경영학석사 학위논문

Do the Factor-Based Strategies Deliver in Korean Stock Market?

한국 주식 시장에서의 요인 모형에 입각한 수익률의 유의성

2017년 08월

서울대학교 대학원

경영학과 재무금융전공

심 미 관

Abstract

This paper measures the significance of returns from factor-based strategies in Korean Stock market. The assessment of the significance employs the differences in the returns of long-short portfolios constructed upon five main factors introduced in many finance papers: volatility, value, size, liquidity, and quality, and that in Sharpe ratios of those portfolios. Although most of the factor-based strategies show no significant result, some factor-based strategies show positive average return with improved volatility. The reason for lack of statistical results possibly attributes to the shortage of data since the stock data after 2000 in Korean market is reliable.

Keyword : Factor, Volatility, Value, Size, Liquidity, Quality
Student Number : 2015-20623

Table of Contents

Tables

Figures

1. Introduction

Since the introduction of factor models and investment strategies based on factors, many investors such as institutional investors and hedge funds have employed these factor-based strategies. However, a huge number of factors and debates on the factor-based strategies irritate the investors and they started to have a doubt on these strategies.

To begin with, the factor models or factor-based strategies are too complicated for investors to duplicate. For instance, replicating the liquidity measure suggested by Amihud (2002)[①] for long period such as more than ten years would not be easy for investors without access to the data and understanding of the meaning of the variables and the value. Moreover, the strategy requires frequent rebalancing which is expensive, especially not feasible to non-institutional or professional investors. McLean and Pontiff (2015) concluded that 12 of 97 factor strategies addressed in the literature could not be built using similar data and time periods after their out-of-sample testing.

Furthermore, the strategy documented in the papers would not work in a different investment period or region. Harvey at al. (2016) insisted that recent factors discovered are not effective. Therefore, some scholars such as Bailey et al. (2014, 2015), Harvey and Liu (2015) offered to put a stricter statistical constraint on discovering a new factor.

---

① Amihud (2002) suggested a measure for liquidity using days available for an asset's return and the trade volume

This paper examines the profitability and statistical significance of factor-based strategies with various factor definitions since the factors introduced include several definition to build, on behalf of non-professional investors.

1.1. Literature Review

- **Volatility**

The volatility of a stock has long been discussed throughout the history of studies in finance. Traditionally, stocks bearing high volatility or beta produce larger return than stocks with low volatility or beta. This is a principle of "trade-off of risk and return". For example, CAPM suggested that expected return is proportional to the market beta so that high beta stocks offer greater expected return.

However, unlike the traditional theories, low volatility (beta) stocks or portfolio generate greater return than high volatility (beta) stocks, which is sometimes tried to be explained by behavioral explanations. Haugen and Heins (1975) documented a flat or inverted security market line, and stocks with higher beta than the equity market portfolio do not generate higher return. There are a series of researches investigating low-beta anomaly and low-volatility puzzle: Blau et al. (2014), Bali et al. (2015), Hsu and Viswanathan (2015) Ang et al. (2006)

- **Value**

Value premium is also a popular topic in finance studies. Basu (1977) documented an investment strategy upon P/E ratio that stocks with low P/E ratio earned higher return than high P/E ratio because P/E ratio information was not fully reflected in the price. Rosenberg et al. (1984) addressed value anomaly that cannot be explained by CAPM.

Two main explanations for value effect exist: (1) the value effect is a compensation for bearing some risk; (2) the value premium is a result of mispricing or market imperfections. Fama and French (1993, 1997) explained the return to B/M as compensation for macroeconomic risk. Campbell and Vuolteenaho (2004) and Zhang (2005) insisted that capital-intensive companies having high book-to-market ratio are more vulnerable to economic shocks due to inflexible downsizing their capital expenditure size in recessions. Shleifer and Vishny (1997) emphasized the arbitrage risk with mispricing associated with book-to-market ratio. Furthermore, transaction costs hinder investors from short-selling to remove mispricing from value effect.

- **Size**

Banz (1981) documented a size effect unexplained by CAPM. Blume and Stambaugh (1983) reported that the size anomaly only concentrated on the month of January when bid-ask effect considered. Several other explanation

for size effect exist: (1) the size premium is a result of bearing corresponding risk such as credit shocks; (2) the discovery of size premium is a result of data mistakes. The former explanation is supported by Fama and French (1993). They documented a size-controlled portfolio and created a factor based on an abnormal return from the portfolio. The latter explanation is addressed by Shumway (1997) and Shumway and Warther (1999). The authors argued that a greater return from small cap stocks is possibly driven by data mistakes due to inappropriate treatment of the delisted stocks.

- **Liquidity**

Since the introduction of liquidity factor into the finance field, it has become an important feature of a stock when picking up to form a portfolio. Amihud (2002) and Pastor and Stambaugh (2004) have discovered the phenomenon that holding illiquid stocks offers a compensation to the investors. Liu (2006) suggested a liquidity-augmented capital asset pricing model. There are several measures for liquidity: zero-return day measure, a liquidity measure suggested by Amihud (2002), and other measures taking the trading cost and daily trading volume.

- **Quality**

Several quality measures have been studied in the finance field. There

are also many definition of "quality". In terms of profitability as one of the quality measures, Novy and Marx (2013) documented a quality term of gross-profits-to-assets ratio. Fama and French (2015) included a profitability term into their five-factor model. On the other hand, Sloan (1996), Hirshleifer et al. (2004) devised a measure for quality using accruals in accounting practices. Chauvin and Hirschey (1993) studied advertising and R&D expenses impact on the equity returns. Among many definition of quality, this paper employs gross profitability, gross margins, return on equity, and book leverage.

2. Data

Most of data are collected from Dataguide. The daily returns of all firms in KOSPI and KOSDAQ from January 1st 2000 to December 31st 2015 are collected from Dataguide. However, data from January 1st 1991 to December 31st 1999 was added to calculate prior-three-year beta. The data includes delisted firms in the test period to prevent survivorship bias.

The book equity value, dividend payments, cash flow, and earnings from operation for value factor portfolio construction are also collected from Dataguide in the same test period. The monthly market capitalization for size factor strategy, and the gross profitability, gross margin, and return on equity for quality factor portfolio formation from Dataguide are used in this paper. Dataguide provides the daily average trade volume for one month, six

months, and twelve months for liquidity factor portfolios.

The risk-free rate is 91-day Treasury bill rate issued by Korean government and collected from the database of Bank of Korea. Since this rate is annualized, the rate has been switched into monthly rate for the analysis.

3. Methodology

In this section, the portfolio creation method, size subuniverse formation and the measure of long-short portfolio return and Sharpe ratio difference.

3.1. Portfolio Formation and Variable Definition

3.1.1. Size Subuniverse

To examine the performance of the various factor strategies in the large- and small- subuniverses separately, all stocks are divided into two groups based on their monthly market capitalization. Every month, bottom 90% market capitalization stocks are assigned to be small subuniverse and top 10% stocks are assigned to be large subuniverse. The reason why the standard percentile of division is not equal to median is stocks in Korean market are usually smaller than the median market capitalization of the US market. Beck et al. (2016) insisted that the median market capitalization of the US market is historically similar to top 10% market capitalization of the

markets outside the US. Therefore, most of stocks in Korean market belongs to small-subuniverse, which the phenomena spotted in small-subuniverse becomes more important than other subuniverse.

While some academic papers utilizes independent sorting, this paper adopts consequent sorting; all stocks firstly are having their size subuniverse and within each subuniverse, the stocks are divided in accordance with the factor definition. With consequent sorting, the number of samples in each portfolio in each period would not vary dramatically.

Additionally, the paper reports the performance of the "combined" portfolio: 50% invested in the large-characteristic portfolio and 50% in the small-characteristic portfolio.

3.1.2. Volatility Portfolio Creation

The portfolios are formed upon four different volatility definitions: average monthly market beta over prior one year using daily return data, average monthly market beta over prior three years using daily return data, average monthly standard deviation of daily returns over prior one year, and average monthly deviation of daily returns over prior three years. For the beta, the definition is $\beta_{i,t} = \rho(\sigma_{i,t}/\sigma_{m,t})$.

First, the estimation of market beta over prior one year using daily return data of all stocks is conducted. The correlation coefficient is measured over prior five years in each month while the monthly standard deviation of an

asset's returns and market returns are estimated with one year of daily returns. For example, for the beta in January 2005, the estimation period for the correlation between an asset's return and the market return is from January 2000 to December 2004, and that for standard deviation of the daily return for an asset and the market is from January 2004 to December 2004. Prior-three-year beta also employs this method but the standard deviations use prior-three-year daily returns. The prior-one-year (the prior-three-year) standard deviation of each asset are estimated with one year (three years) of daily returns. This whole process is implemented in large- and small-universe.

Afterwards, in each size universe, the stocks are divided into two groups: high volatility portfolio and low volatility portfolio by the median market beta or standard deviation. Therefore, the paper has 16 portfolios (the number of size universe is two, that of volatility group is also two and the volatility has four definitions): small with high volatility, small with low volatility, large with high volatility, and large with low volatility in four different volatility definitions. However, since only one definition will be allocated to one test, an asset in small with high prior-one-year market beta can be in small with low prior-three-year market beta.

The returns of every portfolio in this paper are value-weighted return of the portfolio. The weighted return is based on the market capitalization of the month when the portfolio is created. Moreover, the portfolio is rebalanced monthly.

3.1.3. Value Portfolio Creation

The value portfolio has four different factor definitions: book value of equity to market value of equity, book cash flow to market value of equity, book earnings from operation to market value of equity, and book dividend payments to market value of equity.

In each size group, the data associated with the factor definitions is collected. Even though the book values are the same across the fiscal year, the market value of equity varies so that the book-to-market value differs between the months. No lagging is applied in this method.[②]

Unlike Fama and French (1993)[③], the top 70% of book-to-market values in each month will be the value portfolio and the bottom 30% will be the growth portfolio. Therefore, the paper has 16 portfolios (the number of size universe is two, that of book-to-market group is two, and there are four factor definitions): small and value, small and growth, large and value, and large and growth portfolios across the four different definitions.

The return of every portfolio in this paper is a value-weighted return of the portfolio. The weighted return is based on the market capitalization of the month when the portfolio is created. Moreover, all portfolios are rebalanced monthly.

---

② Usually, the whole financial statement of prior one fiscal year is available in March. So some database report three-month lagged book values, but this paper adjusted this lagging.

③ Fama and French (1993) assigned top 30% into value portfolio (High group), bottom 30% into growth portfolio (Low group), and the middle 40% were abandoned.

3.1.4. Size Portfolio Creation

Only in this portfolio creation, the original size-subuniverse is not used. All stocks are divided into four size groups. The stocks in the first and second size groups are in small universe while the stocks in the third and fourth group are in large universe. Hence, the paper is allowed to examine the size effect in depth. The paper has four portfolios: the smallest, small, large, and the largest.

The return of every portfolio in this paper is value-weighted return of the portfolio. The weighted return is based on the market capitalization of the month when the portfolio is created and each portfolio is rebalanced monthly.

3.1.5. Liquidity Portfolio Creation

Similar to other portfolio creation procedures, the liquidity-factor-based portfolio also has two size subuniverse; small- and large-subuniverse. First, all stocks are categorized into two size subuniverse according to top 10% market capitalization of each month. Within each size subuniverse, the stocks will be divided into ten liquidity groups upon each factor definition; average daily trading volume for one month, six month, and twelve months. The stocks in the first group are rarely traded while those in the tenth group are actively traded. The formation of the decile is derived from Pastor and

Stambaugh (2004) even though the authors created the liquidity decile by the betas on the liquidity term in their regression. However, this paper does not deal with a regression so the decile is directly formed upon the average daily trading volume.

There are a stack of papers reporting illiquid stocks bear higher return because it is a compensation of the marketability risk for investors. Therefore, the long-short portfolio in this section takes a long position in the illiquid portfolio and short position in the liquid portfolio in each month and each size-subuniverse.

Here, the returns are all value-weighted according to the market capitalization of each asset in each month.

3.1.6. Quality Portfolio Creation

A lot of papers in finance associated with the quality factors have been published. The quality factors in this report are based on Beck et al. (2016). The stocks are divided into two size groups according to the level of top 10% market capitalization. In each size subuniverse, the stocks are again categorized into two groups: the quality portfolio and the junk portfolio. The stocks with a higher level of those factor definitions are assigned to the quality portfolio and those with lower level are to the junk portfolio.

The factor definitions are gross profitability which is a revenue after deducting cost of goods sold divided by total assets, gross margins which is

a revenue after deducting cost of goods sold divided by revenue, return on equity which is net income divided by book value of equity, and book leverage which is debt-to-equity in book value ratio. The median level of each definition in each month is the standard of classification.

The value weighted return is used similar to other portfolio creations, and the quality and junk portfolios are rebalanced monthly.

3.2. Long−Short Portfolio Returns and Sharpe Ratio Differences

The long-short portfolio returns are gained each month from January 2000 to December 2015. The return from the portfolio in short position is subtracted from the return from the portfolio in long position and this residual return is the return for long-short portfolio return. The tables in this paper report average return and volatility in the test period, with the t-statistic of 192 monthly long-short portfolios. The returns and volatility in this paper are all percentage unit; for example, -0.0130 which is the first value on Table II refers to average -0.0130 % of monthly return in the test period.

To gain Sharpe ratio, the standard deviation of the return of the portfolio is required every month. Two steps are needed for the monthly standard deviations. First, the daily value-weighted portfolio return is computed. Second, the standard deviation of the daily value-weighted portfolio return

in a month is calculated. The table reports the average of the aggregate standard deviations during the test period.

4. Empirical Results

4.1. Volatility Factor Strategy

Table II reports the empirical results of each factor definition. Panel A shows the return and the volatility of each portfolio and t-statistic of the return of the portfolio that takes long position in low volatility portfolio and short position in high volatility portfolio. Panel B presents Sharpe ratio of each portfolio and t-statistics of Sharpe ratio difference of low volatility and high volatility portfolio in each factor definition.

In small universe, low volatility portfolios generate higher returns compared to high volatility portfolios. In addition to prior-one-year beta, the table reports prior-one-year volatility, prior-three-year beta, and prior-three-year volatility estimated with daily data. Even though the returns of long-short portfolios are not statistically significant, low volatility stocks uniformly outperform high volatility stocks in small-subuniverse with lower volatility. Low volatility portfolios in combined subuniverse also display higher returns compared to high volatility portfolios while some low volatility portfolios in large subuniverse show lower returns than high volatility portfolios in the same subuniverse. In most of the case, the low

volatility portfolios have higher Sharpe ratios than high volatility portfolios although some portfolios in large subuniverse shows the opposite.

Many finance papers show long position in high volatility portfolio and short position in low volatility portfolio to create zero-cost portfolio because high volatility portfolios are supposed to bear higher return according to the trade-off relationship between the risk and return. However, Haugen and Heins (1975) first found that stocks with a higher beta than the equity market portfolio did not bear higher returns. They figured it out that low-beta stocks, on average, outperform high-beta stocks.

Additionally, According to Beck et al. (2016), US and global data also show positive long-short portfolio return upon each volatility factor definition, but no statistical significance. The US data spans from 1967 to 2014 while global empirical result deals data from 1987 to 2014.

[Insert Table II here]

4.2. Value Factor Strategy

Table III represents the empirical result of value-factor based portfolios. The strategy takes a long position in the value portfolios and short position in the growth portfolios in every month from 2000 to 2015. Panel A shows the average monthly return and volatility of each portfolio with the t-statistic of long-short portfolio.

A monotonic pattern in return is absent. The returns from the portfolios build upon book-to-market ratio definition show small negative return in all subuniverses. However, in large-subuniverse, some of the returns from growth portfolios are higher than value portfolios. Value portfolios have lower volatilities than growth portfolios.

In small-subuniverse where most of stocks in Korean market belong, the value portfolios built upon the definition of earnings-to-market value, cash flow-to-market value, and dividends-to-market value show lower volatility compared to the growth portfolio in the same factor definition. This is a natural result; firms with higher earnings from operation, cash flow are less risky compared to the firms with lower earnings from operation and cash flow. Furthermore, the firms with high dividends are less risky because, first, investors prefer high dividends to increase their liquid wealth such as cash, and second, firms that can afford high dividends usually are stable in terms of corporate activity.

The investment strategy upon the definition of book-to-market value of equity shows the least significant return according to the t-statistic of long-short portfolio and Sharpe ratio difference, which makes this strategy not recommendable.

Beck et al. documented an empirical result of value factor strategy in US market using the same factor definitions and most of the long-short portfolios showed positive and significant result unlike the result of Korean dataset. Chang and Kim (2003) has showed the value premium existing in

Korean market, but their testing period (1980 to 2001) is far from this paper (2000 to 2015). Therefore, there is a rising need for plotting value premium during the test period of this paper. Figure 1 shows time-series long-short portfolio return based on book-to-market ratio which is a classical value factor definition from 2000 to 2015. As the figure implies, the long-short portfolio is continuously decaying, and even recorded a negative value recently. Although the average long-short monthly return is positive, it has no statistical significance possibly due to this phenomenon.

[Insert Table III here]

[Insert Figure 1 here]

4.3. Size Factor Strategy

Table IV reports the result of long-short portfolio strategy based on the size factor. The returns of different-size-group-portfolios and the volatilities are shown on Panel A including the t-statistic of long-short portfolio; takes a long position in smaller size group portfolio and short position in larger size group portfolio. It is a more intuitive explanation that all stocks are divided into four size groups to form a size-quartile, and the return differences and Sharpe ratio differences are all based on this quartile.

The average monthly return of portfolio containing the first size quartile ("Smallest") and the second size quartile ("Small") is 0.6484% with a

higher volatility of 8.5345%. Moreover, the average return of the portfolio only including the first size quartile ("Smallest") and the fourth quartile ("Biggest") records the return of 1.0868% with a higher volatility of 8.9174%. These strategies are consistent with the traditional size effect: to long smaller stocks and short bigger stocks at the same time bears a positive return. Also, smaller stocks show greater volatility since smaller firms tend to be young, and earn less, which makes those firms riskier. However, all of strategies do not generate significant long-short return.

Beck et al. reported a positive and significant long-short portfolio returns when first, long position in the first and second size quartile and short position in the third and fourth size quartile and second, long in only the first quartile and short in only the fourth quartile. Even though the result using Korean dataset shows positive return, it lacks statistical power.

Figure 2 shows the average market capitalization of each size quartile from 2000 to 2015 in the US and Korea. The last size quartile is approximately ten times larger than the third quartile in the US while the last size quartile is around twenty one times larger than the third quartile in Korea. This implies the size distribution is skewed in Korean compared to the US.

Figure 3 shows the average market capitalization of each size decile from 2000 to 2015 in the US and Korea. US shows even distribution in market capitalization whereas Korea reveals skewed distribution. The first, second, and third quartile have little difference in size, and the fourth quartile is

enormous. Therefore, the reason why longing the first and second quartile and shorting the third and fourth quartile has smaller t-value compared to the portfolio utilizing the first and the fourth quartile.

[Insert Table IV here]

[Insert Figure 2 here]

[Insert Figure 3 here]

4.4. Liquidity Factor Strategy

Table V represents the empirical result of liquidity-factor-based investment strategy from January 2000 to December 2015. Panel A reports the average return and the average volatility of each portfolio with t-statistic of long-short portfolio while Panel B shows the average Sharpe ratio of each portfolio and t-statistic of Sharpe ratio difference.

In both small- and large-subuniverse, the volatility is much lower in illiquid portfolio than in liquid portfolio. This is a consistent result with Beck et al. (2016): globally, the illiquid portfolio recorded no higher return than liquid portfolio and the illiquid portfolio has lower volatility than liquid portfolio in small- and large-subuniverse. This is possibly because in the lowest liquidity decile, the stocks are so rarely traded that they have had similar or the same price as previous period.

The portfolios using average daily trading volume in a month (hereafter ADV1) definition shows an insignificant and negative long-short return

while both average daily trading volume in six months (hereafter ADV 6) and that in twelve months (hereafter ADV 12) definition reveal the significant and positive returns. Figure 4 reports long-short portfolio returns using ADV1, ADV6, and ADV12. It seems that the factor definitions have a critical influence on the long-short return across the size when Table V and Figure 4 simultaneously considered; the return is not monotonically distributed along with its liquidity decile across the factor definition, but ADV6 better shows some return pattern along with the liquidity decile, and ADV12 which has the highest t-value reveals the clearest (not perfectly clear) pattern. It is possible that ADV1 portfolios would have more noise than ADV6 and ADV12 portfolios.

Beck et al. reports a positive and significant returns using all factor definitions in the US. Figure 5 shows the time-series distribution of liquidity-factor based average monthly long-short portfolio returns. The return is quite volatile in each factor definition. It seems that the magnitude of the return is decreasing gradually. Figure 5-1 displays the annual return of the strategy, and the pattern is close to Figure 5. Volatile and decaying long-short portfolio return would be a primary reason for the lack of statistical power in the empirical result in ADV1 portfolios using Korean dataset.

[Insert Table V here]

[Insert Figure 4 here]

[Insert Figure 5 here]

[Insert Figure 5-1 here]

4.5. Quality Factor Strategy

Table VI shows the empirical result of quality-factor base portfolio investment from January 2000 to December 2015. Panel A describes the monthly average return and volatility of each portfolio with the t-statistic of long-short portfolio. Panel B reports average Sharpe ratio of each portfolio with the t-statistic of Sharpe ratio difference.

In small-subuniverse, the average return of quality portfolio is larger than that of junk portfolio. The term "Quality" implies lower risk of the portfolio since the factor contains the level of profitability of a firm. Hence, average volatility of quality portfolio is smaller than that of junk portfolio. This phenomenon is all shown across the factor definition. Although only the portfolio using the factor definition of "Return on Equity" shows a positive and significant value, other portfolios have a positive and relatively high t-value compared to other factor strategies.

In large-subuniverse, quality portfolios outperform junk portfolio in average return and average volatility except the strategy with the factor definition of gross margin. The quality portfolio upon gross margin has higher return in average but its volatility is also higher than junk portfolio. However, across the factor definition, quality portfolios tend to be more profitable than junk portfolios in terms of average return and volatility.

Sharpe ratio of quality portfolio is also larger in magnitude compared to junk portfolio. As in the large-subuniverse in Panel A, the portfolio upon gross margin shows lower Sharpe ratio in quality group than in junk group. Even though most of results except ROE portfolios are not significant, the strategy based on quality-factors is likely to be profitable. Beck et al. also documented insignificant result using US data.

[Insert Table VI here]

5. Conclusion

This paper examines several strategies based on the factors documented in many finance papers. The paper employs multiple definitions of each factor to check the robustness of the factor-based strategies. There are five factors to be tested: volatility, value, size, liquidity, and quality factors. Moreover, to figure out the different effect of factor according to the size group, all stocks are divided into two size subuniverses and then again assigned to their factor groups. Even though all strategies in this paper show no statistically significant result, some strategies leave some possibility of being significantly positive when more data added.

The factor strategy that longs low volatility portfolios and shorts high volatility portfolios generates a positive return on average with lowered volatility overall. The low volatility portfolios tend to have higher return

with lower return than the high volatility portfolios.

The strategy relying value effect also shows a positive average return with lessened volatility except the portfolio formed upon gross margins. This is because stocks with high cash flow, operating income and dividends are less risky, which a lot of risk-averse investors prefer. The value premiums are recently decaying in Korea, however, leading to low statistical power of value premiums.

In terms of size-factor strategy, only the portfolio including the smallest group and the biggest group (so longs the smallest and shorts the biggest) has a positive average return. Small stocks ("Smallest" and "Small" group) show higher volatility with an intuitive explanation behind. Small firms are more likely to be young and gain less compared to large firms.

The liquidity-factor strategy presents different results in small-subuniverse and large-subuniverse. In small-subuniverse, no explicit pattern in return appears while the volatility of liquid portfolio is greater than illiquid portfolio; illiquid portfolio has rare record of price movement, so the return looks less volatile. On the other hand, in large-subuniverse, the return of illiquid portfolio with lower volatility.

Last, quality-factor-based strategy produces a positive average return since the average return of quality portfolio is larger than that of junk portfolio. Similar to the value factor portfolio, these quality portfolios have better profitability, which these portfolios are less risk with lower volatility than junk portfolios.

Most of the case, the strategies show positive average returns but not statistically significant. This is possibly because of the length of data; the data before 2000 are not reliable since Korea was experiencing economic crisis and had poor stock market system. When more data available, the results of this examination can be significant in the future.

Reference

Amihud, Yakov. 2002. “Illiquidity and Stock Returns: Cross-Section and Times-Series Effects. “Journal of Financial Markets, vol. 5, no.1 (January): 31-56.

Ang, Hodrick, Xing, and Zhang. 2006. “The Cross-Section of Volatility and Expected Returns”, The Journal of Finance, vol 61, issue 1: 259-299

Bailey, David H., Jonathan M. Borwein, Marcos Lopez de Prado, and Qiji Jim Zhu. 2014. “Pseudo-Mathematics and Financial Charlatanism: The Effects of Backtest Overfitting on Out-of-Sample Performance.” Notices of the American Mathematical Society, vol. 61, no. 5 (May): 458–471.
———. 2015. “The Probability of Backtest Overfitting.” Working paper (http://papers.ssrn.com/sol3/papers. cfm?abstract_id=2326253).

Bali, Turan G., Stephen Brown, Scott Murray, and Yi Tang. 2015. “A Lottery Demand-Based Explanation of the Beta Anomaly.” Working paper (http://papers.ssrn.com/sol3/papers. cfm?abstract_id=2408146).

Banz, Rolf W. 1981. “The Relationship between Return and Market Value of Common Stocks.” Journal of Financial Economics, vol. 9, no. 1 (March): 3–18.

Blume, Stambaugh. 1983. “Biases in computed returns: An application to the size effect” Journal of Financial Economics, vol. 12, no. 3 (November): 387-404

Basu, Sanjoy. 1977. “Investment Performance of Common Stocks in Relation to Their Price-Earnings Ratios: A Test of the Efficient Market

Hypothesis." Journal of Finance, vol. 32, no. 3 (June): 663–682.

Beck, Hsu, Kalesnik, and Kostka. 2016. "Will Your Factor Deliver? An Examination of Factor Robustness and Implementation Cost." Financial Analysts Journal, vol. 72, no. 5 (September, October): 58-81.

Blau, Benjamin M., Jason Hsu, and Ryan Whitby. 2014. "Stock Lotteries and Expected Returns: International Evidence." Research Affiliates and University of Utah white paper.

Campbell, John Y., and Tuomo Vuolteenaho. 2004. "Bad Beta, Good Beta." American Economic Review, vol. 94, no. 5 (December): 1249–1275

Carhart, Mark M. 1997. "On Persistence in Mutual Fund Performance." Journal of Finance, vol. 52, no. 1 (March): 57–82.

Chauvin, Keith W., and Mark Hirschey. 1993. "Advertising, R&D Expenditures and the Market Value of the Firm." Financial Management, vol. 22, no. 4 (Winter): 128–140.

Fama, Eugene F., and Kenneth R. French. 1993. "Common Risk Factors in the Returns on Stocks and Bonds." Journal of Financial Economics, vol. 33, no. 1 (February): 3–56.

———. 2012. "Size, Value, and Momentum in International Stock Returns." Journal of Financial Economics, vol. 105, no. 3 (September): 457–472.

———. 2015. "A Five-Factor Asset Pricing Model." Journal of Financial Economics, vol. 116, no. 1 (April): 1–22.

Harvey, Campbell R., Yan Liu, and Heqing Zhu. 2016. " . . . and the Cross-

Section of Expected Returns." Review of Financial Studies, vol. 29, no. 1 (January): 5–68.

Haugen, Robert A., and James Heins. 1975. "Risk and Rate of Return on Financial Assets: Some Old Wine in New Bottles." Journal of Financial and Quantitative Analysis, vol. 10, no. 5 (December): 775–784.

Hirshleifer, David, Kewei Hou, Siew Hong Teoh, and Yinglei Zhang. 2004. "Do Investors Overvalue Firms with Bloated Balance Sheets?" Journal of Accounting and Economics, vol. 38 (December): 297–331.

Hsu, Jason, Vitali Kalesnik, and Vivek Viswanathan. 2015. "A Framework for Assessing Factors and Implementing Smart Beta Strategies." Journal of Index Investing, vol. 6, no. 1 (Summer): 89–97.

Liu. 2006. "A liquidity-augmented capital asset pricing model" Journal of Financial Economics, vol. 82: 631-671

Novy-Marx, Robert. 2013. "The Other Side of Value: The Gross Profitability Premium." Journal of Financial Economics, vol. 108, no. 1 (April): 1–28.

McLean, David R., and Jeffrey Pontiff. 2015. "Does Academic Research Destroy Stock Return Predictability?" Journal of Finance, vol. 71, no. 1 (February): 5–32

Pástor, Luboš, and Robert F. Stambaugh. 2003. "Liquidity Risk and Expected Stock Returns." Journal of Political Economy, vol. 111, no. 3 (June): 642–685.

Rosenberg, B., Reid, K., Lanstein, R., 1984. “Persuasive evidence of market inefficiency.” Journal of Portfolio Management, vol. 11: 9–17.

Shleifer, A., Vishny, R., 1997. “The limits of arbitrage.” Journal of Finance vol. 52: 35–55.

Shumway, Tyler. 1997. “The Delisting Bias in CRSP Data.” Journal of Finance, vol. 52, no. 1 (March): 327–340.

Shumway, Tyler, and Vincent A. Warther. 1999. “The Delisting Bias in CRSP’s Nasdaq Data and Its Implications for the Size Effect.” Journal of Finance, vol. 54, no. 6 (December): 2361–2379.

Sloan, Richard G. 1996. “Do Stock Prices Fully Reflect Information in Accruals and Cash Flows about Future Earnings?” Accounting Review, vol. 71, no. 3 (July): 289–315.

Zhang, Lu. 2005. “The Value Premium.” Journal of Finance, vol. 60, no. 1 (February): 67–103.

장영광, 김영택, 한국주식시장에서 가치투자전략의 투자성과와 그 원천, 증권학회지 제 32집 (2003) p. 165-208

Table I Summary Statistics of Each Portfolio

This table reports the summary statistics of each long-short portfolio in each strategy. The data period is January 1st 2000 to December 31st 2015. Panel A shows the descriptive statistics of each portoflio in the small-subuniverse, Panel B reports that in large-subuniverse, and Panel C presents the statistics of size-factor-based portfolio.

Portfolio	Min	Max	Median	Mean	Skewness
A. Small					
Volatility					
Prior-one-year beta	-17.1189	20.4936	0.6473	1.0560	0.2476
Prior-three-year beta	-20.8657	29.4239	0.4758	1.0071	0.4851
Prior-one-year standard deviation	-24.1183	26.6262	2.5653	2.8445	0.2318
Prior-three-year standard deviation	-19.1344	25.8463	3.2005	3.3099	0.5302
Value					
Book to market value	-31.8042	10.0385	-1.9970	-2.6638	-2.2092
Earnings to market value	-31.8957	11.6002	1.2343	0.8785	-2.1171
Cash flow to market value	-33.3771	11.4953	0.7383	0.2313	-2.0827
Dividends to market value	-20.5867	14.4407	-0.0656	-0.4514	-0.7330
Liquidity					
Average trading volume for one month	-59.4389	60.6790	-4.4907	-3.7446	0.8717
Average trading volume for six months	-57.9436	53.8508	-1.2165	-0.4158	0.3895
Average trading volume for twelve months	-50.0854	70.7594	0.9912	2.0933	1.4210
Quality					
Gross profitability	-14.0575	9.0580	1.3879	1.3773	-0.5744
Gross margins	-7.3836	9.3838	0.8724	0.9231	0.2262
Book leverage	-13.7126	40.8677	0.1013	0.1425	5.9002
Return on equity	-15.6944	17.2164	2.0053	1.9357	-0.1988

Portfolio	Min	Max	Median	Mean	Skewness
B. Large					
Volatility					
Prior-one-year beta	-15.4741	24.1030	0.3857	0.0633	0.3325
Prior-three-year beta	-13.8771	18.0623	0.6530	0.4663	0.3241
Prior-one-year standard deviation	-31.0113	19.5575	-0.1093	-0.0212	-1.1619
Prior-three-year standard deviation	-30.9049	18.0313	0.1082	-0.0832	-1.0123
Value					
Book to market value	-18.6970	11.8186	-1.3393	-1.6969	-0.2201
Earnings to market value	-16.1943	21.4422	-0.3700	0.1492	0.6009
Cash flow to market value	-24.6599	20.2421	-0.5360	0.5621	-0.0334
Dividends to market value	-19.6603	18.4825	-0.7105	0.8037	0.0009
Liquidity					
Average trading volume for one month	-51.6318	38.0723	0.4383	0.4660	-0.5623
Average trading volume for six months	-51.6318	38.0723	0.4383	0.4660	-0.5623
Average trading volume for twelve months	-44.1244	48.1010	1.7773	1.7398	-0.1797
Quality					
Gross profitability	-0.6156	0.6688	0.0249	0.0268	0.3148
Gross margins	-0.6102	0.6983	0.0055	0.0102	0.3098
Book leverage	-0.9410	0.7505	0.0604	0.0500	-0.4630
Return on equity	-0.6862	1.3153	0.0184	0.0220	0.8187

Portfolio	Min	Max	Median	Mean	Skewness
C. Size Portfolio					
Small and Smallest, Big and Biggest	-12.3113	13.3764	0.4976	0.5364	0.3148
Smallest, Biggest	-12.2040	13.9653	0.1094	0.2033	0.3098
Small, Big	-13.7242	26.3059	0.3682	0.4395	0.8187

Table II The Empirical Result of Volatility-Factor Base Portfolios

This table reports the empirical result of volatility-factor based portfolios. The volatility factor contains four different definitions: prior-one-year beta, prior-three-year beta, prior-one-year standard deviation, and prior-three-year standard deviation. Detailed explanation of these definitions are in section 3.1. The portfolios are rebalanced monthly, and first portfolios are formed on January 2000 and the last portfolios on December 2015.

	Low Volatility		High Volatility		t-stat of long-short
Definition	average return	volatility	average return	volatility	
A. Robustness of volatility factor across definitions: Returns					
Small					
Prior-one-year beta	-0.2600	8.5294	-1.3160	10.8162	0.2888
Prior-three-year beta	-0.9273	9.2997	-1.9344	11.3253	0.0713
Prior-one-year standard deviation	0.5278	8.6275	-2.3167	11.0518	0.0052
Prior-three-year standard deviation	0.7468	8.9327	-2.5631	10.6365	0.0011
Large					
Prior-one-year beta	1.2159	5.0700	1.1526	7.4538	0.9225
Prior-three-year beta	1.4141	5.5053	0.9478	7.5491	0.0054
Prior-one-year standard deviation	1.0787	6.2580	1.0999	9.0990	-0.9788
Prior-three-year standard deviation	1.0679	6.3143	1.1511	8.9162	-0.9161
Combined					
Prior-one-year beta	0.4779	5.9032	-0.0817	7.8456	0.4302
Prior-three-year beta	0.2434	6.1910	-0.4933	8.2267	0.3222
Prior-one-year standard deviation	0.8033	6.4976	-0.6084	8.6174	0.0708
Prior-three-year standard deviation	0.9073	6.6098	-0.7060	8.5093	0.0387

Definition	Sharpe Ratio Low Volatility	Sharpe Ratio High Volatility	t-stat of Sharpe Ratio difference	Significant
B. Robustness of volatility factor across definitions: Sharpe ratios				
Small				
Prior-one-year beta	-0.0040	-0.0736	0.1185	No
Prior-three-year beta	-0.0629	-0.0697	0.7344	No
Prior-one-year standard deviation	0.0548	-0.1149	0.0000	No
Prior-three-year standard deviation	0.0635	-0.1219	0.0000	No
Large				
Prior-one-year beta	0.0789	0.0569	0.2629	No
Prior-three-year beta	0.0761	0.0540	0.3244	No
Prior-one-year standard deviation	0.0627	0.0697	-0.8044	No
Prior-three-year standard deviation	0.0629	0.0689	-0.8284	No
Combined				
Prior-one-year beta	0.0537	0.0196	0.2060	No
Prior-three-year beta	0.0209	0.0079	0.6326	No
Prior-one-year standard deviation	0.0805	-0.0126	0.0032	No
Prior-three-year standard deviation	0.0839	-0.0161	0.0018	No

Table III The Empirical Result of Value-Factor Base Portfolios

This table reports the empirical result of value-factor based portfolios. The value factor contains four different definitions: book to market value, earnings from operation to market value (to save the space, this will be shown "earnings to market value"), cash flow to market value, and dividneds to market value. Detailed explanation of these definitions are in section 3.1. The portfolios are rebalanced monthly, and first portfolios are formed on January 2000 and the last portfolios on December 2015.

	Value		Growth		t-stat of long-short
Definition	average return	volatility	average return	volatility	
A. Robustness of value factor across definitions: Returns					
Small					
Book to market value	1.0310	7.4788	3.6948	10.5495	-0.0046
Earnings to market value	2.1140	7.7476	1.2356	10.1728	0.3418
Cash flow to market value	1.9797	7.7654	1.7483	10.1713	0.8023
Dividends to market value	1.7802	7.4359	2.2316	9.5523	0.6057
Large					
Book to market value	1.1440	6.5569	2.8409	7.3738	-0.0177
Earnings to market value	1.7715	6.3452	1.7207	8.3334	0.8347
Cash flow to market value	2.0282	6.3227	1.4660	8.9662	0.4782
Dividends to market value	2.1793	6.4142	1.3756	8.2265	0.2864
Combined					
Book to market value	1.0875	6.6078	3.2679	8.1321	-0.0042
Earnings to market value	1.8427	6.5770	1.4781	8.4094	0.6363
Cash flow to market value	1.8882	6.5420	1.7228	8.9151	0.8359
Dividends to market value	2.2055	6.5055	1.5779	8.1577	0.4052

Definition	Sharpe Ratio Value	Sharpe Ratio Growth	t-stat of Sharpe Ratio difference	Significant
B. Robustness of value factor across definitions: Sharpe ratios				
Small				
Book to market value	0.0739	0.2274	0.0000	No
Earnings to market value	0.1491	0.0790	0.0332	No
Cash flow to market value	0.1419	0.1000	0.1914	No
Dividends to market value	0.1322	0.1311	0.9777	No
Large				
Book to market value	0.0789	0.0569	0.2629	No
Earnings to market value	0.0761	0.0540	0.3244	No
Cash flow to market value	0.0627	0.0697	-0.8044	No
Dividends to market value	0.0629	0.0689	-0.8284	No
Combined				
Book to market value	0.0537	0.0196	0.2060	No
Earnings to market value	0.0209	0.0079	0.6326	No
Cash flow to market value	0.0805	-0.0126	0.0032	No
Dividends to market value	0.0839	-0.0161	0.0018	No

Table IV The Empirical Result of Size-Factor Base Portfolios

This table reports the empirical result of size-factor based portfolios. Each stocks are divided into quartile according to its market capitalization of the month when the portfolio is formed. “Small” in this table represents stocks in the second size quartile, “Smallest”, “Big”, and “Biggest” represent the first, the third, and the fourth quartile respectively. Detailed explanation of these definitions are in section 3.1. The portfolios are rebalanced monthly, and first portfolios are formed on January 2000 and the last portfolios on December 2015

	Small		Big		t-stat of long-short
Definition	average return	volatility	average return	volatility	
A. Robustness of size factor across definitions: Returns					
Small and Smallest, Big and Biggest	0.6484	8.5345	0.5076	6.7760	0.6178
Smallest, Biggest	1.0868	8.9174	0.2101	6.4756	1.5823
Small, Big	0.8051	8.9174	0.2101	8.4588	0.5028

	Sharpe Ratio			
Definition	Small	Big	t-stat of Sharpe Ratio difference	Significant
B. Robustness of size factor across definitions: Sharpe ratios				
Small and Smallest, Big and Biggest	0.0497	0.0561	-0.4930	No
Smallest, Biggest	0.0633	0.0364	1.0457	No
Small, Big	0.0745	0.0261	0.1560	No

Table V The Empirical Result of Liquidity-Factor Base Portfolios

This table reports the empirical result of liquidity-factor based portfolios. The liquidity factor contains three different definitions: average trading volume for one month, average trading volum for six months, and average trading volum for twelve months. Detailed explanation of these definitions are in section 3.1. The portfolios are rebalanced monthly, and first portfolios are formed on January 2000 and the last portfolios on December 2015.

	Illiquid		Liquid		t-stat of long-short
Definition	average return	volatility	average return	volatility	
A. Robustness of liquidity factor across definitions: Returns					
Small					
Average trading volume for one month	1.6752	13.4354	5.4198	38.4994	-1.4917
Average trading volume for six months	4.4519	14.0105	4.8678	36.9465	-0.5294
Average trading volume for twelve months	2.9991	14.8678	0.9058	36.5252	2.6538*
Large					
Average trading volume for one month	2.1120	24.8107	1.6460	40.4108	0.6847
Average trading volume for six months	4.3196	25.9240	3.4547	40.2537	1.2742
Average trading volume for twelve months	2.724	26.7367	0.9848	40.1691	2.4714*
Combined					
Average trading volume for one month	1.8936	1.8936	3.5329	35.3723	-1.5922
Average trading volume for six months	4.3857	17.7228	4.1612	34.7578	0.3634
Average trading volume for twelve months	2.8618	18.4724	0.9453	34.8242	3.0204*

Definition	Sharpe Ratio Illiquid	Sharpe Ratio Liquid	t-stat of Sharpe Ratio difference	Significant
B. Robustness of value factor across definitions: Sharpe ratios				
Small				
Average trading volume for one month	0.1219	0.2090	-1.5997	No
Average trading volume for six months	0.3488	0.1940	6.0691*	Yes
Average trading volume for twelve months	0.2155	0.0680	6.0739*	Yes
Large				
Average trading volume for one month	0.0793	0.0606	1.0423	No
Average trading volume for six months	0.1690	0.1099	3.2950*	Yes
Average trading volume for twelve months	0.1013	0.0374	3.6618*	Yes
Combined				
Average trading volume for one month	0.2653	0.6087	-1.7397	No
Average trading volume for six months	0.2580	0.1796	3.9504*	Yes
Average trading volume for twelve months	0.1635	0.0661	5.2156*	Yes

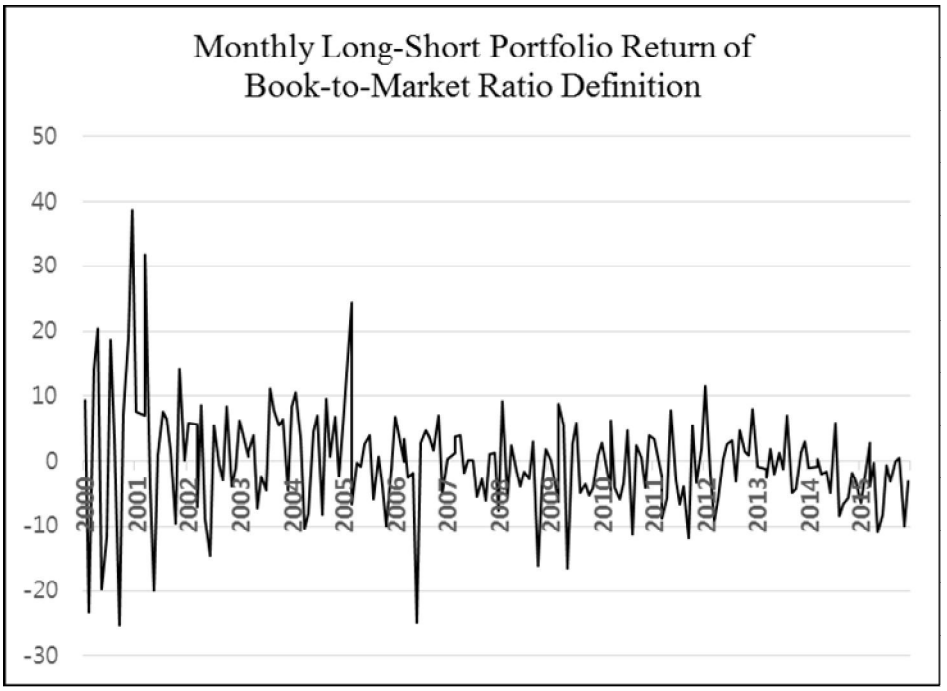
Table VI The Empirical Result of Quality-Factor Base Portfolios

This table reports the empirical result of quality-factor based portfolios. The quality factor contains four different definitions: gross profitability, gross margins, return on equity, and book leverage. Detailed explanation of these definitions are in section 3.1. The portfolios are rebalanced monthly, and first portfolios are formed on January 2000 and the last portfolios on December 2015.

	Quality		Junk		t-stat of long-short
Definition	average return	volatility	average return	volatility	
A. Robustness of quality factor across definitions: Returns					
Small					
Gross profitability	1.8719	26.1548	0.4947	26.7473	1.8761
Gross margins	1.6290	26.1922	0.7059	26.2123	1.2789
Book leverage	1.3404	26.1938	1.1979	27.5400	0.5153
Return on equity	2.0480	25.8170	0.1122	27.7970	2.2812*
Large					
Gross profitability	1.3039	26.1548	0.7674	31.0647	1.6403
Gross margins	1.1681	28.0888	0.9648	26.2123	0.6359
Book leverage	1.3921	28.3696	0.9526	29.9438	1.2987
Return on equity	1.17919	29.0510	0.1739	34.2684	2.8773*
Combined					
Gross profitability	1.5879	25.4754	0.6311	27.1759	1.1854
Gross margins	1.3985	25.4529	0.8353	27.6059	1.4437
Book leverage	1.3663	25.0794	1.0753	26.7526	1.1366
Return on equity	1.6136	25.6159	0.1431	28.9877	2.0954*

Definition	Sharpe Ratio Quality	Sharpe Ratio Junk	t-stat of Sharpe Ratio difference	Significant
B. Robustness of quality factor across definitions: Sharpe ratios				
Small				
Gross profitability	0.1331	0.0694	1.0353	No
Gross margins	0.1215	0.0804	0.2311	No
Book leverage	0.1066	0.1053	0.1558	No
Return on equity	0.1433	0.0415	8.0108*	Yes
Large				
Gross profitability	0.0948	0.0384	1.1954	No
Gross margins	0.0653	0.0892	-0.4179	No
Book leverage	0.0622	0.0551	0.6236	No
Return on equity	0.0623	0.0092	4.8565*	Yes
Combined				
Gross profitability	0.1120	0.0587	1.6913	No
Gross margins	0.1026	0.0680	0.2087	No
Book leverage	0.0926	0.0860	0.7403	No
Return on equity	0.1090	0.0348	6.0954*	Yes

Figure 1. Plot of Long-Short Portfolio Return Using Book-to-Market Ratio Definition



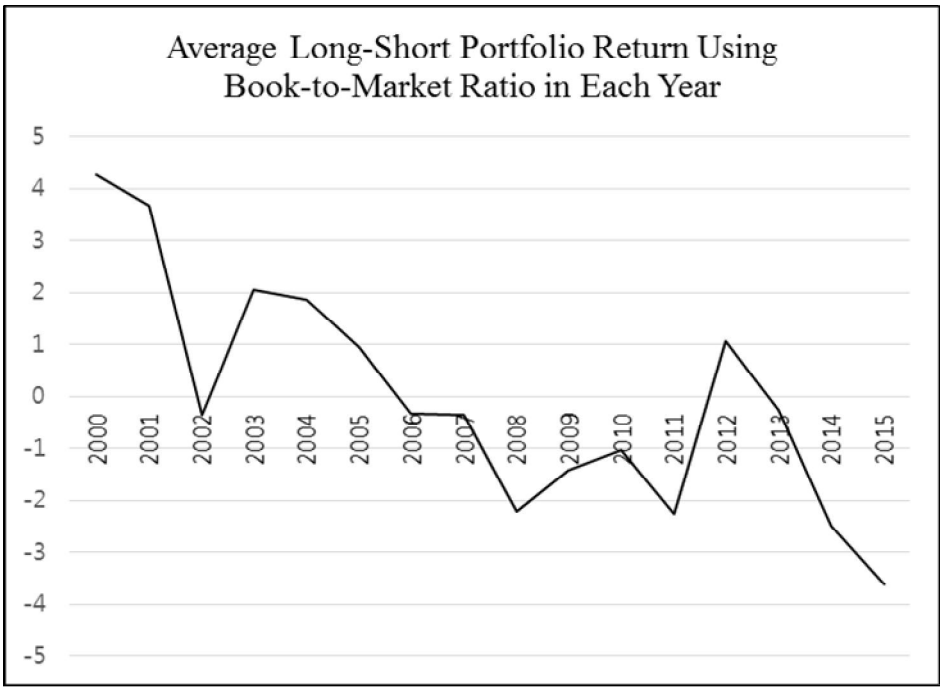


Figure 2. Average Market Capitalization of Each Size Quartile during the Test Period

The distribution of size decile during the test period of 2000 to 2015. Korean market capitalization is one-million KRW base while US market capitalization is one-million USD base.

Country		Smallest	Small	Big	Biggest
Korea	Average Market Capitalization during Test Period (in million KRW)	16718.14	38469.97	86929.44	1832169
	Comparative Size to One-level Smaller Quartile		2.3011	2.2597	21.0765
US	Average Market Capitalization during Test Period (in million USD)	132487.6	563190.1	1860960	19360758
	Comparative Size to One-level Smaller Quartile		4.2509	3.3043	10.4036

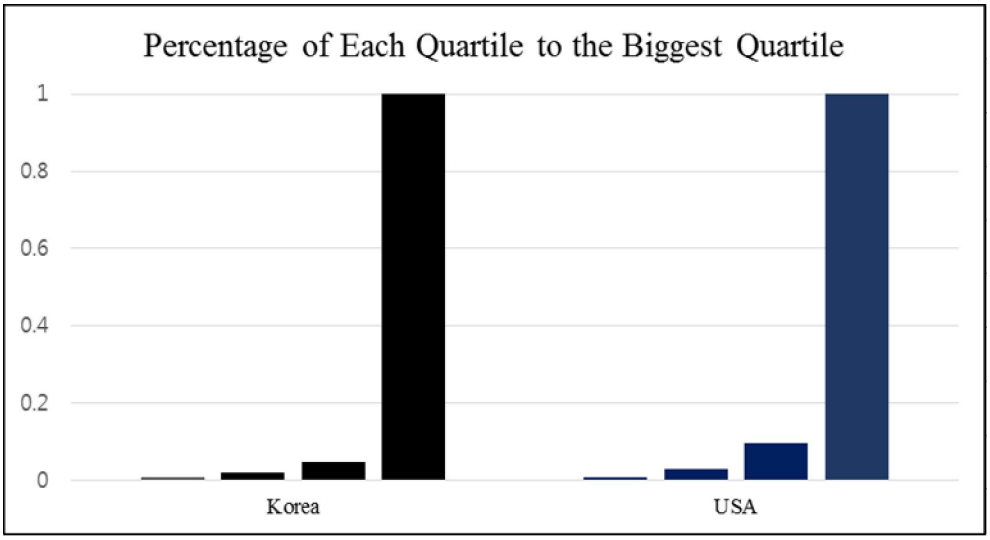
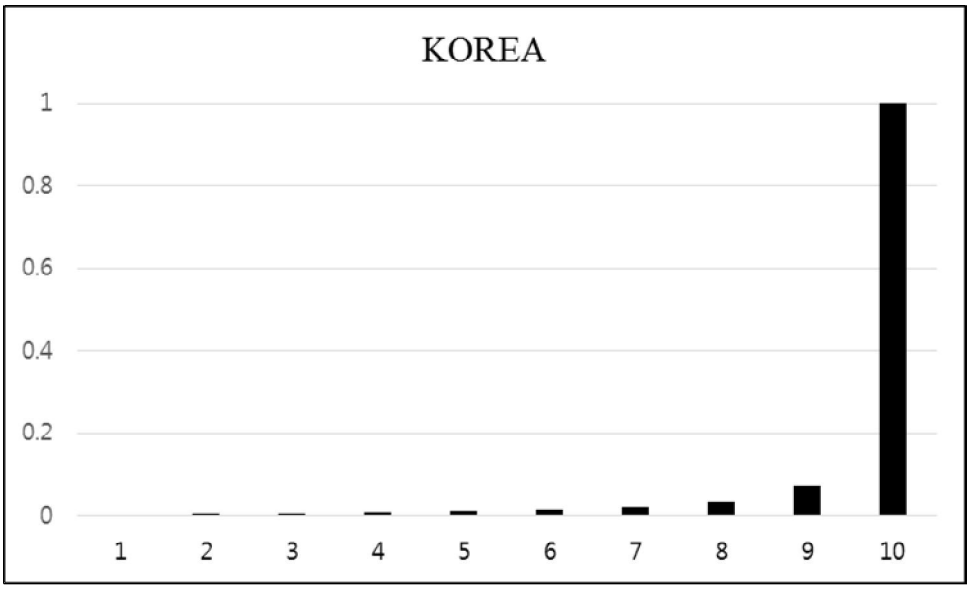


Figure 3. Descriptive Market Capitalization in US and Korea during the Test Period

The distribution of size decile during the test period of 2000 to 2015. Korean market capitalization is one-million KRW base while US market capitalization is one-million USD base. “1” denotes the smallest size decile while “10” refers to the biggest size decile.



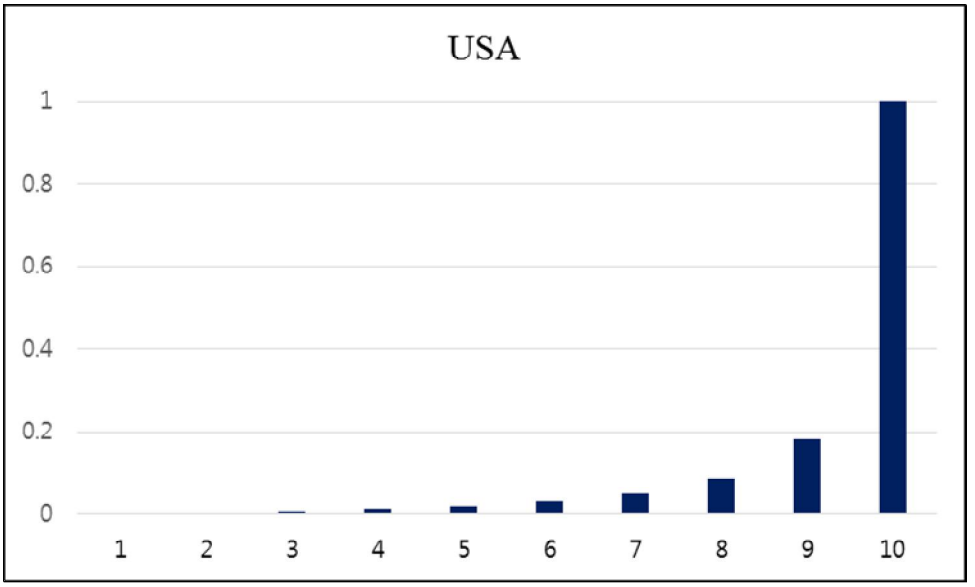
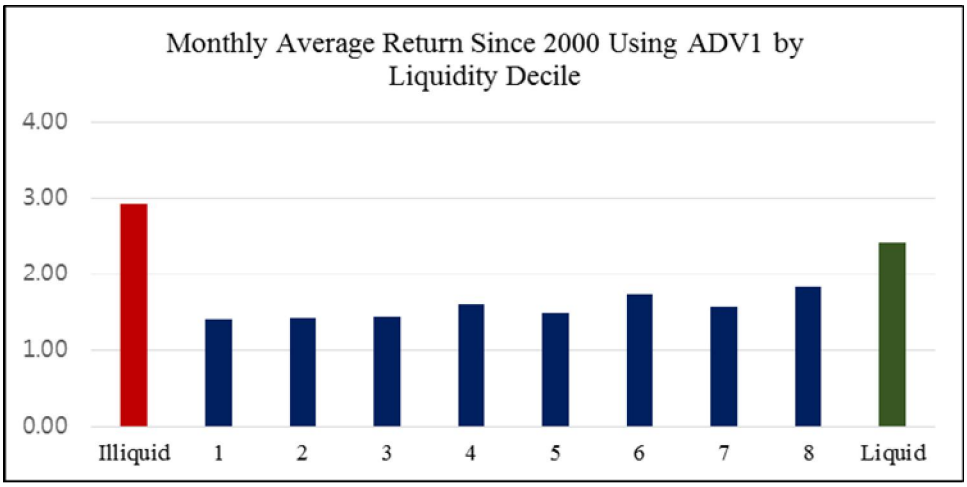
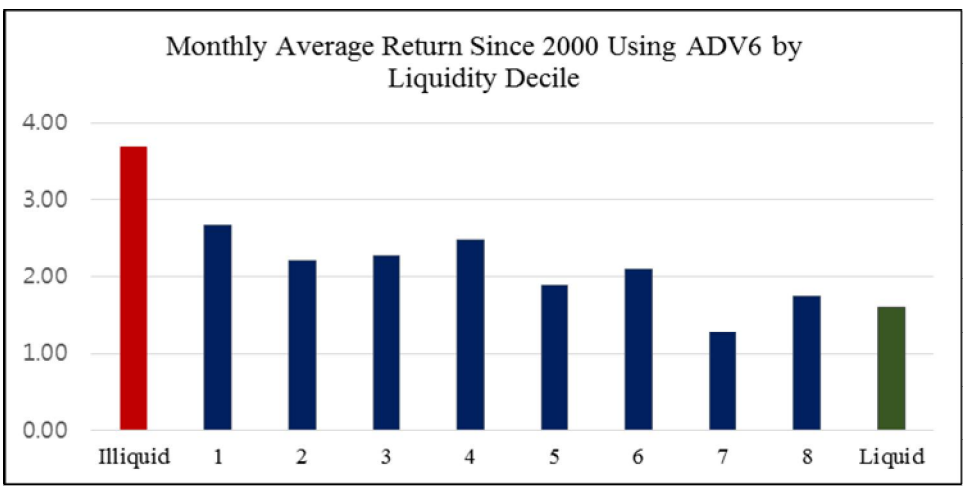


Figure 4. Monthly Average Return during the Test Period Using ADV1, ADV6, and ADV12 by Liquidity Decile





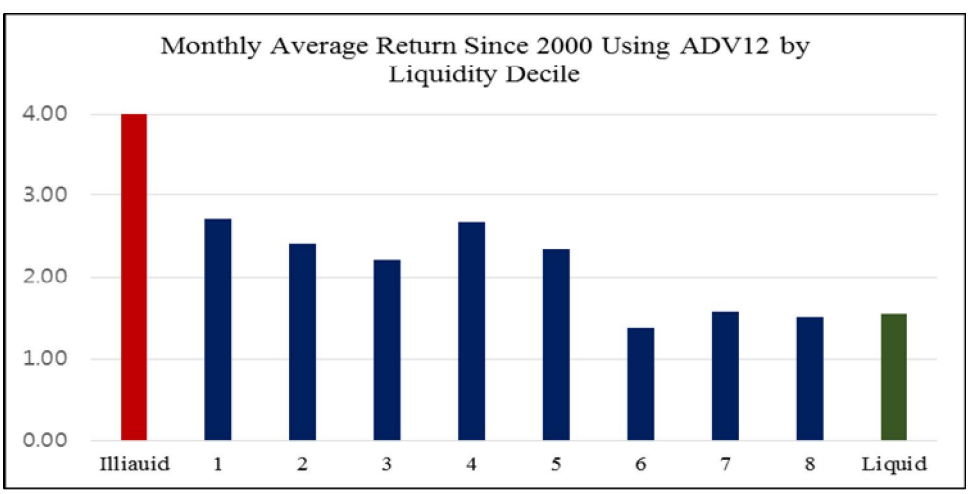
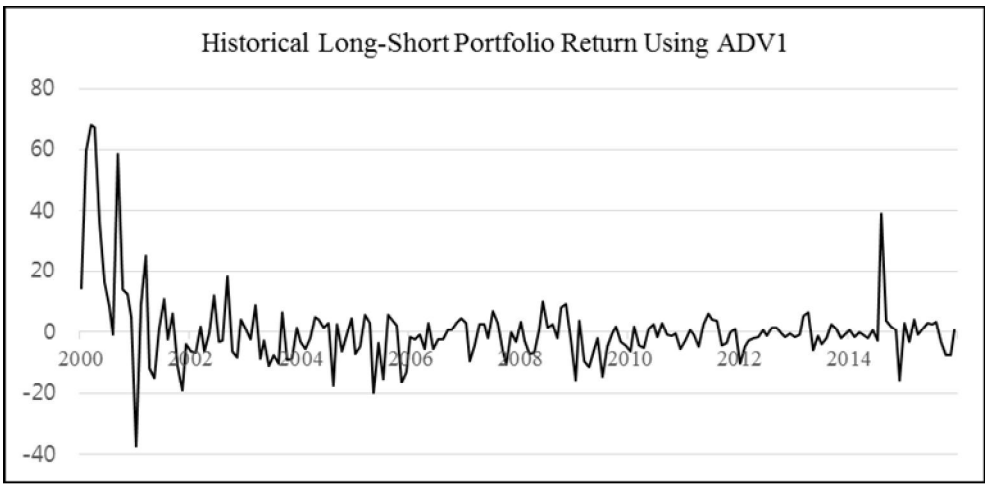
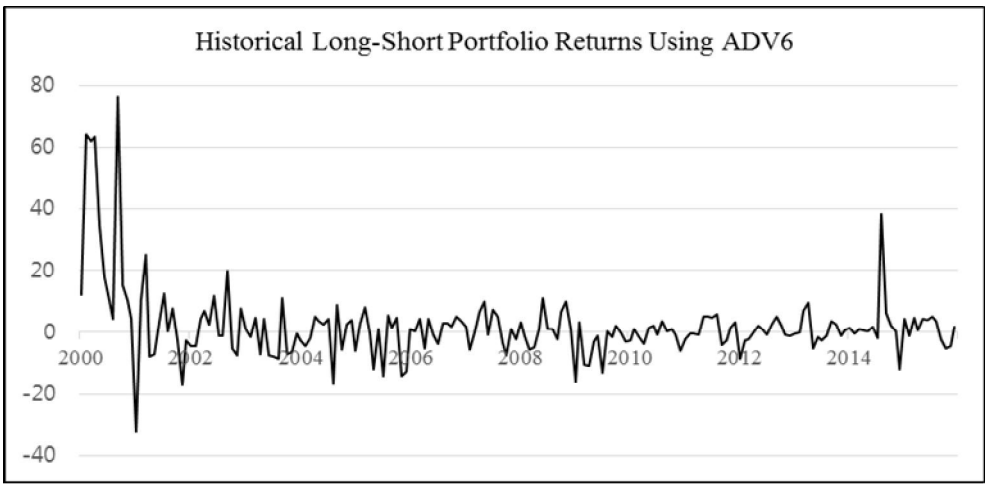


Figure 5. Time-Series Long-Short Portfolio Return Using ADV1, ADV6 and ADV12





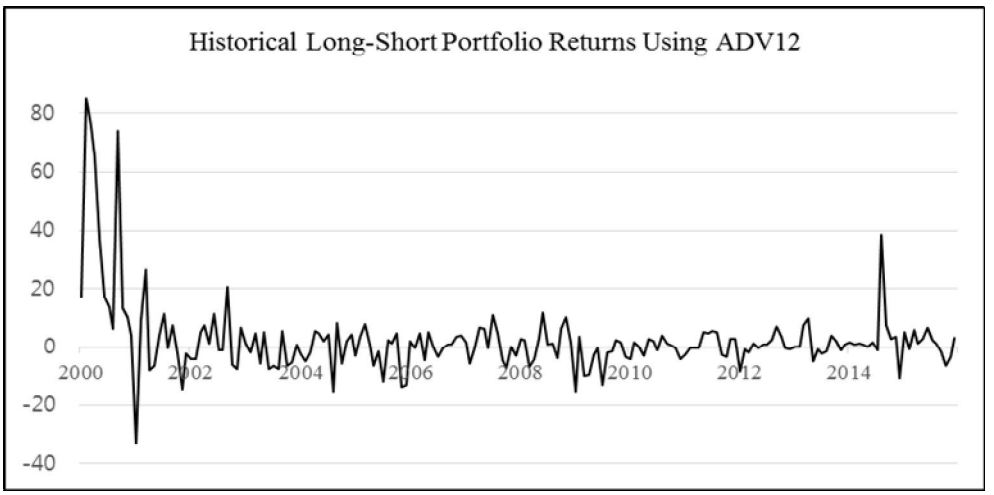
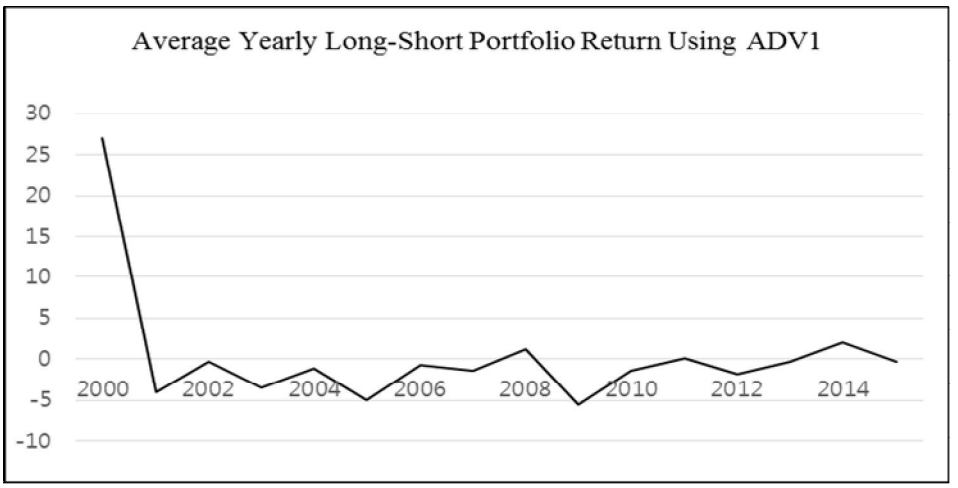
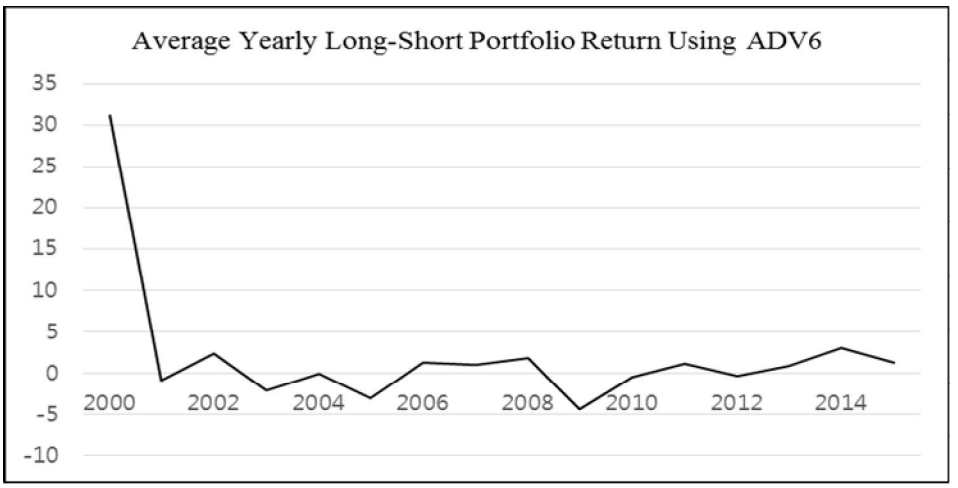
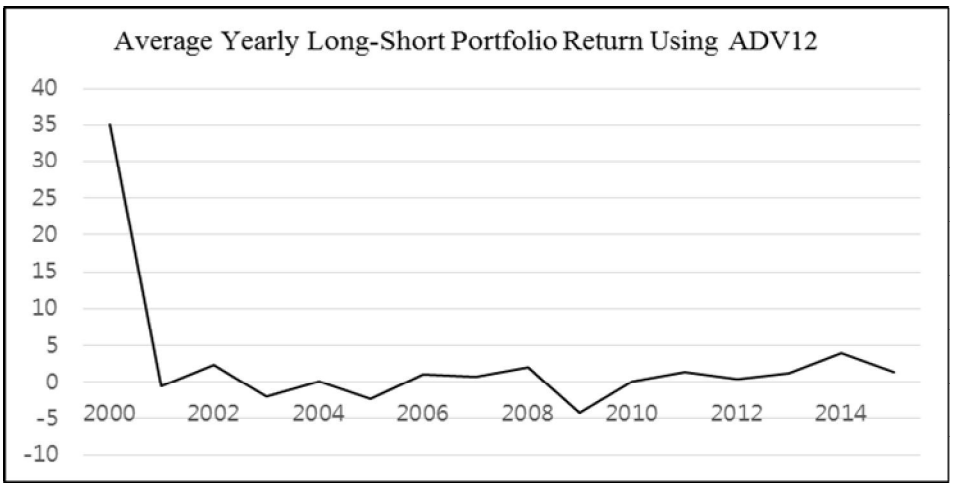


Figure 5-1. Average Yearly Long-Short Portfolio Return Using ADV1, ADV6, and ADV12







국문 초록

한국 주식 시장에서의 요인 모형에 입각한 수익률의 유의성

서울대학교 대학원
경영학과 재무금융전공
심 미 관

본 논문은 요인 모형에 기반한 투자전략이 한국시장에서 유의한 수익률을 보이는지 검토해보았다. 변동성, 가치, 규모, 유동성과 수익성의 질, 이 다섯 가지의 요인으로 포트폴리오를 구축하였다. 유의성을 검토하기 위해 매입·매도 포트폴리오의 수익률 차이와 각 포트폴리오의 샤프지수 차이를 살펴보았다. 대부분의 결과가 유의하지는 않았으나 대개의 전략에서 양의 수익률과 낮은 변동성을 보였다. 통계적 유의성이 부족한 이유는 신뢰할 수 있는 2000년대 한국시장의 데이터 수가 부족하기 때문일 것으로 추측된다.

주요어 : 요인, 변동성 가치, 규모, 유동성, 수익성의 질
학　번 : 2015-20623