# Monthly Effect in Shanghai Stock Exchange

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**Abstract**
This study uses stochastic dominance theory with and without risk-free asset, which is distribution-free, to examine whether the monthly effect exists in the Shanghai Stock Exchange. The main results indicate that the March returns in the smallest firm size portfolio dominate the March returns for all other size-directed portfolios and market index. Similarly, March returns in the smallest firm size portfolio are superior to non-March returns. Our particular finding is that December returns of various size-directed portfolios and market index are dominated by all non-December returns. These findings in an important emerging market are obviously different from that in the most developed markets.

**Keywords**: Monthly Effect, Stochastic Dominance Theory, Efficient Set

## 1. Introduction

Many empirical studies have documented calendar anomalies in stock returns. One of the most prominent anomalies shows that returns on stocks in January are significantly positive and larger than those in any other calendar month. Over six decade ago, Wachtel (1942) first pointed out this January effect. He reports that the Dow Jones Industrial Average returns were larger in January than in other months during the period 1927–42. Rozeff and Kinney (1976), who first rigorous empirical study of the January effect, report that stock returns for January to be significantly higher than the other 11 months for several indices for NYSE Market spanning 1904–74. Banz (1981), Keim (1983), Reinganum, Roll (1983) and Haugen and Lakonishok (1988) further document that nearly fifty percent of the average magnitude of the small firms effect is due to January abnormal returns and all firms tend to do better in January than in any other month. Moller and Zilca (2008) recently document that despite lower abnormal returns in the second part of January, higher abnormal returns in the first part of January keep the January effect unchanged for the NYSE, AMEX and NASDAQ.

Other non-U.S. markets in developed countries exhibit similar monthly pattern: Officer (1975) examines on the Australian capital markets, Gultekin and Gultekin (1983) on seventeen industrialized countries, Tinic *et al*. (1990) on the Canadian markets, Aggarwal *et al*. (1990) on the Tokyo Stock Exchange, and Barone (1990) on the Milan Stock Exchange. Some emerging markets also display the unusually higher returns in January than in non-January months. For example, Nassir and Mohammad (1987) and Pang (1988) document that the January effect exists in Hong Kong and Malaysia, respectively. The findings of Lean *et al*. (2007) and Ho (1990) also support the existence of January effect in some Asia markets.

However, some studies document different patterns or no evidence of the January effect. For example, Kohers and Kohli (1991) examine the anomalous behavior of S&P indexes and find that the January effect is independent of the small firm effect. Dahlquist and Sellin (1996) have found the existence of January and July effects in the Swedish stock market. Bhabra *el al*. (1999) have documented the existence of January and November effects after the passage of the Tax Reform Act of 1986 in the U.S. markets. Gu (2003) finds that the January effect for the U.S. markets exhibits a pronounced decline for both small and large firm stock indices and the effect of some small firm stock indices, like Russell 2000, is disappearing in recent years by using the power ratio method. Kim (2006) recently documents that the raw returns are adjusted by two-factor model,[4] the abnormal returns in January across firm size disappears.

Overall, the above findings indicate that using the different methodologies, like two-factor model or power ratio method and so on, may be one of the reasons to cause the different results about monthly effect. Chan *et al*. (1985) have pointed out that when additional forms of risk, such as inflation risk, business cycle risk and horizon risk, are taken into account, the size of the January effect for small stocks is much smaller. Kim (2006) also asserts that the previously found strong January effect might result from the use of misspecified models in adjusting for risk. In avoidable the argumentation, the pure methodology, stochastic dominance (SD) theory, is appropriately used to examine whether the monthly effect exists for the Shanghai Stock Exchange (SSE) in China in this study.

The first important feature of SD is that it is distribution-free. SD rules are distribution-free in the sense that the distribution of returns can be any type of distribution. Specifically, the assumption of normality is unnecessary. The normal assumption is inappropriate for stock price behaviors because stock price cannot drop below zero whereas the normal distribution is unbounded. Second, the advantage of SD is that it makes minimum assumptions of investor's utility function. For

4. Two factors, market risk factor and standard deviation of the earnings forecast errors factor, are included in Kim's model.

example, first-degree stochastic dominance (FSD) and first-degree stochastic dominance with risk-free assets (FSDR) assume only that investors prefer more return to less; i.e., investor utility function thus can be concave, linear or convex. In addition, SD methodology is enticing as it allows part of investors' money to be invested in the stock portfolio (risky assets) and part of their money to be invested in the risk-free assets.[5] That is, our methodology utilizing SD theory enables investors to have a better tool for assets allocation, which implies that investors can decide an optimal proportion of investment in risky assets and risk-free assets.

The main results in our study indicate that the March returns in the smallest firm size portfolio dominate the March returns for all other size-directed portfolios and market index by the second-order SD with or without risk-free assets. Similarly, March returns in the smallest firm size portfolio are superior to non-March returns by the second-order SD with or without risk-free assets. Evidence also shows that the stochastic dominance results are robust to the use of weekly data. Our particular finding in Shanghai market is that December returns of various size-directed portfolios and market index are dominated by all non-December returns. These results imply that allocating part of investors' assets in risk-free assets is useful in distinguishing returns among months.

Seyhun (1993) has documented that the January return in the smallest portfolio of the U.S. firms dominate the January returns for all other portfolios by the first-order SD and January returns in all portfolios generally dominate non-January returns by some SD rules. Lean *et al*. (2007) recently also find that first-order SD for January effect has largely disappeared in some Asian markets.

Comparing the previous results and our findings, some different phenomena are worthwhile noting. First, SSE appears different pattern of monthly effect; that is, January effect exists in the U.S. and most developed equity markets but March effect in the China market. Secondly, particularly findings in SSE show that December returns for various size-directed portfolios and market index are dominated by all non-December returns which results are not presented in the extant literature. Thirdly, using the SD rules without lending and borrowing the risk-free asset, shown in paper of Seyhun (1993) and Lean *et al*. (2007), can distinguish the performance among the various portfolios for the U.S. and some Asian markets. However, risk

5. An example in the Appendix shows that 60% of investor money is invested in risky assets (buying the smallest firm size portfolio in March), while 40% is lent at the monthly risk-free rate of 0.5%.

assets have to be mixed with risk-free assets, then the performance among the various portfolios can be distinguished for the SSE.

The remainder of this paper is organized as follows: Section 2 briefly Introduce the Shanghai Stock Exchange. Section 3 introduces methodology and sample characteristics. Section 4 explains the empirical results, and finally, Section 5 gives the conclusions that we draw from this study.

## 2. Brief Introduction of Shanghai Stock Exchange

The first stock exchange in China, the Shanghai Stock Exchange (SSE), was established on November, 1990 and in operation on December the same year. It grew rapidly and by the end of December, 2006, the number of listings firms has increased to 842 with a total trading value of US$ 134.15 billion and 162,681 billion shares trading volume SSE now ranks ninth in the world in terms of total market value, according to the World Federation of Exchanges (WFE) focus monthly statistics (2007).

Several features for SSE should be noted. First, two types of shares are traded on the SSE: A shares and B shares. A-shares, restricted to domestic investors, are priced in the local Renminbi yuan currency, while B-shares, available to both domestic (since 2001) and foreign investors, are quoted in U.S. dollars. However, foreign investors are now allowed to trade in A-shares under the Qualified Institutional Investor (QFII) system. There is also a plan to eventually merge the two types of shares.

Secondly, the average market returns for SSE outperformed the most developed and emerging markets during the 1995-2006, which is presented in Table 1. SSE produced average index returns, 18.9%, which surpassed the NYSE (11.46%), LSE (7.81%), TSE (1.04%), HKSE (11.08%) and TWSE (4.24%).[6] The outstanding investment accomplishment of the SSE was accompanied not surprising by higher financial risk (standard deviation). For our study period, SSE (45.01%) exhibited index risk measures greater than that of NYSE (6.27%), LSE (5.49%), TSE (1.94%), HKSE (8.26%) and TWSE (6.26%).

Thirdly, during the last decade, SSE exhibited the higher P/E ratios, investment performance criteria, than the most developed and emerging markets. Table 1 shows

6. NYSE, LSE, TSE, HKSE and TWSE respective stand for New York Stock Exchange, London Stock Exchange, Tokyo Stock Exchange, Hong Kong Stock Exchange and Taiwan Stock Exchange.

that the P/E ratios of SSE are higher than that of most developed and emerging markets except TSE; that is, the average P/E ratio of SSE stocks (33.3) was above that of the NYSE (21.95), LSE (18.81), HKSE (15.68), and TWSE (26.94). In the same period, the average turnover of SSE (192.57%) was also higher than that of NYSE (82.01%), LSE (81.80%) and HKSE (53.80%) except TWSE (233.89%).

China economic development is among the fastest in the world, and has been growing at an average annual GDP rate of 9.4% for the past 25 years.[7] The economy of China has now been the third largest in the world when measured by GDP or trading amount of export and import and its stock market is now the second largest in Asia, behind only Japan.[8] SSE plays an important role for China economy development; however, little is known about this relatively young market in the global financial markets. Therefore, it is worthwhile to examine its stock price behavior.

## 3. Methodology and Sample Characteristics

### 3.1 Methodology

The stochastic dominance (SD) theory provides a simple method of select risky alternatives.[9] Suppose an investor has to choose between two risky assets, $X_1$ and $X_2$, and the return on asset $X_1$ always exceeds that on asset $X_2$. Then, as long as investors prefer more returns to less, no investor would choose asset $X_2$ because asset $X_1$ would always provide a higher return. This illustration is a special case of the first-degree stochastic dominance (FSD). Generally, asset $X_1$ dominates asset $X_2$ by FSD, if the cumulative density function (CDF) of $X_1$ lies, roughly speaking, to the right of the CDF of $X_2$. That is, with the distribution of $G_1$(asset $X_1$), the chance of earning a higher return is always greater than with the distribution of $G_2$(asset $X_2$), regardless of whether investors like or dislike risks. Formally, an asset $X_1$ with the CDF of $G_1$ dominates an asset $X_2$ with the CDF

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7. The information is taken from Sino Defence: Aircraft carrier programme (2006). Accessed 15 April 2006.
8. See Paolo Farah (2006), "Legal Issues of Economic Integration", 33(3), 263-304.
9. The stochastic dominance rules given here are slightly modified from Hadar and Russell (1969), Hanoch and Levy (1969), Levy and Kroll (1979), Seyhun (1993), Liao and Chou (1995) Levy (1998) and Best *et al*. (2000). The readers interested in SD theory should consult Levy and Kroll (1976, 1978), Kroll and Levy (1980), Levy (1992) and Post (2003).

of $G_2$ by the first-degree stochastic dominance if and only if:

$$G_1(r) \leq G_2(r), \text{ for all possible } r \tag{1}$$

The preference is obvious as in the case where $G_1$ lies entirely to the right of $G_2$. When two CDFs cross, the other factor has to be considered to establish the successive dominance. If investors are risk averse, second-degree stochastic dominance (SSD) can be employed. Formally, an asset $X_1$ dominates an asset $X_2$ by the second-degree stochastic dominance if and only if:

$$\int_{-\infty}^{r}[G_2(t) - G_1(t)]dt \geq 0 \text{ for all possible } r \tag{2}$$

where $\int_{-\infty}^{r} G_2(t)dt$ and $\int_{-\infty}^{r} G_1(t)dt$ denote the areas under $G_2$ and $G_1$, respectively. Hence, SSD allows two CDFs to cross by some amounts as long as the area under $G_1$ is always less than $G_2$. Figure 1 shows that when the condition of equation (2) is met, $G_1$ lies far enough to the right of $G_2$ that asset $X_1$ is preferred to asset $X_2$ because the expected utility gain from the positive area to the left of $r_0$ exceeds the reduction in the expected utility loss between $r_0$ and $r_1$.[10]

[Insert Figure 1 here]

When borrowing and lending at the risk-free rate are permitted, a much stronger rule, called stochastic dominance with risk-free asset rules (SDR), can be used. Consider a portfolio containing one risky asset and one risk-free asset, with $(\beta \cdot 100)\%$ of investor's money invested in the risky asset $X_1$, and $(100 - \beta \cdot 100)\%$ of investor's money borrowed or lent at the risk-free rate.[11] The portfolio return, $R_p$, is then computed as the weighted sum of two assets: $R_p = (1-\beta)r_f + \beta X_1$, where $r_f$ is the risk-free interest rate. Additionally, let $F_\beta$ denote the cumulated distribution function of $R_p$. Next, we can compare the two distributions $G_1$ and $G_2$, as illustrated in Figure 2. Clearly, neither $G_1$ nor $G_2$ dominates the other by FSD. Nevertheless, it is possible to rotate $G_1$ about the point $(r_f, G_1(r_f))$ and obtain $G_{1\beta}$, which dominates $G_2$ by FSD; hence, $G_1$ dominates $G_2$ by first-degree stochastic

10. Figures 1 and 2 are taken and slightly modified from Levy (1998).
11. Please refer to Appendix in details.

dominance with a risk-free rate (FSDR). Formally, let $G_1$ and $G_2$ be the CDFs of two risky assets, $X_1$ and $X_2$. Also let $G_{1\beta}$ be the CDF of $R_p$, where $R_p = (1-\beta)r_f + \beta X_1$ and $\beta$ is a constant. Then $G_1$ dominates $G_2$ by FSDR if and only if:

$$G_{1\beta}(r) \le G_2(r) \quad \text{for all possible } r \tag{3}$$

[Insert Figure 2 here]

Similar to SSD, $G_1$ dominates $G_2$ by the second-degree stochastic dominance with a risk-free rate (SSDR) if and only if:

$$\int_{-\infty}^{r} [G_2(t) - G_{1\beta}(t)]dt \ge 0 \quad \text{for all possible } r \tag{4}$$

### 3.2 Sample Characteristics

The stock return and relevant data used in this study is taken from the *Taiwan Economics Journal Data Bank* (*TEJDB*). The five size-directed portfolios rank of securities based on the previous year-end market capitalizations provided by *TEJDB* are used to partition stocks into five size-directed portfolios. Portfolio 1 consists of firms with the lowest market values, and each subsequent portfolio contains the firms with the next highest market values, and accordingly Portfolio 5 consisting of the firms with the highest market values. The monthly portfolio returns are formed by equally weighting each stock within each portfolio and are re-balanced each year on the basis of the previous year-end capitalizations. Both weekly and monthly data are examined in this study.

Table 2 shows the means and standard deviations of the monthly returns separated by five size-directed portfolios and calendar months. The time period for the monthly returns data is 1995/1 to 2005/12. Table 2 displays that the highest average monthly returns (8.71%) occur in March in the smallest firm size group (Portfolio 1) of firms. The March returns in the smallest firm size portfolio also exceed the March returns in larger portfolios and index returns. Note that the other four size-directed portfolios and value-weighted index also appear that the average March returns respectively exceed the non-March returns, which seem to show a tendency to exist the March effect in the Shanghai Stock Exchange. The other interesting results are that the lowest average monthly returns (-5.37%) occur in Portfolio 2 of December and the average returns on December for the various portfolios are respectively the lowest than their non-December returns. These findings are obviously different from Seyhun's (1993) findings for the U.S. stock markets, which documents that the highest average returns occur in January in the smallest portfolio of firms and the January returns exceed the non-January returns in all size-directed portfolios and equally-weighted index except the largest firm size portfolio and value-weighted index.

In short, our results of Table 1 may show that January effect in developed stock markets, like in the NYSE or AMEX markets, does not exist in Shanghai Stock Exchange, since the performance of each portfolio in January is not superior to non-January returns in all portfolios. Additionally, this study also investigates the normality of monthly returns by the K-S (Kolmogorov-Smirnov) test. The results show the monthly returns do not follow a normal distribution.[12] So we may conclude that the monthly effect in SSE is appropriately examined by the SD theory.

## 4. Empirical Results

### 4.1 March Returns

To examine stochastic dominance in March returns across firm size portfolios, Figure 3 shows the cumulative density function (CDF) of the realized returns from 1995 to 2005 for five size-directed portfolios and value-weighted index. To construct the CDF for a given portfolio, the 11 realized monthly March returns are ranked in increasing order. Each observation has an equal probability of occurrence, so each realized return is assigned a probability of 1/11. Hence, the lowest return has a cumulative probability of 1/11, the second lowest return has a cumulative probability of 2/11 and the highest return has a cumulative probability of 1. Plotting these points produce the CDF.

As Figure 3 shows, there is an almost monotonic ordering of the CDFs of March returns by firm size. Figure 3 shows that the CDF of the smallest firm size portfolio (Portfolio 1) is shifted most to the right, while the CDFs of the larger firm size portfolios and value-weighted index are shifted to the left. Appearances of the Figure 3 show that the March returns on the smallest firm size portfolio (Portfolio 1) may beat the March returns on the larger firm size portfolios and index by some SD rule.

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12. For space consideration, the result is omitted, but avialable upon request.

This study uses the SD rules to examine dominance relationship among March returns for five size-directed portfolios and value-weighted index.[13] Table 3 shows the stochastic dominance results for month of March for five size-directed portfolios and value-weighted index. From this table the following conclusions can be drawn.

First, using the weak assumption (U'>0) on investors' preferences, the performances of various size-directed portfolios and value-weighted index cannot be sharp distinguished; i.e., the FSD (without lending and borrowing) efficient set includes five size-directed portfolios and value-weighted index. Allowing investors to borrow and lend money at a risk-free interest rate does not also reduce the size of the FSDR efficient set, the FSDR efficient set still includes five size-directed portfolios and value-weighted index. Thus, sharper decision rules are required to distinguish the performance of various portfolios.

Second, assuming risk aversion (U'> 0 and U"< 0) on investors' preferences, which most economists accept, different phenomena are revealed: The SSD efficient set includes Portfolios 1, 3, 4 and value-weighted index (winners); i.e., Portfolios 2 and 5 (losers) are excluded from SSD efficient set.

Third, the result is much stronger when investors are allowed to borrow and lend money at a risk-free interest rate. The result of the SSDR efficient set shows that returns on Portfolio 1 (the smallest firm size group) outperform all the other larger firm size portfolios and value-weighted index for $r_f \geq 0.4\%$;[14] i.e., only the smallest firm size portfolio is included in SSDR efficient set.

Overall, the evidence in Table 3 suggests that the smallest firm size portfolio (Portfolio 1) in March is dominant over all other larger firm size portfolios and index, which finding is consistent with our guessing in Figure 3.

### 4.2 March Effect in Various Size-directed Portfolios

Figure 4 shows the cumulative density functions (CDFs) of March returns with the January, February, September, November and December returns for the smallest firm size portfolio (Portfolio 1). Other months are omitted to reduce clutter. The

13. The empirical study uses a version of the stochastic dominance algorithm in Levy and Kroll (1979), Levy and Sarnat (1985) or Levy (1992). That is, FSD, SSD, FSDR and SSDR criteria are employed to test the monthly effect in this study. Because some technical errors appear in the third stochastic dominance (TSD) and third stochastic dominance with risk-free asset (TSDR) algorithms, these algorithms are not discussed here. (For more details, see Levy (1992))

14. $r_f$ denotes the monthly return on risk-free assets in the study.

March CDF is again shifted most to the right, while the CDF of the December is shifted most to the left during the most part of returns interval. Appearances of the Figure 4 also show that the March returns may outperform the other monthly returns by some SD rule for the smallest firm size portfolio (Portfolio 1).

Table 4 identifies those months of each size-directed portfolio that appears in the stochastic dominance efficient sets during the 1995-2005 period. From this table the following conclusions can be drawn.

First, using the weak assumption on investors' preferences, the results of the smallest firm size portfolio (Portfolio 1) show that six months, Jan, Apr, May, Jul, Nov and Dec, are excluded from FSD efficient set; i.e., the FSD (without lending and borrowing) efficient set include the other six months.[15] Allowing investors to borrow and lend money at a risk-free interest rate does not also reduce the size of the FSDR efficient set, the FSDR efficient set still includes six months. The other size-directed portfolios and value-weighted index also appear the similar findings. In order to save space, their FSD and FSDR efficient sets are not shown in the Table 4. Thus, sharper decision rules are again required to distinguish the performance for various size-directed portfolios and value-weighted index.

Second, assuming risk aversion for investors' preferences, the result show that the SSD efficient set only includes four months, February, March, August and September, for the smallest firm size portfolio (Portfolio 1); i.e., the other eight months are excluded from efficient set when SSD rule is used to examine the dominance relationship among months. The other four size-directed portfolios (Portfolios 2 to 5) and value-weighted index also show the similar findings. Only February and March are respectively included in their SSD efficient sets. That is, returns on February and March respectively outperform returns on the other ten months for various portfolios.

Third, the results are much stronger when investors are allowed to borrow and lend money at a risk-free interest rate. The results of the SSDR efficient sets for the smallest firm size portfolio (Portfolio 1) and value-weighted index (VW) show that March's returns respectively outperform all the other months' returns for $r_f \geq 0.6\%$ and $r_f \geq 0.1\%$; i.e., only March is included in their SSDR efficient sets at prevailing

15. If a month is included in efficient set, which means that this month is a winner.

monthly risk-free interest rates. The SSDR efficient sets of the other four size-directed portfolios (Portfolios 1 to 4) show that March returns can also beat February returns at very high monthly risk-free interest rates. For example, March returns dominate February returns for $r_f \geq 1.28\%$. Though the findings of Portfolios 1 to 4 do not have a practical value, the results still show a tendency to exist the March effect in the Shanghai Stock Exchange. Or we may conclude that March effect exists in the smallest firm size portfolio and February and March effect exist in the larger firm size portfolios at prevailing risk-free interest rates.

**4.3 December VS. Non-December**

As noted in Table 2, the average returns on December for the various portfolios are respectively the lowest than their corresponding non-December returns. Therefore, we are interested in investigating whether the December returns for various portfolios are respectively dominated by all their corresponding non-December returns by some SD rules. Table 5 summarized stochastic dominance results for the December returns are dominated by non-December returns for five size-directed portfolios and value-weighted index. In the smallest size-directed portfolio (Portfolio 1), seven of 11 non-December outperform December using the FSD rule, three of 11 (June, July and September) non-December outperform December using the SSD rule and January outperform December using the SSDR rule for $r_f \geq 0.1\%$. The other four size-directed portfolios and value-weighted index also appear the similar findings.

In short, December is dominated by all non-December for various portfolios, called "weak December effect", which does not present in the extant literature. It may be a meaningful finding help investors to design their investment strategy.

**4.4 Weekly Data**

The results in Table 2 to 4 are also replicated using weekly returns constructed from *TEJDB*. The use of weekly returns for the Shanghai Stock Exchange is expected to highlight the sensitivity of the findings to the composition of the portfolios, sample period, and holding period returns.

The time period for the weekly data is also from January 1, 1995, to December 31, 2005. Each year, the weekly returns are computed starting from January 1.

The last days of December are included as part of week 52. A week is considered a January week if it starts in January. This procedure yields exactly four March returns per year, for a total of 44 weekly March returns.

As in monthly portfolios, five size-directed portfolios are formed by equally averaging the weekly returns for each stock. Table 6, as Table 3, shows the efficient sets of weekly March returns for five size-directed portfolios and value-weighted index. Portfolios 4 and 5 are excluded from efficient set when SSD rule is used to examine the dominance relationship among various portfolios. The result is again much stronger when investors are allowed to borrow and lend money at a risk-free interest rate. The weekly March returns in the smallest portfolio (Portfolio 1) dominate the weekly March returns in all larger portfolios and value-weighted index for $r_f \geq 0.12\%$.

In short, the evidence, shown in Tables 3 and 6, suggests that stochastic dominance results are robust to the use of weekly and monthly data. That is, the March returns and the weekly March returns in smallest firm size group (Portfolio 1) respectively dominate their returns in all larger firm size portfolios and value-weighted index.

Table 7 shows the efficient sets of weekly month returns for five size-directed portfolios and value-weighted index. The following conclusions can be also drawn from the table.

First, using the weak assumption on investors' preferences, the performances of various size-directed portfolios and value-weighted index cannot be sharp distinguished, i.e., the FSD efficient set includes 8 to 12 months for various portfolios. For example, weekly returns in the month of February to June, August, September and December are included in the FSD efficient set for Portfolio 1 (the smallest firm size group) and weekly returns of all twelve months are included in the FSD efficient set for Portfolio 5 (not shown in the table). Allowing investors to borrow and lend money at a risk-free interest rate does not also reduce the size of the FSDR efficient set for various portfolios. Thus, sharper decision rules are again required to distinguish weekly returns in twelve months for various portfolios.

Second, assuming risk aversion for investor’s preferences, different phenomena are again revealed. For example, weekly returns in the month of February, March and May in smaller firm size groups (Portfolios 1 and 2) dominate the weekly returns in all the other months. Portfolios 3 to 5 and value-weighted index also appear the similar findings.

Third, the results are much stronger when investors are allowed to borrow and lend money at a risk-free interest rate. For example, weekly returns in the month of March in smaller firm size groups (Portfolios 1 and 2) dominate the weekly returns in all the other months for $r_f \geq 0.12\%$. Though the results of Portfolio 3 to 5 and value-weighted index are slightly different from Portfolios 1 and 2; however, it is notable that weekly returns in the month of March are also respectively included in their SSDR efficient sets.

The results, shown in Tables 4 and 7, in the smallest firm size group (Portfolio 1) and value-weighted index (VW) show that the March returns and the weekly March returns respectively dominate returns on all other months in their SSDR efficient sets. Secondly, returns on both February and March or only returns on March outperform returns on all other months for Portfolios 2 to 4. Overall, we conclude that March effect still exists in the smallest firm size portfolio and value-weighted index, and February and March effect exist in the larger firm size portfolios, which show that stochastic dominance results are robust to the use of weekly and monthly data.

## 5. Transaction Costs

So far our main results indicate that March returns in the smallest firm size portfolio are superior to non-March return and the findings also show that the March returns in the smallest firm size portfolio dominate the March returns of all other size-directed portfolios and market index at prevailing risk-free interest rates. These results, however, are obtained ignoring any transaction costs associated with the annual adjustment of the size portfolios. According, we now turn to analyze whether the above results also exist when transaction costs are considered.[16]

We first examine whether March effect exists in various size-directed portfolios and market index with transaction costs. Only using the weak assumption on investors' preferences, the results show that three to six months are excluded from the FSD and FSDR efficient sets in various size-directed portfolios and market index.

16. Transaction costs include tax stamp, commission fee and settlement fees on the Shanghai Stock Exchange. Investors pay a commission fee of 3‰ of the market value to the broker when buying or selling stocks and pay a tax stamp rate of from 1‰ to 5‰ of the market value during our study period when selling stocks. Note that the tax stamp rate changes several times during the research period. Monthly returns are calculated by adjusting the timely tax stamp rate.

Then assuming risk aversion for investors' preferences, the results appear that the SSD efficient set only includes February and March for the five size-directed portfolios and market index. Allowing investors to borrow and lend money at prevailing risk-free interest rates, the SSDR efficient sets only include March for the various size-directed portfolios and market index; i.e., all the other months of the various size-directed portfolios and market index are dominated by March. March effect not only exists in the smallest firm size portfolio but also exists in all the other larger size-directed portfolios and market index with transaction costs, which findings are obviously different from the results considered without transaction costs.

Secondly, we examine whether the March returns in the smallest firm size portfolio (Portfolio 1) still dominate the March returns for all other size-directed portfolios and market index. March returns in the smaller firm size portfolio (Portfolios 1 and 2) dominate the March returns for all other size-directed portfolios and market index. Finally, we are interested in investigating whether the December returns for various portfolios are still respectively dominated by all their corresponding non-December returns by some SD rules. In the smallest size-directed portfolio (Portfolio 1), two of 11 non-December outperform December using the SSD rule, eight of 11 non-December outperform December using the SSDR rule for $r_f \geq 0.1\%$.[17] The other four size-directed portfolios and value-weighted index show that December is dominated by non-December using FSD or SSD rule. In short, "weak December effect" also exists with transaction costs.

## 6. Conclusions

This study uses stochastic dominance theory with and without risk-free asset, which is distribution-free, to examine whether the monthly effect exists in the Shanghai Stock Exchange. Our findings can be summarized as followers.

First, our findings indicate that the March returns in the smallest firm size portfolio dominate the March returns for all other size-directed portfolios and market index by the second-order SD with or without risk-free assets. Similarly, March returns in the smallest firm size portfolio are superior to non-March returns by the second-order SD with or without risk-free assets. Evidence also shows that the stochastic dominance results are robust to the use of weekly data.

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17.

Secondly, our particular finding in Shanghai market is that December returns of various size-directed portfolios and market index are dominated by all non-December returns.

Thirdly, the results also show that allocating part of investors' assets in risk-free assets is useful in distinguishing returns among various portfolios.

**References**


Aggarwal, R., Hiraki, T., and Rao, R. P., 1990. Regularities in Tokyo stock exchange security returns: P/E, size and seasonal influences, Journal of Financial Research 13, 249-263.

Aydocan, K., Booth, G.. G., 2003. Calendar anomalies in the Turkish foreign exchange markets, Applied Financial Economics 13(5), 353-360.

Barone, E., 1990. The Italian stock market: Efficiency and calendar anomalies, Journal of Banking & Finance 14(2-3), 483-510.

Banz, R. W., 1981. The relationship between return and market value of common stocks, Journal of Financial Economics 9, 3–18.

Best, R. J., Best, R. W., Yoder, J. A., 2000. Value stock and market efficiency. Journal of Economics and Finance 24(1), 28-35.

Bhabra, S., Dhillon U., and Ramirez, G., 1999. A November effect: Revisiting the Tax-Loss Selling hypothesis, Financial Management 28(4), 5-15.

Chan, K. C., Chen, N. F., and Hsieh, D. A., 1985. An exploratory investigation of the firm size effect, Journal of Financial Economics 14, 451-471.

Chou, S. R., Liao, T. L., 1996. The relative performance of the PER and PSR filters with stochastic dominance: Evidence from the Taiwan Stock Exchange, Applied Financial Economics 6(1), 19-27.

Gultekin, N., and Gultekin, N. B. 1983. Stock market seasonality: international evidence, Journal of Financial Economics 12, 469-481.

Hadar, J., Russell, W. R., 1969. Rules for ordering uncertain prospects, American Economic Review 59(1), 25-34.

Hanoch, W. C., Levy, H., 1969. The efficiency analysis of choice involving risk, Review of Economics Studies 36(3), 335-346.

Kroll, Y., Levy, H., 1980. Stochastic Dominance: A Review and Some New Evidence. Research in Finance 2, Greenwich, Connecticut: JAI Press Inc., 163-227.

Levy, H., Kroll, Y., 1976. Stochastic dominance with riskless assets, Journal of Financial and Quantitative Analysis 11(5), 743-773.

Levy, H., Kroll, Y., 1978. Ordering uncertain options with borrowing and lending, Journal of Finance 33(2), 553-574.

Levy, H., Kroll, Y., 1979. Efficiency analysis with borrowing and lending: Criteria and their effectiveness, Review of Economics and Statistics 61(1), 125-130.

Levy, H. and Sarnat, M., 1985. Investment and Portfolio Analysis, Wiley, New York, 178-231.

Levy, H., 1992. Stochastic dominance and expected utility: survey and analysis, Management Science 38(4), 555-593.

Levy, H., 1998. Stochastic dominance: investment decision making under uncertainty, Kluwer Academic Publishers, US.

Levy, H., Lerman, Z., 1985. Testing P/E ratios filters with stochastic dominance, Journal of Portfolio Management 11(2), 31-40.

Liao, T. L., Chou, S .R., 1995. Testing PSR filters with stochastic approach, Journal of Portfolio Management 21(3), 85-91.

Ho, Y. K., 1990. Stock return seasonality in Asia Pacific markets, Journal of International Financial Management and Accounting 1, 47-77.

Keim, D. B., 1983. Size-related anomalies and stock return seasonality: Further empirical evidence, Journal of Financial Economics 12(1), 13-32.

Lakonishok, J. and Smidt, S. 1988. Are seasonal anomalies real? a ninety-year perspective. Review of Financial Studies1 (4), 403-425.

Lean, H. H., Smyth, R., and Wong, W. K. 2007. Revisiting calendar anomalies in Asian stock markets using a stochastic dominance approach, Journal of Multinational Financial Management 17 (2), 125-141.

Moller, N., Zilca, S., 2008. The evolution of the January effect, Journal of Banking & Finance forthcoming.

Nassir, A., Mohammad, S., 1987. The January effect of stock traded on the Kuala Lumpur Stock Exchange: an empirical analysis, Hong Kong Journal of Business Management 5, 33-50.

Officer, R. R., 1975. Seasonality in Australian capital markets: Market efficiency and empirical issues, Journal of Financial Economics 2(1), 29-52.

Pang, L., 1988. An analysis of Hong Kong stock return seasonality and firm size anomalies for the period 1977 to 1986, Hong Kong Journal of Business Management 6, 69-90.

Officer, R., 1975. Seasonality in Australian capital markets: Market efficiency and empirical issues, Journal of Financial Economics 2(1), 29-52.

Paolo, F., 2006. Five years of China's WTO membership. EU and US perspectives about China's compliance with transparency commitments and the transitional review mechanism, Legal Issues of Economic Integration, 33(3), 263-304.

Ritter, J. and Chopra, R. N., 1989. Portfolio rebalancing and the turn-of-the-year Effect, Journal of Finance 44(1), 149-166.

Roll, R., 1983. The turn of the year effect and the return premia of small firms, Journal of Portfolio Management 9(2), 18-28.

Rozeff, S. and Kinney, W. R., 1976. Capital market seasonality: The case of stock returns. Journal of Financial Economics 3(4), 379-402.

Seyhun, H. N., 1993. Can omitted risk factors explain January effect: a stochastic dominance approach, Journal of Financial and Quantitative Analysis 28(2),195-212.

Tinic, S. M. and West, R.R., 1984. Risk and return: January the rest of the year. Journal of Financial Economics 13,561-574.

Tinic, S. M. and West, R.R., 1987. Seasonality in Canadian stock prices: A test of the Tax-Loss Selling hypothesis, Journal of Financial and Quantitative Analysis 22 (1), 51-63.

Tonchev, D., Kim, T. H., 2004. Calendar effects in Eastern European financial markets: evidence from the Czech Republic, Slovakia and Slovenia, Applied Financial Economics 14(14), 1035-1043.

Wachtel, B., 1942. Certain observations on seasonal movements in stock prices, Journal of Business of the University of Chicago, 15(2), 184-193.

World Federation of Exchanges website: http://www.world-exchanges.org/

Table 1
Summary of Market Characteristics of SSE and Some World's and Asian Major Markets from 1995 to 2006[1]

| Year | SSE Composite | Return Rate | Market Value (in billions of $) | Trading Value (in billions of $) | Trading Volume (in billion of shares) | Turnover | P/E Ratio | No. of Stocks |
|---|---|---|---|---|---|---|---|---|
| 1995 | 555.29 | -14.29% | 30 | 65.67 | 51,399 | 216.27(%) | 15.71 | 188 |
| 1996 | 917.02 | 65.14 | 66 | 333.33 | 110,233 | 504.97 | 31.32 | 293 |
| 1997 | 1,194.10 | 30.22 | 111 | 360.43 | 121,645 | 323.74 | 41.24 | 383 |
| 1998 | 1,146.70 | -3.97 | 128 | 414.74 | 112,795 | 323.13 | 32.96 | 438 |
| 1999 | 1,366.58 | 19.18 | 176 | 434.71 | 156,037 | 246.85 | 37.09 | 484 |
| 2000 | 2,073.48 | 51.73 | 325 | 602.86 | 243,766 | 185.29 | 58.22 | 572 |
| 2001 | 1,645.97 | -20.62 | 333 | 536.93 | 181,995 | 77.98 | 37.71 | 646 |
| 2002 | 1,357.65 | -17.52 | 306 | 586.26 | 178,109 | 60.33 | 34.43 | 715 |
| 2003 | 1,497.04 | 10.27 | 360 | 255.96 | 269,274 | 86.7 | 36.54 | 780 |
| 2004 | 1,266.50 | -15.4 | 314 | 322.83 | 360,773 | 86.16 | 24.23 | 837 |
| 2005 | 1,161.06 | -8.33 | 286 | 238.81 | 398,660 | 76.82 | 16.33 | 833 |
| 2006 | 2,675.47 | 130.43 | 918 | 134.15 | 162,681 | 122.57 | 33.3 | 842 |
| SSE | 1,404.74 | 18.90 (45.01)[3] | 279 | 407.62 | 195,613.9 | 192.57 | 33.26 | |
| NYSE[2] | 9,476.65 | 11.46 (6.27) | 10,680 | 9,856.08 | 259,019 | 82.01 | 21.95 | |
| LSE | 5,188.93 | 7.181 (5.49) | 2,428 | 3,804.03 | 527,370 | 81.80 | 18.81 | |
| TSE | 14,536.28 | 1.04 (1.94) | 3,188 | 2,189.81 | 239,859 | 62.46 | 144.97 | |
| HKSE | 13,226.63 | 11.0 (8.62) | 671 | 335.31 | 2,602,192 | 53.80 | 15.68 | |
| TWSE | 6,358.95 | 4.24 (6.26) | 339 | 731.63 | 632,940 | 233.89 | 26.94 | |

1. The information in the table is taken from website of Taiwan Stock Exchange Corporation. (http://www.tse.com.tw/ch/statistics/)
2. NYSE, LSE, TSE, HKSE and TWSE respective stand for New York Stock Exchange, London Stock Exchange, Tokyo Stock Exchange, Hong Kong Stock Exchange and Taiwan Stock Exchange.
3. The figures in parentheses are standard deviation of index returns for each market during the 1995 to 2006. Note that the same time interval for the other figures, like market value, trading value and so on, is calculated for each markets in the table.

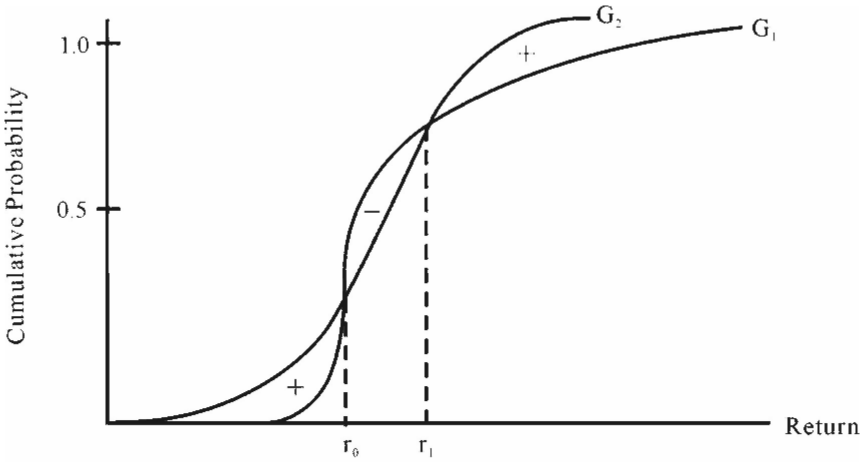


Figure 1 $G_1$ Preferred to $G_2$ with Risk Aversion

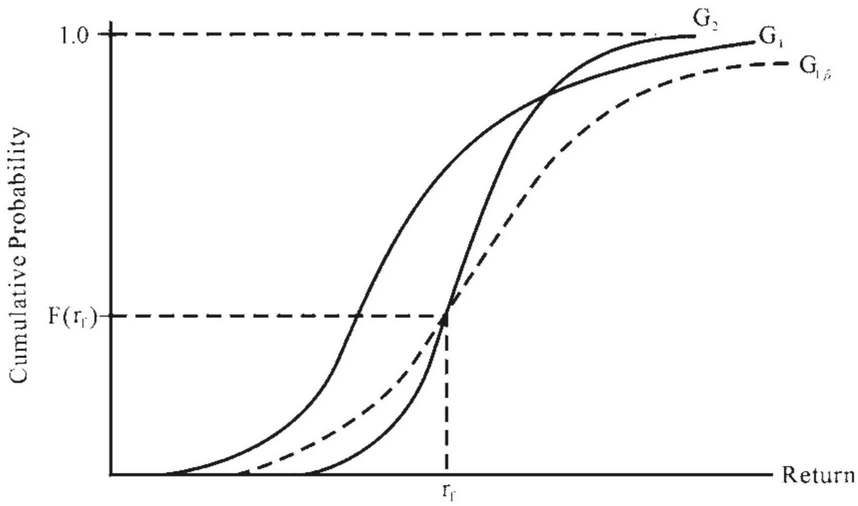


Figure 2 $G_1$ and $G_2$ Intersect but $G_{1\beta}$ Dominate $G_2$

Table 2
Means and Standard Deviations in Parentheses (in percent) for Monthly Returns to Five Portfolios of SSE firms and Value-weight Index from 1995-2005

| | Five Size-directed Portfolios[1] | | | | | |
|---|---|---|---|---|---|---|
| Month | 1 | 2 | 3 | 4 | 5 | VW |
| Jan | -0.24% | 0.01 | 0.16 | 0.05 | 0.54 | 0.32 |
| | (9.12%) | (9.52) | (8.54) | (8.68) | (8.12) | (8.00) |
| Feb | 4.92 | 3.93 | 3.61 | 3.48 | 2.38 | 2.50 |
| | (7.33) | (6.29) | (6.09) | (6.36) | (5.70) | (5.59) |
| Mar | 8.71 | 6.60 | 5.34 | 5.11 | 3.58 | 5.34 |
| | (11.21) | (10.33) | (9.07) | (8.06) | (7.26) | (7.88) |
| Apr | 2.26 | 2.07 | 1.53 | 1.95 | 1.23 | 2.42 |
| | (11.50) | (11.39) | (11.40) | (10.73) | (9.10) | (9.39) |
| May | 2.93 | 2.06 | 2.15 | 0.66 | 0.70 | 1.62 |
| | (10.11) | (11.41) | (11.04) | (10.29) | (9.30) | (9.61) |
| Jun | 1.13 | 0.39 | 1.84 | 1.76 | 3.09 | 3.78 |
| | (10.78) | (11.99) | (14.38) | (12.22) | (15.29) | (14.04) |
| Jul | -2.27 | -1.77 | -1.29 | -0.55 | -0.79 | -1.24 |
| | (5.75) | (5.80) | (6.34) | (7.09) | (7.07) | (6.13) |
| Aug | 2.69 | 1.33 | 0.91 | 0.91 | -0.91 | -0.83 |
| | (8.04) | (7.26) | (7.33) | (7.31) | (7.31) | (5.29) |
| Sep | -0.61 | -1.71 | -1.91 | -1.77 | -2.45 | -1.13 |
| | (7.26) | (5.97) | (6.37) | (6.38) | (5.74) | (5.78) |
| Oct | 0.58 | 0.44 | 0.21 | 0.38 | 1.40 | -0.58 |
| | (8.11) | (9.35) | (7.35) | (7.06) | (9.41) | (5.64) |
| Nov | 0.55 | 0.00 | -0.63 | -1.64 | -1.46 | -0.05 |
| | (6.05) | (5.61) | (5.97) | (5.90) | (5.92) | (5.18) |
| Dec | -4.65 | -5.37 | -4.76 | -4.82 | -5.32 | -3.32 |
| | (6.61) | (7.74) | (5.68) | (6.14) | (6.64) | (6.86) |

1. Portfolio 1 is the smallest-cap portfolio, while Portfolio 5 is the largest-cap portfolio. VW denote value-weighted index of SSE firms.

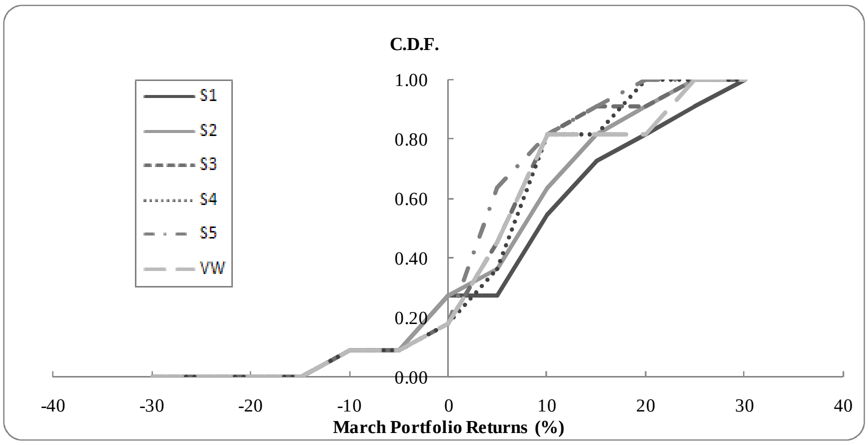


Figure 3

Cumulative Density Function of March Returns for Five Portfolios of SSE Stocks ($S_1$ denotes the smallest-cap portfolio, $S_5$ denotes the largest-cap portfolio, and VW denotes the value-weight Index)

Table 3
Efficient Sets of March Returns for Five Size-directed Portfolios and Value-weighted Index

| | FSD[2] | SSD | FSDR $r_f \geq 0.4\%$ [4] | SSDR $r_f \geq 0.4\%$ |
|---|---|---|---|---|
| Portfolio 1[1] | +[3] | + | + | + |
| 2 | + | - | + | -[5] |
| 3 | + | + | + | - |
| 4 | + | + | + | - |
| 5 | + | - | + | - |
| VW | + | + | + | - |

1. Portfolio 1 denotes the smallest-cap portfolio, Portfolio 5 denotes the largest-cap portfolio, and VW denotes the value-weight Index.
2. FSD: first-degree stochastic dominance, SSD: second-degree stochastic dominance, FSDR: first-degree stochastic dominance with risk-free asset, SSDR: second-degree stochastic dominance with risk-free asset.
3. Efficient sets (winner) marked by "+", inefficient sets (loser) marked by "-".
4. $r_f$ denotes the return on risk-free assets.
5. Portfolio 1 dominates Portfolios 3 and 4 at monthly risk-free rate, $r_f \geq 0.1\%$ and Portfolio 1 dominates value-weighted index at monthly risk-free rate, $r_f \geq 0.4\%$ .

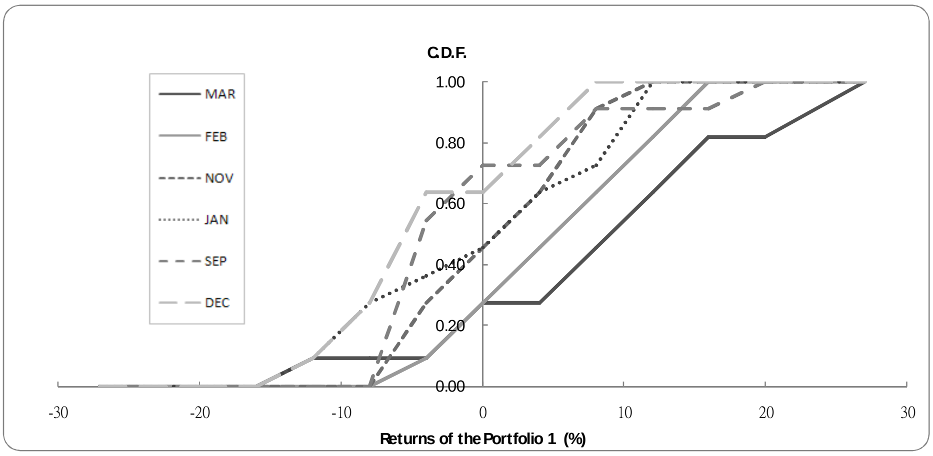


Figure 4

Cumulative Density Function of the Monthly Returns for the Smallest Firm Size Portfolio (Portfolio 1) for the Months of January, February, March, September, November and December

Table 4

Efficient Sets of Monthly Returns for Five Size-directed Portfolios and Value-weighted Index

| | Portfolio 1[3] | | | | Portfolio 2 | | Portfolio 3 | | Portfolio 4 | | Portfolio 5 | | VW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FSD | SSD[2] | FSDR $r_f \geq 0.6\%$[4] | SSDR $r_f \geq 0.6\%$ | SSD | SSDR $r_f \geq 1.66\%$ | SSD | SSDR $r_f \geq 1.98\%$ | SSD | SSDR $r_f \geq 1.57\%$ | SSD | SSDR $r_f \geq 1.28\%$ | SSD | SSDR $r_f \geq 0.1\%$ |
| Jan | -[1] | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Feb | + | + | + | - | + | - | + | - | + | - | + | - | + | - |
| Mar | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Apr | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| May | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Jun | + | - | + | - | - | - | - | - | - | - | + | - | - | - |
| Jul | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Aug | + | + | + | - | - | - | - | - | - | - | - | - | - | - |
| Sep | + | + | + | - | - | - | - | - | - | - | - | - | - | - |
| Oct | + | - | + | - | - | - | - | - | - | - | - | - | - | - |
| Nov | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dec | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

1. Efficient sets (winner) marked by "+", inefficient sets (loser) marked by "-".
2. FSD: first-degree stochastic dominance, SSD: second-degree stochastic dominance, FSDR: first-degree stochastic dominance with risk-free asset, SDR: second-degree stochastic dominance with risk-free asset.
3. Portfolio 1 denotes the smallest-cap portfolio, Portfolio 5 denotes the largest-cap portfolio, and VW denotes the value-weight Index. In order to save space, only the SSD and SSDR efficient sets for Portfolios 2 to 5 and VW are shown in the table.
4. $r_f$ is the monthly returns on risk-free assets.

Table 5

Stochastic Dominance of December Returns are Dominated by Non-December Returns for Each Size-directed Portfolios and Value-weighted Index

| | Size-directed Portfolios | | | | | |
|---|---|---|---|---|---|---|
| | 1[1] | 2 | 3 | 4 | 5 | VW |
| Jan | SSDR[2] | FSD | SSDR | SSD | FSD | FSD |
| Feb | FSD[3] | FSD | FSD | FSD | FSD | FSD |
| Mar | FSD | FSD | SSDR | FSD | FSD | FSD |
| Apr | FSD | SSD | FSD | FSD | FSD | FSD |
| May | FSD | SSD | FSD | SSD | SSD | SSD |
| Jun | SSD | FSD | SSDR | FSD | FSD | FSD |
| Jul | SSD | SSD | SSDR | FSD | FSD | SSDR |
| Aug | FSD | FSD | FSD | FSD | FSD | SSD |
| Sep | SSD | SSD | FSD | FSD | FSD | SSD |
| Oct | FSD | FSD | FSD | FSD | FSD | SSD |
| Nov | FSD | SSD | FSD | SSD | FSD | SSD |

1. Portfolio 1 denotes the smallest-cap portfolio, Portfolio 5 denotes the largest-cap portfolio, and VW denotes the value-weight Index.
2. January returns dominant over December returns for $r_f \geq 0.1\%$. Note that the other five months, like January in Portfolio 3, in this table also use the same monthly risk-free interest rate to beat December.
3. FSD: first-degree stochastic dominance, SSD: second-degree stochastic dominance, FSDR: first-degree stochastic dominance with risk-free asset, SSDR: second-degree stochastic dominance with risk-free asset.

Table 6
Efficient Sets of Weekly March Returns for Five Size-directed Portfolios and Value-weighted Index

| | FSD[2] | SSD | FSDR $r_f \geq 0.12\%$[4] | SSDR $r_f \geq 0.12\%$ |
|---|---|---|---|---|
| Portfolio 1[1] | +[3] | + | + | + |
| 2 | + | + | + | - |
| 3 | + | + | + | - |
| 4 | + | - | + | - |
| 5 | + | - | + | - |
| VW | + | + | + | - |

1. Portfolio 1 denotes the smallest-cap portfolio, Portfolio 5 denotes the largest-cap portfolio, and VW denotes the value-weight Index.
2. FSD: first-degree stochastic dominance, SSD: second-degree stochastic dominance, FSDR: first-degree stochastic dominance with risk-free asset, SSDR: second-degree stochastic dominance with risk-free asset.
3. Efficient sets (winner) marked by "+", inefficient sets (loser) marked by "-".
4. $r_f$ is the weekly return on risk-free assets.

Table 7

Efficient Sets of Weekly Month Returns for Five Size-directed Portfolios and Value-weighted Index

| | Portfolio 1[3] | | | | Portfolio 2 | | Portfolio 3 | | Portfolio 4 | | Portfolio 5 | | VW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FSD | SSD[2] | FSDR $r_f \geq 0.12\%$[4] | SSDR $r_f \geq 0.12\%$ | SSD | SSDR $r_f \geq 0.12\%$ | SSD | SSDR $r_f \geq 0.12\%$ | SSD | SSDR $r_f \geq 0.12\%$ | SSD | SSDR $r_f \geq 0.12\%$ | SSD | SSDR $r_f \geq 0.12\%$ |
| Jan | -[1] | - | - | - | - | - | + | - | + | - | - | - | - | - |
| Feb | + | + | + | - | + | - | + | + | + | + | + | - | + | - |
| Mar | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| Apr | + | - | + | - | - | - | - | - | + | - | + | - | + | - |
| May | + | + | + | - | + | - | - | - | - | - | - | - | - | - |
| Jun | + | - | + | - | - | - | - | - | + | + | + | + | + | + |
| Jul | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Aug | + | - | + | - | - | - | - | - | - | - | - | - | - | - |
| Sep | + | - | + | - | - | - | - | - | - | - | - | - | - | - |
| Oct | - | - | - | - | - | - | + | - | + | - | + | - | + | - |
| Nov | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dec | + | - | + | - | - | - | - | - | - | - | - | - | - | - |

1. Efficient sets (winner) marked by "+", inefficient sets (loser) marked by "-".
2. FSD: first-degree stochastic dominance, SSD: second-degree stochastic dominance, FSDR: first-degree stochastic dominance with risk-free asset, SDR: second-degree stochastic dominance with risk-free asset.
3. Portfolio 1 denotes the smallest-cap portfolio, Portfolio 5 denotes the largest-cap portfolio, and VW denotes the value-weight Index. In order to save space, only the SSD and SSDR efficient sets for Portfolios 2 to 5 and VW are shown in the table.
4. $r_f$ is the monthly returns on risk-free assets.

## Appendix

SD and SDR Tests
Comparison of March and October returns:

(1) FSD test: $Q_M(p) < Q_O(p)$ for $0 < p \leq 1/11$,

$Q_M(p) > Q_O(p)$ for $2/11 \leq p \leq 1$

(see columns (7) and (3)). No FSD between March and August returns.

(2) SSD test:

$$\int_0^p Q_M(p)dt < \int_0^p Q_O(p)dt \quad \text{for} \quad 0 < p \leq 2/11,$$

$$\int_0^p Q_M(p)dt > \int_0^p Q_O(p)dt \quad \text{for} \quad 3/11 \leq p \leq 1.$$

(see columns (8) and (4)). No SSD between March and October returns.

Comparison of $Q_\alpha(p)$ with October returns:

(1) FSDR test: $Q_\alpha(p) > Q_O(p)$ for $0 < p \leq 10/11$,

$Q_\alpha(p) < Q_O(p)$ for $1 \leq p \leq 1$

(see columns (5) and (7)). No FSDR between March and October returns.

(2) SSDR test: $\int_0^p Q_\alpha(p)dt > \int_0^p Q_O(p)dt$ for $0 < p \leq 1$

(see columns (6) and (8)). Mixture $Q_\alpha(p)$ dominates October returns by SSD; hence March returns dominate October returns by SSDR for $r_f = 0.5\%$.

| Step | | March | | Mixture March With Risk-free $r_f = 0.5\%$[1] | | October | |
|---|---|---|---|---|---|---|---|
| No. | C.D.F.[2] | $Q_M(p)$ | $\int_0^p Q_M(t)dt$ | $Q_\alpha(p)$[3] | $\int_0^p Q_\alpha(t)dt$ | $Q_O(p)$ | $\int_0^p Q_O(t)dt$ |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| 1 | 1/11 | -12.9982 | -12.9982 | -7.5989 | -7.5989 | -7.8270 | -7.8270 |
| 2 | 2/11 | -2.4083 | -15.4065 | -1.2450 | -8.8439 | -7.5589 | -15.3859 |
| 3 | 3/11 | -0.2983 | -15.7048 | 0.0210 | -8.8229 | -6.8447 | -22.2306 |
| 4 | 4/11 | 5.0824 | -10.6224 | 3.2494 | -5.5735 | -4.6480 | -26.8786 |
| 5 | 5/11 | 7.8075 | -2.8149 | 4.8845 | -0.6890 | -4.1746 | -31.0532 |
| 6 | 6/11 | 9.9873 | 7.1724 | 6.1924 | 5.5034 | -2.1903 | -33.2435 |
| 7 | 7/11 | 11.1015 | 18.2739 | 6.8609 | 12.3643 | 1.3950 | -31.8485 |
| 8 | 8/11 | 13.5902 | 31.8641 | 8.3541 | 20.7184 | 5.1696 | -26.6789 |
| 9 | 9/11 | 15.4064 | 47.2705 | 9.4438 | 30.1622 | 6.2171 | -20.4618 |
| 10 | 10/11 | 22.4078 | 69.6783 | 13.6447 | 43.8069 | 9.8565 | -10.6053 |
| 11 | 1 | 26.1063 | 95.7846 | 15.8638 | 59.6707 | 16.9698 | 6.3645 |

1. The similar calculation can also consult Levy and Lerman (1985) and Chou and Liao (1996) paper.
2. C.D.F. represents cumulative probability.
3. The mixture quantile $Q_\alpha(p) = \alpha Q_2(p) + (1-\alpha) r_f$ calculated for $r_f = 0.5\%$ and $\alpha = 0.60$ as $Q_\alpha = 0.60 \times Q_M(p) + 0.40 \times 0.5\%$. Annually risk-free rate is equal 6%; therefore, monthly risk-free rate is $0.5\%$.