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On the investigation of investment style allocation under the OCIO structure: Evidence from the Korean stock market

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Abstract

Purpose – Given the importance of style allocation strategy under the outsourced chief investment officer (OCIO) structure, the authors examine the validity of style allocation strategies in the Korean stock market. The authors find that external investment agencies can improve performance by using newly suggested investment styles such as high dividend yield and low volatility as well as traditional styles. In addition, the authors find that the style combination strategies create economically large and statistically significant returns. Finally, empirical results indicate that factor timing strategies suggested in this study can improve the reward-to-risk ratio. In sum, the empirical findings indicate that external investment agencies under the OCIO structure can improve performance using active style allocation strategies.

Keywords Investment style, OCIO, Style combining strategy, Style timing strategy

Paper type Research paper

1. Introduction

The total assets under management (AUM) of public pension funds in Korea has increased significantly from 574.5tn won at the end of 2015 to 785.8tn won at the end of 2019 (Korea Public Finance Information Service). As of the end of 2019, while most of AUMs are managed by social security funds including National Pension Fund (647.6 trillion won), Teachers Pension (16.7 trillion won), Government Employees Pension (9.6 trillion won), funds for business operation also manage several trillion won to tens of trillion won per year, including National Housing Fund (38.4 trillion won), Radioactive Waste Management Fund (2.6 trillion won).

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Despite the striking increase of total AUMs over the past several years, the infrastructure for fund management has not kept pace with the increase in AUMs. Accordingly, the difference in performance between pension funds has widened from 5.60% in 2015 to 9.78% in 2019. For example, the return on the National Pension Fund or Teachers Pension, which is equipped with human and physical infrastructure for fund management, is over 10% in 2019. However, many funds that do not have the expertise in fund management invest most of money into fixed income securities, and the annual rate of return remains in the $1\% \sim 2\%$ range. To improve the profitability and achieve diversification by enhancing the expertise of fund management, more and more funds are now interested in outsourced chief investment officer (OCIO) structure.

Under the OCIO structure in Korea, an external investment agency manages part or all of the money entrusted from fund beneficiary. Based on the characteristics of the fund, the external investment agency helps set a target rate of return and allowable risk limit, and it involves with strategic and tactical asset allocation. Additionally, the external investment agency performs manager selection and monitoring. In Korea, the National Housing Fund, the Employment Insurance Fund and the Industrial Accident Compensation Insurance and Prevention Fund have introduced the OCIO structure, and by using the expertise of external managers, the rate of return is comparable to that of the National Pension Fund.

To achieve the target rate of return, the external investment agency usually allocates money into asset classes such as stocks, bond and alternative assets. Then, for each asset class, the external investment agency puts the money into sub-asset class called investment style. The composition of investment style reflects the view of the external investment agency, and therefore, it is the key ingredient under the OCIO structure. Also, investment via styles helps achieve diversification by reducing concentration on specific sectors. For bonds, the classification of investment style is very clear because there is ample evidence that maturity and credit rating affect returns on bonds. On the contrary, there are many different investment styles for stocks because numerous researchers have shown that various firm characteristics affect stock returns. Accordingly, different external investment agencies use different investment styles on stocks. For example, some use firm size and book-to-market, and others use dividend, past return and volatility to construct investment styles.

Given various investment styles on stocks adopted, it is necessary to examine the validity of investment styles. This is very important in both practical and academic aspects. First, this study has a great impact on practice in terms of verifying the effectiveness of the style strategies that external investment agencies are performing. In addition, this study has significant contribution to the existing literature because our work eventually attempts to discover firm characteristics that drive stock returns. Specifically, we raise the following research questions.

First, we verify whether investment styles used by external investment agencies create superior returns in the long-term period. To this end, we consider traditional firm characteristics including firm size, book-to-market ratio and past return. In addition, we use newly suggested styles including volatility, quality, dividend and asset growth adopted by global asset management companies such as BlackRock and AQR. Second, we examine whether performance is improved when we construct portfolios by combining individual investment styles. This research question is very important in that it is desirable to use a diversified investment strategy by combining each style from the position of external investment agency which should pursue diversification. Previous studies have witnessed that each investment style performs well in different period. Therefore, it is expected that performance will be improved when individual styles are combined. Third, we examine whether timing strategies are valid in the Korean stock market. While acknowledging that

style investment strategy is based on a long-term period, it is true that external investment agencies inevitably use style timing strategy to some extent. It is because performance of each style is different across economic conditions. Also, timing strategy is required because of the nature of current OCIO structure that an external investment agency is evaluated by short-term performance such as 6 or 12 months.

Our empirical findings are summarized as follows. First, we find that traditional investment styles including firm size and book-to-market ratio are strong determinants of cross-sectional returns in Korea. In particular, the most pronounced investment style is the book-to-market ratio. The average excess return on stocks in the KOSPI with the highest 10% book-to-market ratio is 2.01% per month, and it is statistically significant. Our empirical finding is consistent with prior studies documenting strong value effect in the Korean stock market. In addition, our empirical finding indicates that external investment agencies can use other investment styles such as dividend and volatility. For KOSPI firms, the return difference between decile "10" and "1" is economically large and statistically significant for dividend yield and volatility regardless of the weighting scheme. In sum, our empirical results suggest that external investment agencies can improve performance by using newly suggested investment styles and traditional styles.

Second, our empirical results show that style combination strategies create economically large and statistically significant returns. We measure performance of combining strategies by mixing six investment styles that create return difference in our earlier analysis. In addition, we examine performance on combining strategies based on two widely used investment styles such as book-to-market and gross profitability, book-to-market and quality, book-to-market and past return and past return and volatility. We find superior performance in both combining strategies. Our empirical finding has not only academic but also practical implications. Large domestic funds, such as National Pension Fund and Teachers Pension invest their money into large stocks, small- and medium-sized stocks, value stocks, growth stocks and stocks with high dividend yield. From our point of view, it is a kind of "MIX" combining strategy that combines multiple styles. In addition, some external investment agencies use a combination strategy that combines two investment styles such as large and growth, small and value and high dividend and growth. Therefore, empirical results in this study provide justification for current investment strategies used by domestic pension funds under the OCIO structure. We interpret our empirical finding with a caution because money managers should consider the tracking error constraints that they face. Our additional analysis, however, shows that if some modifications are made in a way that reflects the characteristics of the funds, our combining strategy can be successfully implemented within the risk limit of the predefined fund.

Third, our style timing strategies based on cross-sectional momentum create superior returns. In cross-sectional momentum strategy, one increases the proportion of investment styles that have recently performed well and to reduce the proportion of styles that have been relatively poor in recent periods. We use the five style timing strategies, and the average monthly excess return is statistically significant for all strategies. Also, the excess return increases as we use more aggressive style timing strategies. In sum, empirical results indicate that factor timing strategies suggested in this study can be used in practice.

We think that our study has important contribution. First, we find that style timing strategies can improve the performance of managed fund. While acknowledging that individual investment styles such as size, value, momentum display superior long-term performance, some studies show that different styles perform well in different periods. Therefore, empirical evidence in previous literature emphasizes the importance of factor timing strategies. Unfortunately, however, little is known in the Korean stock market. To fill

this gap, we measure the empirical performance of style timing strategies and find that the performance can be improved. Second, we find that style combination strategies can improve the risk-return profile. While numerous works have been conducted on the performance of combining strategies in the US stock market, little is known in the Korean stock market. Given that some external investment agencies use combination strategies, empirical results in this study provide justification for current investment strategies used by domestic pension funds under the OCIO structure.

The remainder of this paper is organized as follows. Section 2 provides related literature and draws implications from previous studies. Section 3 describes the data and main variables, and Section 4 presents empirical findings. Finally, Section 5 summarizes and concludes the paper.

2. Related literature

Numerous researchers have attempted to discover firm characteristics that explain the cross-section of stock returns. In particular, studies on overseas stock market have investigated not only performance of individual styles but also performance of combined strategies. Although studies on investment styles have been actively conducted in Korea, most of them have been limited to individual style strategies. In Section 2, we derive implications from related literature in oversees and the Korean market.

2.1 Studies on overseas stock market

Basu (1977) finds that stocks with low price-to-earnings ratio have superior returns, and Banz (1981) reports that stocks with low market capitalization have higher returns than those with high market capitalization. Jegadeesh and Titman (1993) discover the momentum effect, that is, relatively high-performance stocks in the past 3–12 months continue to outperform in the following 3–12 months. Dividing the global market into North America, Europe, Japan and Asian markets excluding Japan, Fama and French (2012) find that there does not exist size effect anywhere. On the contrary, they find that value effect is present everywhere, especially among small firms. In addition, the momentum effect is strongly observed in all markets except Japan.

Ang *et al.* (2006) find that stocks with lower idiosyncratic volatility create higher returns, and they report that the negative relation between idiosyncratic volatility and equity returns are also present stock markets in other countries (Ang *et al.*, 2009). In addition, literature documents that stocks with high quality have superior returns. For example, Piotroski (2000) measures the quality of a firm with an F-score calculated by combining nine indicators related with profitability, liquidity and efficiency of a firm. George and Hwang (2004) divide the stock price at that time by the highest price for the past 52 weeks and find that the higher this ratio, the higher the future realized return. Cooper *et al.* (2008) find the asset growth effect, that is, firms with higher asset growth have lower subsequent returns.

In addition to studies on individual styles such as size, value and momentum, more and more studies now investigate performance of combined strategies. For instance, Novy-Marx (2013) finds that stocks with higher book-to-market ratio and higher profitability superior returns. Asness *et al.* (2013) discover that investment performance can be improved via diversification when one invests in value stocks and past winners at the same time. Finally, Asness *et al.* (2019) show that investors obtain higher risk-adjusted returns if they hold small and high-quality stocks.

Also, studies on factor timing strategies have been actively conducted. Examining the US stock market, Copeland and Copeland (1999) find that performance of large and value stocks is superior to that of small and growth stocks after the increase in volatility index.

Cohen *et al.* (2003) show that returns on value stocks are higher than those on growth stocks when the value spread is large in the US stock market. Relatedly, Asness *et al.* (2017) report that the value effects in stock markets, stock index futures markets, currency markets and global bond markets are especially pronounced during periods of high value spread.

2.2 Studies in the Korean stock markets

Numerous studies on investment styles have been conducted in the Korean stock market, and earlier works report contradicting results on size and value effects. Kim (1997) finds that while book-to-market ratio is a significant determinant of stock returns in Korea, firm size has no explanatory power. Song and Lee (1997), however, report that stocks with low market capitalization have higher returns. Kim and Kim (2000) argue that both firm size and book-to-market ratio are important firm characteristics in explaining the cross-section of stock returns.

The effect of firm characteristics on stock returns is well observed after the Asian financial crisis period. Dividing the data from 1990 to before and after the Asian financial crisis, Eom *et al.* (2014) find that size effect exists before the crisis period, but disappears after the crisis period. Instead, they observe the value effect after the crisis period. Analyzing firms listed on the KOSPI and KOSDAQ markets from 1980 to 2009, Eom (2013) finds that the momentum effect is not present during the entire period. In sub-sample analysis, however, the momentum effect does exist after the Asian financial crisis period. Lee and Jang (2015), and Jang (2017) also find momentum effect in the Korean stock market after 2000. Kim and Byun (2011), and Kho and Kim (2014) report that stocks with low volatility have higher returns in the Korean stock market. Up to now, there is little work on the direct relation between quality of a stock and stock return in Korea. From the perspective that a firm's bankruptcy risk is the opposite of quality, however, Kim and Park (2011) and Kim and Shin (2014) find a negative relation between the bankruptcy risk and stock returns.

Recently, some researchers have measured empirical performance of combining strategies and timing strategies of investment styles. Yoon *et al.* (2017) study the usefulness of the smart beta strategy as an alternative to traditional index investment strategy in the Korean stock market and report performance of portfolios combining various styles. Our work differs from theirs in that we consider the combining strategies from the perspective of external investment agencies, and we additionally study empirical performance of factor timing strategies. Lee and Ryu (2014) document that large and growth stocks have higher returns after the increase in volatility index in Korea. Classifying economic conditions based on liquidity, volatility and currency growth rate, Lee and Jang (2015) show that returns on large and growth stocks are higher than those of small and value stocks when the market is not stable. They interpret empirical results are consistent with flight-to-quality phenomenon, which states that investors prefer safe assets in times of high uncertainty.

Our work is also related with recent papers studying the OCIO structure in Korea. Shin *et al.* (2020) review the history of OCIO and suggest critical factors leading the OCIO business in Korea. Shin and Lee (2020) examine the effect of the performance evaluation period on the long-term investment portfolio choice and the agency problem of outsourced investments.

2.3 Implication

Reviewing the related literature, we have two important implications. First, empirical findings on previous studies emphasize the importance of factor timing strategies. While acknowledging that individual investment styles such as size, value, momentum display superior long-term performance, some studies show that different styles perform well in

different periods. Therefore, one can improve performance by exploiting timing strategies. Second, while numerous works have been conducted on the performance of the combining strategies in the US stock market, little is known in the Korean stock market. Again, given that different investment styles perform well in different states, one can improve reward-to-risk ratio by constructing combining strategies.

Under the OCIO structure, an external investment agency uses style allocation strategies for stocks. Developing new styles and allocating styles strategically and tactically to improve performance of fund is an essential role of the external investment agency. In this study, we attempt to suggest individual style strategies, style combination strategies and style timing strategies, thus providing practical help to the investment strategies under the OCIO structure. In addition, it is expected to lay the foundation for the sound development of the OCIO market, as it is possible to secure the reliability of the investment strategy of the external investment agency from the standpoint of the fund beneficiary.

3. Data and main variables

3.1 Data

We investigate all nonfinancial firms listed on the KOSPI and KOSPI200 markets from July 2000 to June 2019. As most pension funds in Korea use the KOSPI or KOSPI200 index as benchmarks, we use firms constituting those indices. We use stock returns for monthly frequency reflecting stock splits and stock and cash dividends. For weighting scheme, we use both market value-weighted and equal-weighted returns. For each stock, monthly stock price, firm size, book-value of equity and other firm characteristics come from the FnGuide database. Finally, our sample covers 2,344 firms, and we use 364-day monetary stabilization bond issued by the Bank of Korea as a proxy for risk-free asset.

3.2 Main Variables

Reviewing prior studies, we investigate nine investment styles in this study. Those are firm size, book-to-market ratio, past return, profitability, volatility, dividend yield, quality, asset growth and the ratio of current price to the 52-week highest price. Guided by previous works, we perform monthly rebalancing for past return, volatility, and the ratio of current price to the 52-week highest price, and we conduct the annual rebalancing for other variables.

For firm size, we measure the market capitalization of each firm at the end of each year's June. The portfolios are constructed based on firm size at the end of June each year (year t) and are used from July of year t to June of year $t + 1$. For book-to-market ratio, at the end of each year's June, we use the ratio of the book equity in the prior fiscal year to market value at the end of December of the prior year. Again, at the end of each year's June, we construct portfolios based on the book-to-market ratio, and we hold them until June of the next year. For momentum, following Fama and French (1996), for each month, we sort common stocks based on the past eleven-month gross returns (t-12 to t-2).

For volatility, the standard deviation calculated from the daily returns for the previous year is used, and the dividend yield is defined as the closing price at the end of period divided by the total amount of dividends per share paid for one year. In case of quality, the F-score suggested by Piotroski (2000) is used. The F-score is calculated as the sum of nine indicators related to a firm's profitability, liquidity and efficiency. Each indicator is in the form of a binary variable and has a value of 1 for a positive signal and 0 for a bad signal. As a result, the F-score may have a value from 0 to 9.

To measure the profitability of a firm, we use gross profits-to-assets (GPA) proposed by Novy-Marx (2013). GPA is computed as a ratio of the gross profit to the total asset over the

previous one year. Asset growth is measured as the percentage change in total assets compared to the previous year. Finally, following the George and Hwang (2004), the ratio of current price to the 52-week highest price (Pth) is calculated by dividing the stock price at that time by the highest price for the past 52 weeks.

4. Empirical results

4.1 Performance on individual styles

Table 1 reports the average monthly excess returns of decile portfolios sorted by each investment style for KOSPI firms. The investment styles used are firm size (Size), book-to-market (BM) ratio, gross profitability (GP), asset growth (AG), dividend yield (DV), quality (Qual), past return (Mom), volatility (Vol), and the ratio of current price to the 52-week highest price (Pth). Panel A shows the equal-weighted (EW) results, and Panel B reports the market value-weighted (VW) results. The decile "10" ("1") represents average excess return of 10% stocks, which are known to have the highest (lowest) return. The "10–1" is the return on portfolio taking a long position on decile "10" and a short position on decile "1." The values in parentheses are the *t*-statistics.

We find that traditional investment styles including firm size and book-to-market ratio are strong determinants of cross-sectional returns in Korea. In Panel A, in case of BM, which exhibits the value effect, the monthly average excess return for decile "10" is 2.01%, and it is statistically significant. The return on "10–1" portfolio is most pronounced in BM, which is consistent with prior studies documenting strong value effect in the Korean stock market. Also, our empirical finding is consistent with prior works reporting value effect in the global market (Fama and French, 2012). For firm size, the average monthly excess return of the decile "10" is 2.70%, and the return difference between decile "10" and "1" is 1.88% per month and it is statistically significant. For value-weighted results in Panel B, we observe size and value effects in the Korean stock market. Especially, the average monthly excess return of decile "10" sorted by firm size is 2.54%. In addition, the excess return of the decile "10" portfolio ranked by book-to-market ratio is 1.33% per month. In sum, regardless of the weighting scheme, we find strong size and value effects in Korea, confirming their usefulness as investment styles.

In addition, our empirical finding indicates that external investment agencies can use newly suggested investment styles, too. In Panel A, the return difference between decile "10" and "1" is economically large and statistically significant for gross profitability, asset growth, dividend yield, quality, past return and volatility. For value-weighted results in Panel B; however, the return difference between decile "10" and "1" is statistically significant only for dividend yield and volatility. It may be because small firms are likely to generate anomalous returns relative to large firms (Hou *et al.*, 2020). In sum, our empirical results suggest that external investment agencies can improve performance by using newly suggested investment styles such as dividend and volatility.

Table 2 shows the average monthly excess returns of quintile portfolios sorted by each investment style for KOSPI200 firms. The number of firms for KOSPI200 is 200, and it is composed of large stocks and some mid-cap stocks, so it has somewhat different characteristics from the KOSPI. As the number of constituents in the KOSPI200 is smaller than that of the KOSPI, we construct quintile portfolios. The results in Table 2 reveal that value effect is still strong among firms in the KOSPI200. On the contrary, we do not observe size effect for both equal-weighted and value-weighted returns in Table 2. We think that size effect may disappear as the KOSPI200 consists of large and some mid-cap stocks. In addition, we find that asset growth, dividend yield and past return are important

Table 1. Monthly excess returns of the decile portfolios: KOSPI firms

Decile	1	2	3	4	5	6	7	8	9	10	10-1
Panel A: EW											
Size	0.82 (1.83)	0.84 (1.79)	0.68 (1.41)	0.93 (1.99)	0.68 (1.46)	0.96 (2.13)	1.11 (2.48)	1.23 (2.64)	1.68 (3.53)	2.70 (5.40)	1.88 (4.30)
BM	−0.07 (−0.15)	0.50 (1.07)	0.94 (1.94)	0.86 (1.97)	1.19 (2.51)	1.36 (3.05)	1.37 (3.23)	1.84 (4.29)	1.61 (3.61)	2.01 (4.17)	2.08 (6.11)
GP	0.56 (1.13)	0.94 (1.96)	1.17 (2.41)	1.44 (2.93)	1.23 (2.62)	1.15 (2.57)	1.29 (2.96)	1.11 (2.61)	1.39 (3.31)	1.34 (3.28)	0.78 (2.40)
AG	0.39 (0.82)	0.83 (1.84)	0.87 (2.01)	1.21 (2.76)	1.24 (2.84)	1.23 (2.90)	1.52 (3.52)	1.69 (3.75)	1.47 (3.06)	1.17 (2.34)	0.78 (2.87)
DV	1.01 (1.96)	0.47 (1.04)	0.73 (1.61)	1.11 (2.47)	1.16 (2.65)	1.35 (3.08)	1.36 (3.18)	1.47 (3.59)	1.49 (3.60)	1.80 (4.33)	0.79 (2.46)
Qual	NaN NaN	0.04 (0.07)	0.86 (1.57)	1.13 (2.34)	1.17 (2.57)	1.09 (2.50)	1.32 (3.09)	1.31 (3.09)	1.27 (2.74)	NaN NaN	1.23 (2.92)
Mom	0.07 (0.14)	0.80 (1.73)	1.43 (3.08)	1.30 (3.07)	1.45 (3.45)	1.23 (2.93)	1.41 (3.25)	1.33 (3.06)	1.45 (3.05)	1.13 (2.14)	1.06 (3.15)
Vol	−0.17 (−0.27)	1.09 (1.90)	1.45 (2.56)	1.49 (3.02)	1.35 (2.83)	1.29 (2.94)	1.23 (2.96)	1.34 (3.39)	1.35 (3.72)	1.23 (4.09)	1.39 (2.83)
Pth	0.40 (0.62)	0.89 (1.73)	1.08 (2.18)	1.11 (2.37)	1.46 (3.22)	1.40 (3.27)	1.43 (3.30)	1.48 (3.56)	1.38 (3.58)	1.02 (2.50)	0.62 (1.32)
Panel B: VW											
Size	0.52 (1.24)	0.89 (1.89)	0.67 (1.38)	0.93 (2.00)	0.67 (1.43)	0.97 (2.14)	1.11 (2.48)	1.24 (2.66)	1.65 (3.50)	2.54 (5.10)	2.03 (4.54)
BM	0.23 (0.45)	0.40 (0.84)	1.02 (2.28)	0.88 (1.85)	0.96 (1.71)	1.04 (2.18)	1.10 (2.30)	1.45 (3.02)	1.46 (2.87)	1.33 (2.61)	1.10 (2.31)
GP	0.62 (1.22)	0.11 (0.19)	0.88 (1.46)	0.81 (1.46)	0.86 (1.67)	0.55 (1.08)	0.29 (0.70)	1.08 (2.15)	0.80 (1.72)	0.37 (0.93)	−0.24 (−0.55)
AG	0.20 (0.35)	0.30 (0.56)	0.17 (0.37)	0.67 (1.41)	0.90 (1.98)	0.72 (1.53)	0.86 (2.17)	1.15 (2.34)	0.99 (1.67)	0.86 (1.54)	0.66 (1.46)
DV	0.08 (0.14)	−0.03 (−0.07)	0.53 (1.11)	0.83 (1.72)	1.36 (2.58)	1.09 (2.10)	0.86 (2.03)	1.28 (3.02)	1.10 (3.00)	1.33 (2.99)	1.24 (2.61)
Qual	NaN NaN	−0.31 (−0.45)	0.56 (0.87)	0.64 (1.02)	0.35 (0.77)	0.51 (1.25)	0.51 (1.22)	0.76 (1.47)	0.56 (0.99)	NaN NaN	0.87 (1.33)
Mom	0.17 (0.27)	0.19 (0.40)	0.64 (1.41)	0.57 (1.17)	0.17 (0.35)	0.47 (0.97)	1.25 (2.63)	0.88 (1.53)	1.13 (2.14)	0.95 (1.64)	0.77 (1.31)
Vol	−1.67 (−2.07)	0.17 (0.22)	0.71 (1.04)	0.64 (1.05)	1.13 (2.01)	1.02 (2.14)	0.72 (1.47)	0.97 (2.45)	0.21 (0.49)	0.25 (0.73)	1.92 (2.53)
Pth	−0.79 (−1.00)	0.50 (0.82)	0.51 (0.91)	0.11 (0.21)	0.76 (1.51)	0.93 (1.90)	0.63 (1.50)	0.95 (2.18)	0.64 (1.51)	−0.04 (−0.08)	0.75 (1.06)

Notes: This table reports the average monthly excess returns (%) of decile portfolios sorted by each investment style for KOSPI firms. The investment styles used are firm size (Size), book-to-market ratio (BM), gross profitability (GP), asset growth (AG), dividend yield (DV), quality (Qual), past return (Mom), volatility (Vol), and the ratio of current price to the 52-week highest price (Pth). Panel A shows the equal-weighted (EW) results, and Panel B reports the market value-weighted (VW) returns. The decile "10" ("1") represents average excess return of 10% stocks, which are known to have the highest (lowest) return. For quality, we construct a total of eight portfolios, as few stocks have F-score of 0 or 9. Thus, stocks with an F-score of 0 and 1 (8 and 9) are included in the same group. The "10–1" is the return on portfolio taking a long position on decile "10" and a short position on decile "1." For quality, the "10–1" is the return on portfolio taking a long position on portfolio "9" and a short position on portfolio "2." The values in parentheses are the *t*-statistics, and the sample period is from July 2000 to June 2019

Quintile	1	2	3	4	5	5-1
Panel A: EW						
Size	0.68 (1.52)	0.98 (2.05)	0.76 (1.54)	0.72 (1.43)	0.69 (1.37)	0.02 (0.05)
BM	0.15 (0.32)	0.55 (1.17)	0.74 (1.58)	1.02 (2.16)	1.36 (2.60)	1.20 (3.63)
GP	0.65 (1.17)	0.88 (1.66)	0.72 (1.49)	0.61 (1.40)	0.96 (2.34)	0.31 (0.91)
AG	0.42 (0.83)	0.59 (1.31)	0.74 (1.61)	1.01 (2.26)	1.08 (2.08)	0.66 (2.53)
DV	0.32 (0.55)	0.35 (0.73)	0.90 (1.91)	0.98 (2.13)	1.22 (2.88)	0.90 (2.57)
Qual	0.08 (0.12)	0.77 (1.65)	0.97 (2.18)	0.96 (2.11)	NaN NaN	0.20 (1.20)
Mom	0.38 (0.72)	0.50 (1.07)	0.77 (1.69)	0.94 (2.05)	1.22 (2.37)	0.84 (2.31)
Vol	0.31 (0.48)	0.79 (1.48)	0.88 (1.83)	1.05 (2.60)	0.79 (2.30)	0.47 (1.02)
Pth	0.23 (0.36)	0.69 (1.36)	0.91 (1.95)	1.09 (2.60)	0.88 (2.13)	0.65 (1.41)
Panel B: VW						
Size	0.49 (1.17)	1.03 (2.14)	0.84 (1.70)	0.70 (1.40)	0.66 (1.35)	0.18 (0.48)
BM	0.10 (0.20)	0.82 (1.71)	0.69 (1.45)	0.98 (2.11)	0.91 (1.97)	0.81(1.93)
GP	0.45 (0.92)	0.82 (1.40)	0.53 (1.14)	0.97 (2.22)	0.37 (0.90)	−0.08 (−0.21)
AG	0.29 (0.60)	0.41 (0.84)	0.78 (1.77)	0.63 (1.49)	0.82 (1.61)	0.53 (1.34)
DV	0.10 (0.16)	0.14 (0.31)	0.80 (1.71)	1.29 (2.62)	1.02 (2.81)	0.92 (1.96)
Qual	0.40 (0.58)	0.40 (0.96)	0.55 (1.26)	0.75 (1.48)	NaN NaN	0.36 (1.00)
Mom	0.46 (0.91)	0.07 (0.15)	0.68 (1.40)	0.70 (1.37)	1.21 (2.25)	0.75 (1.52)
Vol	0.11 (0.14)	1.19 (2.05)	0.70 (1.37)	0.90 (2.19)	0.12 (0.32)	0.01 (0.01)
Pth	0.57 (0.80)	0.34 (0.69)	0.66 (1.35)	0.89 (2.27)	0.25 (0.59)	−0.32 (−0.55)

Notes: This table reports the average monthly excess returns of quintile portfolios sorted by each investment style for KOSPI200 firms. The investment styles used are firm size (Size), book-to-market ratio (BM), gross profitability (GP), asset growth (AG), dividend yield (DV), quality (Qual), past return (Mom), volatility (Vol), and the ratio of current price to the 52-week highest price (Pth). Panel A shows the equal-weighted (EW) results, and Panel B reports the market value-weighted (VW) returns. The quintile "5" ("1") represents average excess return of 20% stocks, which are known to have the highest (lowest) return. For quality, we construct a total of 4 portfolios: Stocks with an F-score from 0 to 2 (3 to 4) are included in portfolio 1 (2), and stocks with an F-score from 5 to 6 (7 to 9) are included in portfolio 3 (4). The "5–1" is the return on portfolio taking a long position on quintile "5" and a short position on quintile "1." For quality, the "5–1" is the return on portfolio taking a long position on portfolio "4" and a short position on portfolio "1." The values in parentheses are the *t*-statistics, and the sample period is from July 2000 to June 2019

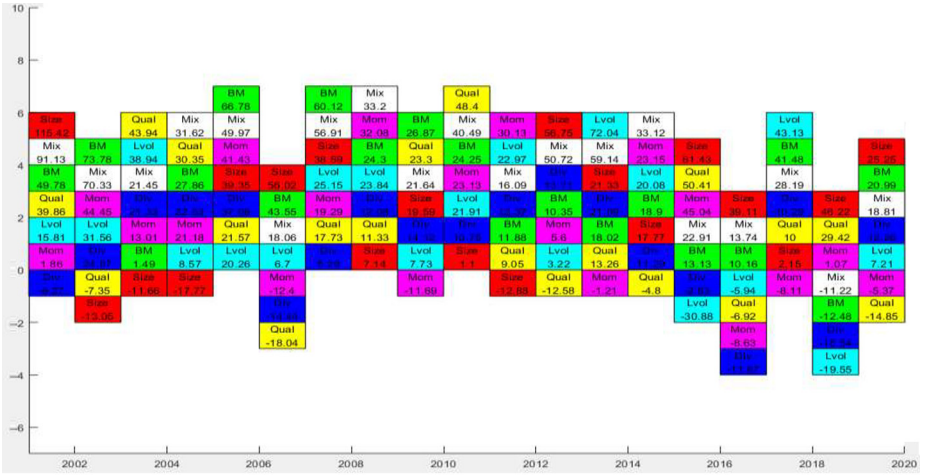
Table 2.
Monthly excess returns of the quintile portfolios: KOSPI200 firms

determinants in the cross-section of equity returns in Panel A. Similar to the case of the KOSPI, the statistically significance has weakened for value-weighted returns.

In sum, our empirical results in Tables 1 and 2 show that for KOSPI firms, the size and value effects are very strong regardless of the weighting scheme. In addition, dividend yield and volatility are statistically significant, indicating that investment styles currently used by external investment agencies indeed generate superior returns.

4.2 Performance on combining strategies

Figure 1 displays the annual performance of each of six investment styles and combining strategy for KOSPI firms. We use six investment styles that create return difference in previous subsection and have been widely used in the industry. Those are firm size (Size), book-to-market (BM) ratio, past return (Mom), dividend yield (Div), quality (Qual) and volatility (Lvol). The numbers in the squares represent the value-weighted annual return of the decile portfolio which is known to have the highest return. "MIX" portfolio is constructed as follows. First, for each stock, we form decile portfolios based on each investment style, and assign score x if a firm belongs to xth decile. The decile "10" ("1") represents average excess return of 10% stocks, which are known to have the highest (lowest) return. For each



Notes: This figure displays the annual returns (%) of each of six investment styles and combining strategy for KOSPI firms. Six investment styles are firm size (Size), book-to-market ratio (BM), past return (Mom), dividend yield (Div), quality (Qual), and volatility (Lvol). The numbers in the squares represents the value-weighted annual return of the decile portfolio which is known to have the highest return. "MIX" portfolio is constructed as follows. First, for each stock, we form decile portfolios based on each investment style, and assign score x if a firm belongs to xth decile. The decile "10" ("1") represents average excess return of 10% stocks, which are known to have the highest (lowest) return. For each stock, we then compute the sum of the scores for the six investment styles. The portfolio "MIX" contains 10% stocks with the largest sum, and we calculate the equal-weighted annual returns from this portfolio. The sample period is from July 2000 to June 2019

Figure 1.
Annual returns from individual style strategies and combining strategies: KOSPI firms

stock, we then compute the sum of the scores for the six investment styles. The portfolio "MIX" contains 10% stocks with the largest sum, and we calculate the equal-weighted annual returns from this portfolio. Figure 1 shows that styles for achieving excellent performance are different for each year, and the relative ranking of returns varies substantially. On the other hand, the "MIX" strategy achieves higher returns on the average, and the relative ranking of the "MIX" strategy does not change significantly. In sum, empirical results in Figure 1 indicate that the external investment agency can improve performance by combining individual strategies.

4.2.1 Performance of strategy combining six styles. Table 3 shows the annual returns (percentage) of strategies on combining six investment styles. Six investment styles are firm size, book-to-market ratio, past return, dividend yield, quality and volatility. Panel A reveals the annual returns for the KOSPI firms, and Panel B displays the annual returns for the KOSPI200 firms. In Panel A, "1/N" is an equal-weighted portfolio that combines six individual decile portfolios that are known to have the largest returns, and "MIX" portfolio refers to the one used in Figure 1.

Table 3 shows that performance of "MIX" strategy is much better than that of the "1/N" strategy. In the KOSPI market, the average annual return of the "MIX" strategy is 35.07%, while it is 17.99% for the "1/N" strategy. In addition, the difference between the two

Year	Panel A: KOSPI MIX	Panel A: KOSPI 1/N	Panel B: KOSPI200 MIX	Panel B: KOSPI200 1/N
2001	91.13	36.07	55.79	18.37
2002	70.33	25.71	47.88	40.12
2003	21.45	17.84	14.05	6.45
2004	31.62	15.45	−0.46	5.13
2005	49.97	37.75	72.69	29.91
2006	18.06	10.23	−7.60	0.02
2007	56.91	27.69	22.56	11.58
2008	33.20	18.46	10.31	3.90
2009	21.64	13.32	0.53	−8.02
2010	40.49	21.59	10.29	8.92
2011	16.09	12.25	−7.86	0.14
2012	50.72	12.84	7.03	9.59
2013	59.14	24.09	57.98	24.32
2014	33.12	14.40	0.87	3.41
2015	22.91	22.77	22.22	14.70
2016	13.74	2.65	5.16	−2.95
2017	28.19	16.49	13.75	1.79
2018	−11.22	4.69	−6.99	−5.90
2019	18.81	7.58	11.04	1.88

Notes: This table shows the annual returns (%) on strategies on combining six investment styles. Six investment styles are firm size, book-to-market ratio, past return, dividend yield, quality and volatility. Panel A reveals the annual returns for the KOSPI firms, and Panel B displays the annual returns for the KOSPI200 firms. In Panel A, "1/N" is an equal-weighted portfolio that combines six individual decile portfolios that are known to have the largest returns. In Panel A, "MIX" portfolio is constructed as follows. First, for each stock, we form decile portfolios based on each investment style, and assign score x if a firm belongs to xth decile. The decile "10" ("1") represents average return of 10% stocks, which are known to have the highest (lowest) return. For each stock, we then compute the sum of the scores for the six investment styles. "MIX" represents the 10% stocks with the largest sum. The portfolio construction methodology in Panel B is the same as that of Panel A except for using the quintile portfolios. The sample period is from July 2000 to June 2019

Table 3.
Annual returns on strategies combining six investment styles

strategies is statistically significant with a *t-values* of 4.53. In the KOSPI200 market, the annual average return of the "MIX" strategy is 17.33% while it is 8.60% for the "1/N" strategy. Also, the return difference is statistically significant with a *t-values* of 2.70. Therefore, empirical finding in Table 3 indicates that one can improve performance by combining the individual investment styles.

4.2.2 Performance of strategy combining two styles. Table 4 shows the monthly excess value-weighted returns on strategies combining two investment styles. To this end, we construct the independent two by two portfolios, "HH," "HL," "LH" and "LL." Specifically, stocks listed on the KOSPI200 are sorted into two groups (50%, 50%) based on each of the two investment styles, independently. "H" ("L") represents average excess return of 50% stocks, which are known to have the highest (lowest) return. The values in parentheses are the *t*-statistics.

Panel A shows the results combining the book-to-market and gross profitability followed by Novy-Marx (2013), and Panel B reports excess returns of strategy combining the book-to-market and quality proposed by Piotroski (2000). In Panel C, following Asness *et al.* (2013), we examine performance on combining strategy based on book-to-market and past return, and we report the combining strategy of momentum and volatility in Panel D, which is

		Panel A: BM and GP				Panel B: BM and Qual	
		GP				Qual	
		L	H			L	H
BM	L	0.17 (0.31)	0.55 (1.29)	BM	L	−0.18 (−0.35)	0.61 (1.37)
	H	1.16 (2.24)	1.11 (2.54)		H	1.08 (2.06)	1.25 (2.66)
		Panel C: BM and Mom				Panel D: Mom and Vol	
		Mom				Vol	
		L	H			L	H
BM	L	0.03 (0.06)	0.73 (1.54)	Mom	L	0.89 (2.19)	0.21 (0.37)
	H	0.99 (1.96)	1.34 (2.79)		H	0.99 (2.56)	1.02 (1.85)
		Panel E: Size and Qual				Panel F: Size and BM	
		Qual				BM	
		L	H			L	H
Size	L	0.34 (0.65)	0.84 (1.75)	Size	L	0.05 (0.10)	0.98 (2.01)
	H	0.77 (1.45)	0.94 (2.18)		H	0.57 (1.27)	1.39 (2.85)

Notes: This table shows the monthly excess value-weighted returns (%) on strategies combining two investment styles. We construct the independent two by two portfolios, "HH", "HL", "LH" and "LL." Specifically, stocks listed on the KOSPI200 are sorted into two groups (50%, 50%) based on each of the two investment styles, independently. "H" ("L") represents average excess return of 50% stocks, which are known to have the highest (lowest) return. Investment styles used are firm size (Size), book-to-market ratio (BM), past return (Mom), gross profitability (GP), quality (Qual) and volatility (Vol). The values in parentheses are the *t*-statistics, and the sample period is from July 2000 to June 2019

Table 4.
Monthly excess returns on strategies combining two investment styles

widely used in the ETFs. Panel E investigates a strategy for combining firm size and quality proposed by Asness *et al.* (2019), and results on size and book-to-market sorted portfolios are presented in Panel F. Based on previous studies, we expect that the "HH" portfolios have superior returns. The monthly average excess returns of "HH" are the highest for most cases. For example, in Panels B and C, the monthly average excess returns of "HH" are estimated to be the highest at 1.25% and 1.34%, respectively. In addition, they are statistically significant, suggesting that the results of previous studies by Piotroski (2000) and Asness *et al.* (2013) are also confirmed in the Korean stock market.

Empirical results on Tables 3 and 4 show that style combination strategies generate economically large and statistically significant returns. Our empirical finding has not only academic but also practical implications. Large domestic funds, such as National Pension Fund and Teachers Pension invest their money into large stocks, small and medium-sized stocks, value stocks, growth stocks and stocks with high dividend yield. From our point of view, it is a kind of "MIX" combining strategy that combines multiple investment styles. In addition, some external investment agencies use a combination strategy that combines the two investment styles such as large and growth, small and value and high dividend and growth. Therefore, empirical results in this study provide justification for current investment strategies used by domestic pension funds under the OCIO structure.

However, to apply the combination strategies proposed by this study in practice, we need to consider the constraints that money managers face. Figure 2 displays the time-series of tracking errors estimated from the "MIX" strategies in Table 3. We use the KOSPI and KOSPI200 indices as benchmarks and tracking errors are defined as the standard deviations obtained by subtracting the returns of the benchmark from the returns of the combined strategy during previous 24 months. Figure 2 shows that tracking errors are over 20% in earlier periods. Then, tracking errors tend to decrease, but they are still around 10% recently. Considering that the tracking error of general public equity fund using the KOSPI

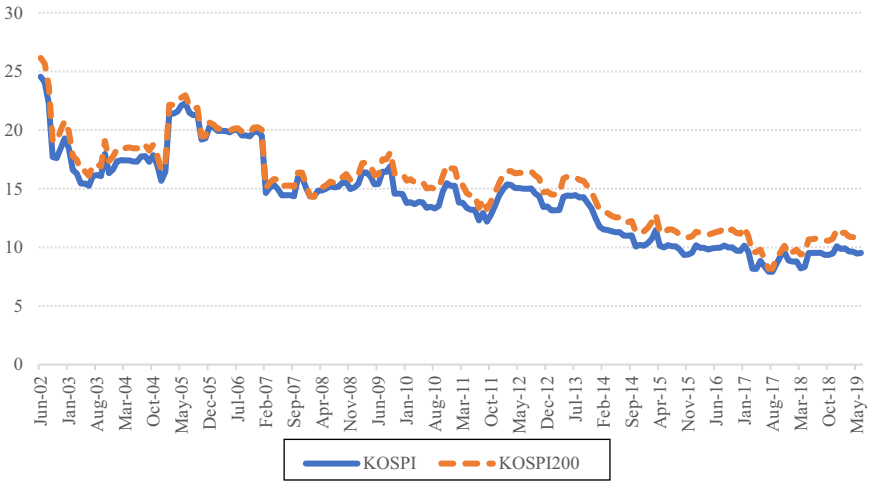


Figure 2.
Time-series of tracking errors estimated from style combining strategy

Notes: This figure displays the time-series of tracking errors estimated from the "MIX" strategies in Table 3. The KOSPI and KOSPI200 indices are used as benchmarks. Tracking errors are defined as the standard deviations of the value obtained by subtracting the returns of the benchmark from the returns of the combined strategy during previous 24 months. The sample period is from July 2000 to June 2019

or KOSPI200 as a benchmark is about 3%–6%, the tracking error of 10% is still large. While acknowledging that a certain level of tracking error is required to create alphas, excessively high tracking errors can be a significant burden under the OCIO structure. Therefore, we propose the following ways when applying the style combination strategy under the OCIO structure.

First, the style combination strategy is used as one of the sub-strategies of the OCIO's external investment agency or as a satellite strategy that complements the core strategy. For example, investment styles such as small and medium-sized stocks that have already been introduced in OCIO structure have a very large tracking error. Reflecting this, managers investing those stocks are given a relatively high tracking error limit. Like small and mid-cap investment strategy, the style combination strategy is a subtype and can be implemented in practice as long as it is given an appropriate risk limit to achieve excess returns.

Second, to reflect the active risk limit set by an external investment agency, money managers can partially modify and apply combination strategy suggested in this study. Because of the nature of the funds, the overall risk limit and active risk limit are different across funds. The tracking error of the style combination strategy suggested in this study is somewhat high, but if some modifications are made in a way that reflects the characteristics of the funds, our combining strategy can be successfully implemented within the risk limit of the predefined fund.

4.3 Performance of style timing strategies

Previous studies and empirical findings in this paper show that one can obtain superior returns from investment style strategies in the long-term. However, some previous works also indicate that different investment styles perform well in different economic conditions.

For example, Lee and Jang (2015) show that returns on large and growth stocks are higher than those of small and value stocks when the market is not stable. If different investment styles indeed create superior returns in different periods, how to construct a style timing strategy in each state can make a huge difference in performance. While strategic allocation is very important for external investment agencies, there is a need to adjust styles tactically in the face of changing market conditions or expanding market volatility. In particular, considering the domestic OCIO structure which conducts annual performance evaluation, an appropriate style timing strategy for improving performance may be essential.

It is known that external investment agencies perform style timing strategies on a quarterly or semiannual basis depending on the economic conditions or the relative recent performance of investment styles. Out of the two well-known timing strategies, we only consider style timing strategies based on the relative strength between different styles, that is, cross-sectional momentum. It is because there are tremendous variables and methodologies for defining economic conditions. Therefore, it is not so easy to draw an integrated implementable strategy based on economic regimes.

4.3.1 Performance of style timing strategies based on cross-sectional momentum. Table 5 shows the average monthly excess returns of the five style timing strategies based on cross-sectional momentum. It is a strategy to increase the proportion of investment styles that have recently performed well and to reduce the proportion of investment styles that have been relatively poor in recent periods. Panel A shows the excess returns for KOSPI firms, and Panel B displays the excess returns for KOSPI200 firms. Specifically, for each month, we measure the cumulative returns of the six investment styles over the past 12 months. Six investment styles are firm size, book-to-market ratio, past return, dividend yield, quality and volatility. We then adjust the relative weights of each investment style based on the relative performance and hold that portfolio for one month. Below, the five strategies are given:

(1) Strategy 1: Set the same weight of 1/6 in six investment styles (1/N strategy).

(2) Strategy 2: Set the weights from styles with the best to the worst performing as follows: (1/6+0.05, 1/6+0.03, 1/6, 1/6, 1/6-0.03, 1/6-0.05).

	Strategy 1	Strategy 2	Strategy 3	Strategy 4	Strategy 5
Panel A: KOSPI					
Average monthly return (%)	1.45	1.51	1.56	1.87	1.94
t-statistic	3.71	3.79	3.83	4.20	4.31
Panel B: KOSPI200					
Average monthly return (%)	1.07	1.09	1.10	1.23	1.20
t-statistic	2.72	2.73	2.72	2.90	2.73

Notes: This table shows the average monthly excess returns of the five style timing strategies based on cross-sectional momentum. Panel A shows the excess returns for KOSPI firms, and Panel B displays the excess returns for KOSPI200 firms. First, for each month, we measure the cumulative returns of the six investment styles over the past 12 months. Six investment styles are firm size, book-to-market ratio, past return, dividend yield, quality and volatility. Second, we adjust the relative weights of each investment style based on the relative performance and hold that portfolio for one month. Below, the five strategies are given. - Strategy 1: Set the same weight of 1/6 in six investment styles (1/N strategy) - Strategy 2: Set the weights from styles with the best to the worst performing as follows. (1/6 + 0.05, 1/6 + 0.03, 1/6, 1/6, 1/6–0.03, 1/6–0.05) - Strategy 3: Set the weights from styles with the best to the worst performing as follows. (1/6 + 0.10, 1/6 + 0.05, 1/6, 1/6, 1/6–0.05, 1/6–0.10) - Strategy 4: Set the same weight of 1/3 in each of the three best performing styles - Strategy 5: Set the weights of 1/2, 1/4 and 1/4, respectively, in the three best performing styles The sample period is from July 2000 to June 2019

Table 5. Performance of style timing strategies based on cross-sectional momentum

(3) Strategy 3: Set the weights from styles with the best to the worst performing as follows (1/6+0.10, 1/6+0.05, 1/6, 1/6, 1/6-0.05, 1/6-0.10).

(4) Strategy 4: Set the same weight of 1/3 in each of the three best performing styles.

(5) Strategy 5: Set the weights of 1/2, 1/4 and 1/4, respectively, in the three best performing styles.

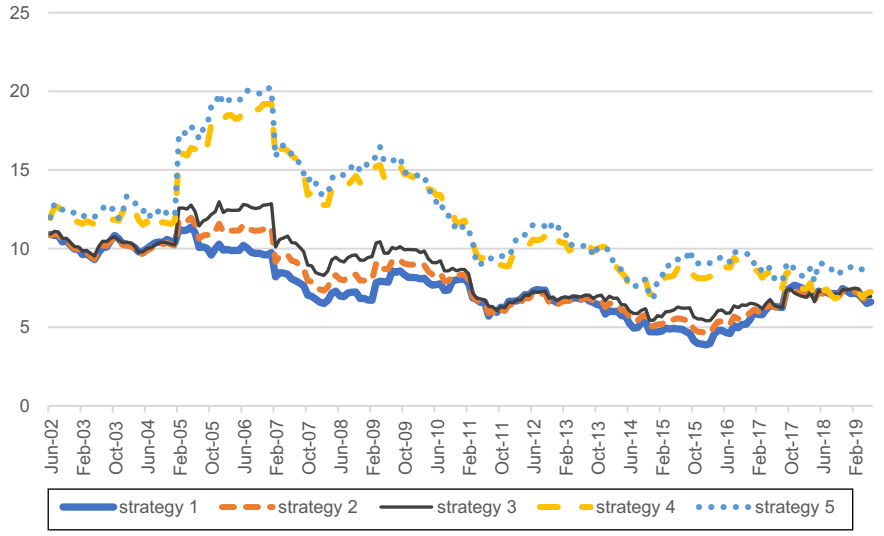
Strategy 1 is a portfolio that invests the same weight in six investment styles, which does not reflect recent relative performance. On the other hand, strategy 2 allocates 5% and 3% additionally to the two styles with the best performing styles over the past 12 months and reduces the same weight to those with low performance. Strategy 3 doubles the portfolio of rebalancing compared to strategy 2. Strategy 4 invests only in three investment styles that have performed well in the past 12 months and stops investing in the three styles with low performance. Finally, strategy 5 invests only in three styles with superior performance, but expands the proportion of investment styles with the best performing style compared to strategy 4. In Panel A, the average monthly excess return is statistically significant for all strategies, and the excess return increases as we use more aggressive timing strategies from strategy 1 to strategy 5. The empirical results in Panel B also show that style timing strategies create statistically significant excess returns.

To apply the style timing strategy in practice, it is necessary to examine the tracking error like the style combination strategy in subsection 4.2. Figure 3 reports the time-series of tracking error estimated from the style timing strategy when the KOSPI is used as a benchmark. In earlier period, a tracking error is approximately 10%, but the tracking error tends to decrease over time. In particular, for strategies 2 and 3, where the cross-sectional momentum strength is relatively weak, there is a period where the tracking error is controlled to be less than 5%. On the other hand, the tracking errors of strategies 4 and 5, which have strong cross-sectional strategies, are relatively high. Figure 4 shows the trend of estimated tracking errors when the KOSPI200 is used as a benchmark. We find that tracking errors have been slightly reduced compared to the case when the KOSPI is used as a benchmark, and the overall tracking error has recently decreased. In sum, empirical results indicate that factor timing strategies suggested in this study can be used in practice.

4.3.2 Performance of style timing strategies based on value spread. We have shown that compared to other investment strategies, the value effect is very strong in the Korean stock market. Therefore, focusing on value strategy, we investigate whether performance on value strategy can be improved by using value timing strategy in this subsection. One disadvantage of cross-sectional momentum strategy, however, is that one cannot use it as an individual style timing strategy; therefore, we cannot apply it to value timing strategy. As an alternative, we use the value spread used by Cohen *et al.* (2003). As shown in equation (1), the value spread (VS) is calculated by subtracting the average book-to-market (BM) ratio of the 30% with the lowest percentage from the average value of the 30% with the highest percentage among KOSPI firms. The book-to-market ratio at time t is calculated as the value obtained by dividing the book value at the end of December of the prior year by the market value of the same period:

$$VS_t = Top\ 30\%\ BM_t - Bottom\ 30\%\ BM_t \tag{1}$$

A large value spread may imply undervaluation of value stocks, and therefore, there is an opportunity for value stocks to achieve higher returns compared to growth stocks. Conversely, a small value spread means that value stocks are relatively overvalued implying that there is little chance to obtain superior returns by investing value stocks.



Notes: This figure displays the time-series of tracking errors estimated from the style timing strategy when the KOSPI is used as a benchmark. Tracking errors are defined as the standard deviations of the value obtained by subtracting the returns of the benchmark from the returns of the factor timing strategy during previous 24 months.
- Strategy 1: Set the same weight of 1/6 in six investment styles (1/N strategy)
- Strategy 2: Set the weights from styles with the best to the worst performing as follows. (1/6+0.05, 1/6+0.03, 1/6, 1/6, 1/6-0.03, 1/6-0.05)
- Strategy 3: Set the weights from styles with the best to the worst performing as follows. (1/6+0.10, 1/6+0.05, 1/6, 1/6, 1/6-0.05, 1/6-0.10)
- Strategy 4: Set the same weight of 1/3 in each of the three best performing styles
- Strategy 5: Set the weights of 1/2, 1/4 and 1/4, respectively, in the three best performing styles

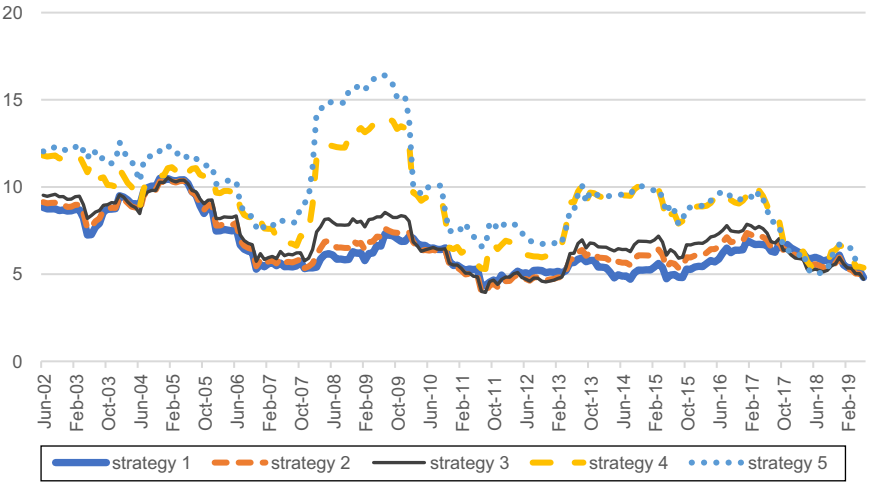
The sample period is from July 2000 to June 2019

Figure 3. Time-series of tracking errors estimated from style timing strategy: KOSPI

We run the following regression to examine the forecasting power of value spread on value strategy:

$$r^i_{t+1} - r^f_{t+1} = a_i + b_i VS_t + \epsilon^i_{t+1} \quad (2)$$

r^i_t is the quarterly or monthly value-weighted return of portfolio with the highest 10% book-to-market ratio, and r^f_t represents the quarterly or monthly risk-free return at time t. VS_t is the value spread at time t, computed either a quarterly or monthly basis. Panel A of Table 6 reports the regression results. The slope on the value spread is always positive and statistically significant, meaning that the value spread may be used as an indicator for factor timing strategy. Figure 5 shows the time-series of standardized value spread and the return on value portfolio. The value portfolio consists of the 10% of the stocks with the highest book-to-market ratio, and the value spread and return on value stocks are calculated



Notes: This figure displays the time-series of tracking errors estimated from the style timing strategy when the KOSPI200 is used as a benchmark. Tracking errors are defined as the standard deviations of the value obtained by subtracting the returns of the benchmark from the returns of the factor timing strategy during previous 24 months.
- Strategy 1: Set the same weight of 1/6 in six investment styles (1/N strategy)
- Strategy 2: Set the weights from styles with the best to the worst performing as follows. (1/6+0.05, 1/6+0.03, 1/6, 1/6, 1/6-0.03, 1/6-0.05)
- Strategy 3: Set the weights from styles with the best to the worst performing as follows. (1/6+0.10, 1/6+0.05, 1/6, 1/6, 1/6-0.05, 1/6-0.10)
- Strategy 4: Set the same weight of 1/3 in each of the three best performing styles
- Strategy 5: Set the weights of 1/2, 1/4 and 1/4, respectively, in the three best performing styles

The sample period is from July 2000 to June 2019

Figure 4.
Time-series of tracking errors estimated from style timing strategy: KOSPI200

among KOSPI firms. There seems a positive relation between return on value stocks and the value spread with a certain lag, suggesting that the value spread can predict the return on value portfolio.

To estimate return gained from timing strategy based on value spread, Panels B and C in Table 6 report the performance from factor timing strategies. We use two strategies, and Panel B (C) displays performance on timing strategy 1 (2). Both are dynamic zero-cost strategies that buy value stocks and sell the risk-free asset, and the two strategies differ in terms of the weight in value stocks. As shown in equation (3), in strategy 1, the weight investing in value portfolio is determined comparing current value spread and the historical average of the value spread. In addition, in strategy 2, the weight is adjusted based on the standardized value spread as shown in equation (4). We conduct quarterly rebalancing and measure the performance on the quarterly basis. In equations (3) and (4), $\mathrm{E_t[VS]} = \frac{1}{t}\sum_{k=1}^{t} VS_k$, and $\mathrm{Var_t}(VS) = \frac{1}{t}\sum_{k=1}^{t}\left(VS_k - E_t[VS]\right)^2$. To obtain stable values of $\mathrm{E_t[VS]}$ and $\mathrm{Var_t}(VS)$, the weight is calculated from February 2002:

Panel A: Regression results of excess return on value stocks on value spread

	Quarterly			Monthly	
b	*t*-statistic	R^2	b	*t*-statistic	R^2
0.95	3.21	0.11	0.18	2.12	0.02

Panel B: Performance from strategy 1

	Quarterly			Monthly		
	E(r)	Vol	TE	E(r)	Vol	TE
EW	1.061	0.965	0.970	1.054	0.960	0.969
VW	1.134	0.976	0.981	1.131	0.973	0.984

Panel C: Performance from strategy 2

	Quarterly			Monthly		
	E(r)	Vol	TE	E(r)	Vol	TE
EW	1.061	0.949	0.960	1.058	0.945	0.961
VW	1.152	0.965	0.975	1.157	0.963	0.982

Notes: In Panel A, we run the following regression to examine the forecasting power of value spread on value strategy:

$$r^i_{t+1} - r^f_{t+1} = a_i + b_i VS_t + \epsilon^i_{t+1}$$

r^i_t is the quarterly or monthly value-weighted return of portfolio with the highest 10% book-to-market ratio, and r^f_t represents the quarterly or monthly risk-free return at time *t*. VS_t is the value spread at time *t*, calculated by subtracting the average book-to-market ratio (BM) of the 30% with the lowest percentage from the average value of the 30% with the highest percentage among KOSPI firms. The book-to-market ratio at time *t* is calculated as the value obtained by dividing the book value at the end of December of the previous year by the market value of the same period. Panels B and C report the performance from factor timing strategies. We use two strategies, and Panel B (C) displays performance on timing strategy 1 (2):

$$Strategy\,1 : w^{st1}_t = \frac{VS_t}{E_t[\mathrm{VS}]}$$

$$Strategy\,2 : w^{st2}_t = 1 + 0.1 * \frac{VS_t - Et[VS]}{\mathrm{Var}_t(\mathrm{VS})^{0.5}}$$

We conduct quarterly rebalancing and measure the performance on the quarterly basis. We also measure performance from factor timing strategies based on monthly rebalancing, where the weight is determined based on the value spread at time t-2. $E_t[\mathrm{VS}] = \frac{1}{t}\sum_{k=1}^{t} VS_k$, and $\mathrm{Var}_t(\mathrm{VS}) = \frac{1}{t}\sum_{k=1}^{t}\left(VS_k - E_t[\mathrm{VS}]\right)^2$. To obtain stable values of E_t [VS] and $\mathrm{Var}_t(VS)$, the weight is calculated from February 2002. To estimate return gained from timing strategy, we estimate the benchmark return, the return from static strategy estimated by setting the weight of investing value stocks equal to 1. The return of style timing strategy is calculated by multiplying the benchmark return by the time-varying weight as shown below:

$$Benchmark\,return : r^b_{t+1} = r_{t+1,i} - r_{f,t}$$

$$Return\,from\,strategy\,1 : r^{st1}_{t+1,i} = w^{st1}_t r^b_{t+1}$$

$$Return\,from\,strategy\,2 : r^{st2}_{t+1,i} = w^{st2}_t r^b_{t+1}$$

E(r) in Panels B and C is defined as the ratio of return on each strategy to benchmark return. Vol is defined as the ratio of standard deviation of returns on each factor timing strategy to standard deviation of benchmark returns, and TE is the ratio of tracking error estimated from each factor timing strategy to the tracking error from benchmark strategy. Tracking errors are estimated based on the KOSPI using the 24-month data. We calculate values for both equal-weighted (EW) and value-weighted (VW) returns. The sample period is from July 2000 to June 2019

Table 6.
Performance on factor timing strategies based on value spread

Figure 5.
Time-series of standardized value spread and return on value stocks

Notes: This figure shows the time-series of standardized value spread and the return on value portfolio. The value spread is calculated by subtracting the average book-to-market ratio (BM) of the 30% with the lowest percentage from the average value of the 30% with the highest percentage among KOSPI firms. The value portfolio consists of the 10% of the stocks with the highest book-to-market ratio. The value spread and return on value stocks are calculated for KOSPI firms. The sample period is from July 2000 to June 2019

$$\text{Weight in strategy 1} : \mathrm{w}_{\mathrm{t}}^{(\mathrm{st1,Q})} = \frac{VS_t}{\mathrm{E_t[VS]}} \tag{3}$$

$$\text{Weight in strategy 2} : \mathrm{w}_{\mathrm{t}}^{\mathrm{st2,Q}} = 1 + 0.1 * \frac{VS_t - \mathrm{E_t[VS]}}{Var_t(VS)^{0.5}}. \tag{4}$$

We also measure performance from factor timing strategies based on monthly rebalancing. When computing the weight on a monthly basis, the value spread at time t-2 is used as shown in equations (5) and (6):

$$\text{Weight in strategy 1} : \mathrm{w}_{\mathrm{t}}^{\mathrm{st1,M}} = \frac{VS_{t-2}}{\mathrm{E_{t-2}[VS]}}. \tag{5}$$

$$\text{Weight in strategy 2} : \mathrm{w}_{\mathrm{t}}^{\mathrm{st2,M}} = 1 + 0.1 * \frac{VS_{\mathrm{t-2}} - E_{t-2}[\mathrm{VS}]}{\mathrm{Var_{t-2}(VS)}^{0.5}}. \tag{6}$$

To estimate return gained from timing strategy, we estimate return from benchmark as displayed in equation (7). The benchmark return is the return from static strategy, estimated by setting the weight of value stocks equal to 1. The return of style timing strategy is calculated by multiplying the benchmark return by the time-varying weight as shown in equations (8) and (9):

$$\text{Benchmark return} : r_{t+1}^{b} = r_{t+1,i} - r_{f,t} \tag{7}$$

$$\text{Return from strategy 1} : r_{t+1,i}^{st1} = w_t^{st1} r_{t+1}^{b} \tag{8}$$

$$\text{Return from strategy 2}: r^{st2}_{t+1,i} = w^{st2}_{t} r^{b}_{t+1} \quad (9)$$

E[r] in Panels B and C is defined as the ratio of return on each strategy to benchmark return. Vol is defined as the ratio of standard deviation of returns on each factor timing strategy to standard deviation of benchmark returns, and TE is the ratio of tracking error estimated from each factor timing strategy to the tracking error from benchmark strategy. Tracking errors are estimated based on the KOSPI using the 24-month data. We calculate values for both equal-weighted (EW) and value-weighted (VW) returns.

As shown in Panels B and C, E[r] is estimated to be greater than 1, indicating that the two style timing strategies outperform the benchmark strategy. In addition, Vol and TE are less than 1, confirming that the style timing strategies improve both in terms of total risk and tracking error compared to the benchmark strategy. In sum, our factor timing strategies improve the return compared to the benchmark case and reduce the risk, suggesting that the risk-return profile can be improved once the strategies are implemented in practice.

5. Conclusion

To improve the profitability and achieve diversification by enhancing the expertise of fund management, more and more funds are now interested in OCIO structure. To achieve the target rate of return, the external investment agency usually allocates money into asset classes such as stocks, bond and alternative assets. The composition of investment style reflects the view of the external investment agency, and therefore, it is the key ingredient under the OCIO structure. As different external investment agencies use different investment styles on stocks, we examine the validity of investment styles.

We find that traditional investment styles including firm size and book-to-market ratio are strong determinants of cross-sectional returns in Korea. In addition, our empirical finding indicates that external investment agencies can use other investment styles such as dividend and volatility. Our empirical results also show that style combination strategies generate economically large and statistically significant returns. Finally, our style timing strategies based on cross-sectional momentum create superior returns suggesting that factor timing strategies suggested in this study can be used in practice.

Given that little is known about performance of style timing strategies and style combination strategies, our empirical findings have important contribution. We find that style combination strategies can improve the risk-return profile. Given that some external investment agencies use a combination strategy, empirical results in this study provide justification for current investment strategies used by domestic pension funds under the OCIO structure. In addition, we measure the empirical performance of style timing strategies and find that performance can be improved. Our empirical results indicate that factor timing strategies suggested in this study can be successfully implemented in practice.

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Further reading

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