom to KOSPI+KOSDAQ100 for the 95%/5% investment weights

	KOSPI+KOSDAQ100	KOAQ_Value	KOAQ_Moment	KOAQ_Val_Mom
Average	0.404%	0.452%	0.436%	0.444%
Std. dev.	5.733%	5.465%	5.443%	5.453%
Excess return to risk-free rate	0.317%	0.338%	0.349%	0.332%
Sharpe Ratio	0.055	0.061	0.064	0.061
Active return		0.012%	-0.006%	0.003%
Tracking error		0.307%	0.375%	0.316%
Information ratio		0.033	-0.013	0.008

KOSDAQ100 with changing investment ratios from 95%/5% to 60%/40%.

Again, we observe that the results of Panel C follow the same pattern as those of Panel A and Panel B. That is, first, the Sharpe ratio of three proposed benchmarks (value oriented, momentum oriented, and value and momentum oriented) improves compared to the existing benchmark's Sharpe ratio of 0.055. Second, the Sharpe ratio of the value oriented benchmarks is highest except in the case of the 95%/5% investment weight. Third, the Sharpe ratios are better with increased investment weights of value and/or momentum.

Overall, the results of Table 10 indicate that the more oriented against value or momentum, the higher the return and the lower the risk, and thus the higher the Sharp ratio. Based on the results, we cautiously recommend the existing benchmarks be replaced with our proposed benchmarks.

V. Conclusion

The fund management committee of NPS divided the national pension domestic stock investment into internal investment and outsourcing investment for diversity. The committee also determines that the domestic stocks benchmark is the KOSPI, the internal

Table 10. Sharpe ratio of proposed benchmarks

Panel A. Sharpe ratio of proposed benchmarks to existing benchmark of KOSPI

Existing benchmark of KOSPI	Three proposed benchmarks			
	weights	① value oriented	② momentum oriented	③ value & momentum oriented
0.110	95%/5%	0.121	0.116	0.119
	90%/10%	0.134	0.123	0.128
	80%/20%	0.162	0.137	0.150
	70%/30%	0.196	0.153	0.177
	60%/40%	0.236	0.169	0.209

Panel B. Sharpe ration of proposed benchmarks to existing benchmark of KOSPI200

Existing benchmark of KOSPI200	Three proposed benchmarks			
	weights	① value oriented	② momentum oriented	③ value & momentum oriented
0.111	95%/5%	0.123	0.117	0.120
	90%/10%	0.135	0.124	0.130
	80%/20%	0.135	0.124	0.130
	70%/30%	0.198	0.154	0.178
	60%/40%	0.237	0.171	0.210

Panel C. Sharpe ratio of proposed benchmarks to existing benchmark of KOSPI+KOSDAQ100

Existing benchmark of KOSPI+KOSDAQ100	Three proposed benchmarks			
	weights	① value oriented	② momentum oriented	③ value & momentum oriented
0.055	95%/5%	0.061	0.064	0.061
	90%/10%	0.073	0.067	0.070
	80%/20%	0.095	0.081	0.089
	70%/30%	0.122	0.097	0.111
	60%/40%	0.153	0.113	0.138

investment benchmark is the KOSPI 200, and the outsourcing investment benchmark is the composite index of KOSPI + KOSDAQ 100.

The outsourcing management can generate an agency problem. The investment horizon of the outsourcing fund managers (the agent) is relatively short since they are compensated on an annual basis. The NPS (the principal), however, has a longer investment horizon. BBK (2008) shows that an optimally designed benchmark better aligns the incentives between the principal and the agent. Ang (2014) argues that the agency problem can be alleviated through the design of appropriate benchmarks. The researchers argue that benchmarks such as market indexes are not appropriate to alleviate the agency problems. Instead, factor benchmarks containing management strategies and directions can act as better benchmarks that could align the interests of fund managers and asset owners.

This paper advocates for three new benchmarks to propose the existing benchmarks be modified to obtain the value premium and momentum premium. It designs two ways to propose benchmarks. The first way is to include the value and momentum factors into the domestic stock benchmark (KOSPI). The second way is to include the value and momentum factors into the internal investment (KOSPI200) and outsourcing investment benchmarks (KOSPI+ KOSDAQ100). This study then performs return-to-risk analysis of the proposed benchmarks for internal and outsourcing investments.

We find three important results. First, the Sharpe ratios of three proposed benchmarks (value oriented, momentum oriented, and value and momentum oriented by 50%) are better compared to those of existing benchmarks. Second, the Sharpe ratio of value oriented benchmarks is the most improved among the proposed benchmarks. Third, the Sharpe ratios improve with increasing investment weights of value and/or momentum.

The importance and implications of this study are as follows. Above all, it is important to establish an investment strategy in consideration of momentum and value factors. In other words, it is necessary to create benchmarks using momentum factor and value factor rather than simple benchmarks (KOSPI, KOSPI200) based on market capitalization, and then present fund managers investment guidelines based on created benchmarks. In addition, when assessing the performance of a fund manager, the investment performance tiled in momentum and value factors should be evaluated separately from that of the manager's stock selection ability.

This study uses the Sharpe ratio to measure return-to-risk relationship. There could be other measures to capture the relationship. This may pose as a limitation to this research and is left as a challenging task to future research.

Acknowledgments

This paper is based in part on the research project of management of outsourcing pension fund at the National Pension Research Institute.

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