Mutual fund stochastic dominance

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Abstract

2nd-order stochastic dominance of mutual fund (over the market return) responses to the preference of fund investors is conceptually more important than traditional performance measures. In this paper, we show that investors on average do not rationally response to the 2nd-order stochastic dominance. Fund managers, on the other hands, agree on its importance and tend to make the fund return to stochastic dominant market, when they own more stakes of the funds. 2nd-order stochastic dominance is positively correlated with future Carhart alpha and can be achieved by using both equity holding and non-equity holdings.

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1 Introduction

Investors put money into the mutual funds to maximize their utility. However, other than risk averse, people do not have more information about the utility function of mutual fund investors. Traditional performance measures which take both return and risk into account, such as the Sharpe ratio and Treynor ratio make the simple assumption that fund returns are normal distributions. In this paper, we empirically show that this assumption is not true for majority of funds. That calls for a measure of utility comparing different fund return distributions in a robust manner for those risk averse investors which is 2nd-order stochastic dominance of mutual fund (over the market return).

In this paper, we first test whether mutual fund can provide a net return distribution that stochastic dominate the market return. Investor can always choose from putting their money into mutual funds and suffer from the expense ratio, trade cost, or they can do a simple buy and hold of market portfolios. Which option to choose really depends on the utility brought by the investments. We use the stochastic dominance tests based on a generalized Kolmogorov-Smirnov test in Linton, Maasoumi, and Whang (2005). We find there are significant number of funds (13.8%) can perform significantly better than the market over the sample periods from the 3rd quarter, 1999 to the 4th quarter, 2015 by provide a higher utility.

Then the natural question to ask is that whether investors realize it and respond to the information of stochastic dominance. In order to empirically measure the level of stochastic dominance across different funds, we use second order almost stochastic dominance measures (ASDs). Leshno and Levy (2002) first proposes this dominance rules. Bali, Brown, and Demirtas (2013) use this measure in hedge funds.

We find that better ASD means higher cross-section of *future* fund returns. Using a calendar portfolio approach, we find that the portfolios of funds in the highest decile of ASD (funds that least dominate the market) significantly underperform those in the lowest (funds that most dominate the marke) decile by 3.13% per annum on a risk-adjusted return basis, a significant opportunity cost that investors should take into account when choosing funds.

These findings are not sensitive to several choices that we make in our empirical analysis. Our results are qualitatively similar when we change the weighting procedure in portfolio sorts from equal-weighting to value-weighting, and control for other commonly used predictors of fund performance. Our results continue to hold even after controlling for known measures of manager skill such as the return gap, active share and sharpe ratio.

Further question to ask is how investors of mutual funds respond to ASD and how the response compared with conceptually similar measure, sharpe ratio. We find that funds with better ASD attracts more investor flow. However, the effect is not as strong as Sharpe ratio, which may reflects the irrationality and “dumb” moenty effect of mutual funds as in Frazzini and Lamont (2008). Furthermore, we find that when the fund managers own more of the funds, their funds have a better ASD. It reflects that managers realize the importance of 2nd-order stochastic dominance and make their portfolios to have higher dominance.

Finally, we want to know how managers are able to main the 2nd-order stochastic dominance over market. We exam their holding not only for equity but also for other holdings such as option, loan and so on from their N-SAR reports. We find by using short sale and holding equity options and index options, they can achieve more ASD.

Bali, Brown, and Demirtas (2013) use almost stochastic dominance measure in hedge funds to compete with traditional performance measures. But we argue that there are several differences between hedge funds and mutual funds. First, compared with mutual funds, hedge funds more intensively use derivatives, short-selling, leverage and invest in non-U.S. equity which makes the risk factors different from the Carhart 4 factors in equity funds. Specifically, it includes macro risk (because of commodity), currency risk and so on. Second, investors in hedge funds are much more sophisticated than mutual funds which makes flow response differently. Because to decide which factor is risk factor rather than skill, fund investors could see if they can mimic the factor themselves. If they can, it is risk factor and has nothing to do with skill. For example, exotic beta such as beta related with currency, commodities are alpha or skill for fund managers since fund investors do not understand those risk factors and it is hard for investor to trade them. When investors are more sophisticated, they may be able to understand and trade more risk factors and the alpha is harder to get. For example, hedge fund investors are more sophisticated than mutual fund investors. Then they may attribute less factors to alpha. Third, incentive contracts for hedge funds are different from mutual funds which makes fund manager behave differently.

2 Data and variable definitions

2.1 Data

We obtain both daily and monthly mutual fund net return data from from the Center for Research in Security Prices (CRSP) Survivorship Bias Free Mutual Fund Database.We calculate monthly gross return based on the summation of net return and expense ratio divded 12. Other fund characteristics variables such as turnover ratio, total net asset and family size, fund age (oldest share class in the fund) are also from CRSP. For fund turnover, we subsittue missing values by turnover from Morningstar whenever available. We calculte sizes of fund family as the sum of total net assets (TNA) of all fund in a fund family (excluding the fund itself). We use previous month end TNA for each fund shareclass as weight to get fund level return, turnover ratio and expense ratio as the average of all share classes of funds. Monthly fund flow is caculated as the change of total net asset not from net return. Daily fund flow is from Trimtabs dataset.

Following Kacperczyk, Sialm, and Zheng (2008), we select and focus our sample on active-managed domestic equity funds. We drop ETF fund, annuity and index funds based on either indicator variables or fund names both from CRSP. We filter out funds whose percentage of asset under management to be in the form of stock smaller than 80% (exclusively). We restrict our sample to funds that are at least a year old and have at least $15 million in assets, and use the date the fund ticker was created to control for the incubation bias of Evans (2010). We caculate stochastic dominance (SD) measure based on daily fund return data from January 1st, 1999[1] to December 31st, 2015. It reflects second order stochastics dominance of daily net fund return over contempoary market return.

We caculate fund level stock holding charactereics such as holding value-weighted market capitalization, book-to-market ratio (supplemented by the book values from Ken French's website.), past six-month cumulative return (Jegadeesh and Titman (1993)). We first keep for all

[1] Daily fund return is available from September, 1998

common stock listed in NYSE, AMEX, or NASDAQ and cacaulate charcteresics[2]. We obtain share volume of mutual fund portfolio holding from the Thomson Reuters Mutual Fund Holdings (formerly CDA/Spectrum S12) database. We use the holding value as the weight and we calculate the fund level holding characteristics. In Thomson Reuters, we filter out fund hold less than 10 stocks. We also remove funds with investment objective code of 1, 5, 6, 7 and 8 which stands for International, Municipal Bonds, Bond and Preferred, Balanced, and Metals funds. Finally, we merge the CRSP Mutual Fund database and the Thomson Reuters Mutual Fund Holdings database using the MFLINKS tables provided WRDS.

To calculate SD measures from daily fund returns in each quarter-end, we require the fund to have more than 210 daily returns in the past 12 months. Therefore our first SD is in the 3rd quarter, 1999. Thus, the final sample contains 155954 fund-quarters and 5198 unique funds.

2.2 Stochastic dominance measures

In order to compare different fund return distributions in a robust manner, and relative to a large class of utility functions, we examine stochastic dominance rankings in this session. The stochastic dominance approach does not impose any parametric specifications regarding investor's preferences or about asset return distributions, when compared with other traditional performance measures, such as the Sharpe ratio and the Treynor ratio. Specifically, we conduct stochastic dominance test for realized daily net fund return over market daily return. We want to answer whether skillful fund managers can generate daily fund return series that stochastically dominate the market return. We conduct dominance test at the first and second orders.

The first-order stochastic dominance corresponds to a class (denoted as U_1) of all (increasing) von Neumann-Morgenstern type of utility functions u such that the utility is increasing in returns, i.e. $u' > 0$. The second-order stochastic dominance corresponds to a class of utility functions in U_1 such that $u'' > 0$, i.e. those concave utility functions with risk-aversion, denoted as U_2. Concavity implies an aversion to higher risk or variance of returns in the time series. We denote the cumulative distribution function (CDF) of an excess

[2] We adjust trading volume for stocks in NASDAQ as in Gao and Ritter (2010).

return series for fund i by $F_i(r) \equiv \Pr[r_{it} \leq r]$ and the CDF of market excess returns by $F_m(r) \equiv \Pr[r_{mt} \leq r]$. Then the 1st- and 2nd-order stochastic dominance can be defined as follows:

Case 1. first-order dominance: The distribution of mutual fund excess return series first-order stochastically dominates the market excess return distribution (denoted as r_{it} FSD r_{mt}) if and only if

1. $E[u(r_{it})] \geq E[u(r_{mt})]$ for all $u \in U_1$ with strict inequality for some utility u;
2. Or $F_i(r) \leq F_m(r)$ for all r with strict inequality for some value of r.

Case 2. second-order dominance: The distribution of mutual fund excess return series second-order stochastically dominates the market excess return distribution (denoted as r_{it} SSD r_{mt}) if and only if

1. $E[u(r_{it})] \geq E[u(r_{mt})]$ for all $u \in U_2$ with strict inequality hold for some utility u;
2. Or $\int_{-\infty}^{r} F_i(t)dt \leq \int_{-\infty}^{r} F_m(t)dt$ for all r with strict inequality hold for some value of r.

The stochastic dominance tests used in this paper are based on a generalized Kolmogorov-Smirnov test as discussed in Linton, Maasoumi, and Whang (2005). The test statistics for FSD and SSD are given respectively by

$$d = \sqrt{\frac{T_i T_m}{T_i + T_m}}\, min\{\sup[F_i(r) - F_m(r)], \sup[F_m(r) - F_i(r)]\}$$

$$s = \sqrt{\frac{T_i T_m}{T_i + T_m}}\, min\left\{\sup \int_{-\infty}^{r} F_i(t) - F_m(t)dt, \sup \int_{-\infty}^{r} F_m(t) - F_i(t)dt\right\}$$

In empirical applications, the CDFs are estimated using empirical CDFs, given by $\widehat{F_i(r)} = \frac{1}{T_i}\sum_{t=1}^{T_i} I(r_{it} \leq r)$, where $I(\cdot)$ is an indicator function. The underlying distribution of the test statistics are generally unknown and depend on the data. Following Maasoumi and Heshmati (2000), simple bootstrap technique based on 199 replications are employed to obtain the empirical distribution of the test statistics.

The stochastic dominance tests are useful in detecting dominance relations in a statistical manner. However, when comparing certain distributions with some small violation areas, the stochastic dominance rules may seem to be too strict. Using the following two graphs, we illustrate cases where the stochastic dominance rules fail to give us preference ranks for two return distributions. In Figure 1, note that the distribution H fails to first-order stochastically dominate distribution L due to the existence of a small violation region V, which can be mathematically denoted as $\int_{r_1}^{r_2}[F_H(t) - F_L(t)]dt$. By the definition of FSD, the cumulative distribution H should always be lower than the cumulative distribution L, while in this region, H lies strictly above L. It also violates the SSD definition, since the integration of L at the violation area is smaller than that of H, i.e. $\int_{-\infty}^{r_2} F_L(t)dt \leq \int_{-\infty}^{r_2} F_H(t)dt$. What is worse, under certain pathological utility function[3], an investor may prefer distribution L to distribution H. However, in many empirical examples, as long as the violation area V is small enough and the values of r_1 and r_2 are not large, most investors would still prefer distribution H to distribution L. To overcome this issue, Leshno and Levy (2002) proposed dominance rules known as the almost stochastic dominance (ASD), which are appropriate for a given class of utility functions, after eliminating those pathological preferences.

In order for the distribution H to first-order dominate L by the ASD rules, the violation area has to be small enough. We use ε to denote the violation area H as the fraction of the entire area in-between H and L. This violation fraction in Figure 1 is given by

$$\varepsilon_1 = \frac{\int_{r_1}^{r_2}[F_H(t) - F_L(t)]dt}{\int_{-\infty}^{+\infty} |F_H(t) - F_L(t)|dt} = \frac{V}{V + K}$$

How to determine whether ε is small enough for the ASD to hold is an empirical issue. Theoretically, suppose each investor has a threshold value $\varepsilon_1^{*,i}$, above which the dominance relation would not hold for this investor. Then, the minimum of all the threshold values $\varepsilon_1^{*,i}$ would be the critical value ε_1^* such that the ASD holds for all investors. Levy et al. (2010) conducted a series of experimental studies and found ε_1^* to be 5.9% for the almost first-order stochastic dominance rule (AFSD).

[3] Please refer to Bali, Brown, and Demirtas (2013) for more detailed examples of pathological utilities.

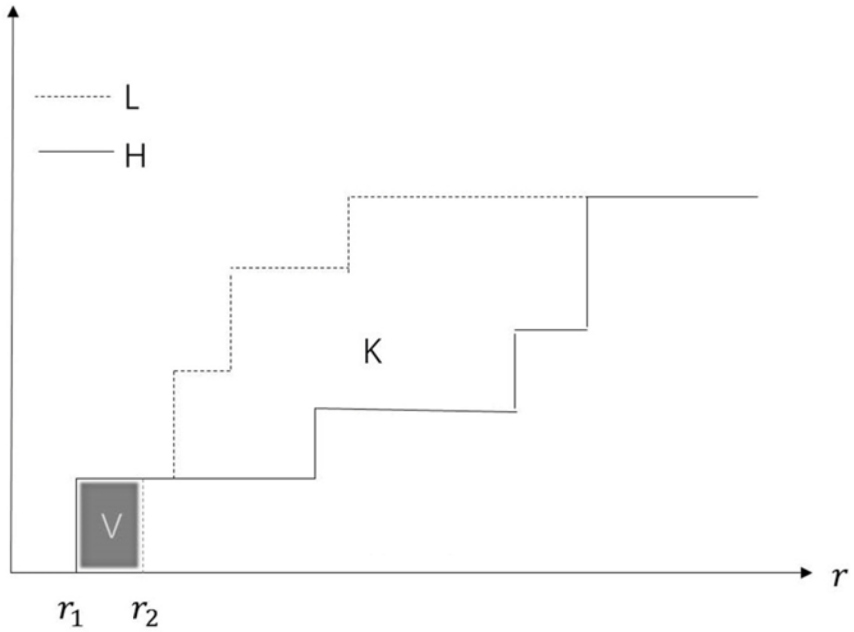

Figure 1. Violation to the first-order stochastic dominance

Figure 2 shows a case where H has a much higher mean than L, so L cannot dominate H. However, due to the violation area Q within the return interval $[r_1, r_2]$, there is no SSD of H over L because the total integrated area between distribution H and distribution L turns positive starting at the return value r_1. However, similar as the definition of FASD, suppose for all investors there exist some threshold value ε_2^*, below which the second-order stochastic dominance by the ASD rules. Then we can define the almost second-order stochastic dominance (ASSD) as the cases where the violation fraction ε_2 is smaller than ε_2^*. As described by Levy et al. (2010), ε_2^* is obtained from a series of experimental studies and found to be 3.2% for the almost second-order stochastic dominance (ASSD) rule.

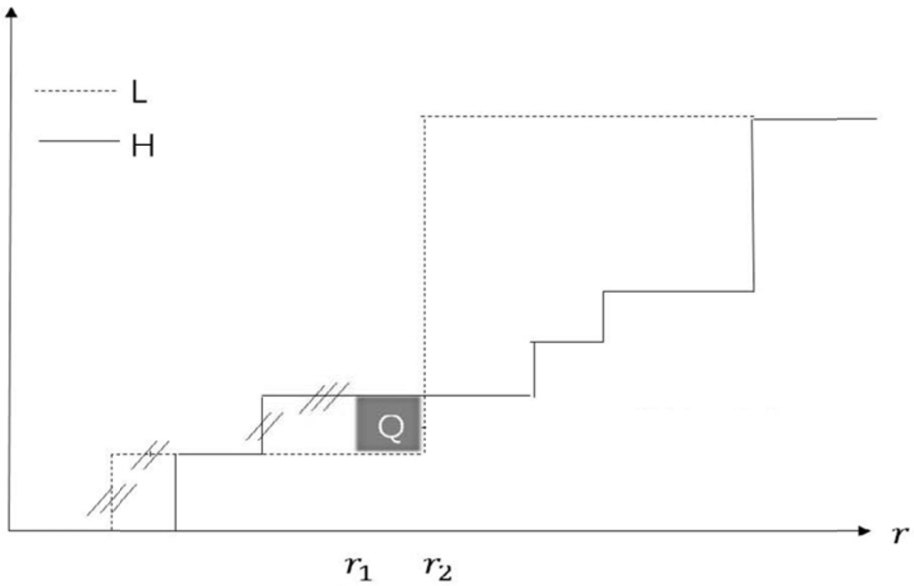

Figure 2. Violation to the 2st order stochastic dominance

Similar as SD tests, ASD imposes general conditions regarding preferences and considers the entire return distribution with high-order moments. Computing both stochastic dominance and almost stochastic dominance measures for each fund-quarter, we find there are substantial occasions for either the fund dominates the market or market dominates the fund. At each quarter end, we compute both stochastic dominance and almost dominance measures of both first-order and second-order for each fund using the previous 12 months' daily returns of the fund and the market. For mutual fund and market return series, first-order stochastic dominance is very rare (with neither fund-quarters dominate nor be dominated by the market in stochastic dominance measure, with only 0.10% of fund-quarters dominate the market and 0.04% of fund-quarters dominated by the market in almost stochastic dominance measure). Second-order stochastic dominance is more prevail in our sample, with 13.8% (18.6%) of fund-quarters dominating the market and 22.5% (25.0%) of fund-quarters being dominated by the market in stochastic dominance measure (almost stochastic dominance measure). It seems active management industry cannot beat the market on average, but there is a cross-sectional differentiation in actively managed fund performance.

As first-order stochastic dominance is rare, we choose second-order stochastic dominance as our main measure to do the empirical research. Moreover, stochastic dominance measure is a test statistic from a generalized Kolmogorov-Smirnov test as discussed in Linton, Maasoumi, and Whang (2005), while almost stochastic dominance measure is a ratio of two areas in the empirical distribution function, thus using almost stochastic dominance measure in the cross-sectional comparisons is more plausible (although the correlation between these two measures are fairly high, with 0.545 and 0.582 as the correlation of the fund dominates the market and the market dominates the fund). From now on, we will conduct the empirical tests using second-order almost stochastic dominance measure and show the results for second-order stochastic dominance measure in the robustness test.

Particularly, there are two second-order almost stochastic dominance measures for each fund. One is ASD_fdm, which means the degree that the fund dominates the market; the other is ASD_mdf, which is the degree that the market dominates the fund. When ASD_fdm is lower than 0.032, the fund dominates the market in a second-order almost stochastic dominance sense. The lower ASD_fdm is, the higher degree that the fund dominate the market. Similarly, if ASD_mdf is less than 0.032, the fund is dominated by the market. The lower ASD_mdf is, the higher degree that the fund is dominated by the market. There are three kind of scenarios for each fund-quarter, that is the fund dominates the market, the fund is dominated by the market, the fund neither dominates the market nor be dominated by the market. ADS_fdm and ASD_mdf are opposite and with a high correlation of -0.935, which means the higher degree the fund dominate the market, the lower degree the fund would be dominated by the market, and vice versa. As the definition of second-order almost stochastic dominance, both measures are bounded in [0, 1].

3 Stochastic dominance and performance

In this section, we investigate the predictive power of second order almost stochastic dominance measures (ASDs) on fund returns in the future months. First, we perform a univariate portfolio-level analysis based on ASDs. We find that funds with relatively low ASD_fdm or high ASD_mdf tend to have higher future performance. Low ASD_fdm means the fund dominates the market more. High ASD_mdf means that the fund is less dominated by the market. Second, we examine the cross-sectional relation between ASDs and future fund returns using univariate and multivariate Fama-MacBeth regressions, finding the above mentioned results are quite robust after controlling for fund characteristics and other well-known performance measures.

3.1 Univariate sorts

Table 1 shows the univariate sorting results. At the beginning of each quarter, we form deciles portfolios of mutual funds based on ASD_fdm/ASD_mdf. Decile 1 contains funds with the lowest ASD_fdm/ASD_mdf and decile 10 contains funds with the highest ASD_fdm/ASD_mdf. Funds remain in the same portfolio for the whole quarter and then rebalance every quarter. We provide both equal-weighted and value-weighted portfolios to test if funds holding small stocks alone are driving the result.

[Table 1 about here]

Panel A presents excess return and Carhart (1997) four-factor alpha on portfolios of mutual fund sorted on ASD_fdm. The first column is the equal-weighted excess return, which is net fund return minus risk-free rate. The average excess return decreased from 0.618% to 0.250% per month from decile 1 to decile 10, indicating a monthly average return difference of -0.367% between high and low decile with t-statistic of -2.08, showing that this negative return difference is economically and statistically significant. This also implies a 4.4% per annum excess return difference between lowest and highest SD decile. In the second column, the equal-weighted Carhart (1997) four-factor alpha shows a similar pattern as that of excess return, the monthly average alpha difference between high and low decile is -0.261%. That means commonly used statistical benchmark and factor loadings cannot explain the return difference. In the third and fourth column, value-weighted excess return and four-factor alpha are lower than that of equal-weighted portfolios but the return difference is still significantly negative. Besides, in equal-weighted sorting, alpha difference mainly comes from the good performance of the lowest decile portfolio, with positive alpha significant at 5%, while alpha difference in value-weighted sorting is due to the bad performance of the highest decile portfolio, with significantly negative alpha.

In panel B, we show results for portfolios sorted on ASD_mdf. Since ASD_mdf is opposite to ASD_fdm, the return patterns are also reversed. The positive return difference between high and low decile is still significant both economically and statistically, with 0.351%, 0.239% and 0.274% per month for equal-weighted excess return, equal-weighted four-factor alpha and value-weighted excess return. The value-weighted 4-factor alpha is marginal significant with 0.165% per month. These results justify that our results are not only driven by funds holding small stocks.

Besides, as we mentioned earlier, ASD_fdm and ASD_mdf is highly negatively correlated, sorting according to these two measures should have opposite return patterns, that is the lowest ASD_fdm decile portfolio is supposed to be alike with the highest ASD_mdf portfolio, and vice versa. This is confirmed in panel A and panel B. For example, in equal-weighted sorting, the lowest ASD_fdm (highest ASD_mdf) decile portfolio has an excess return of 0.618 (0.631) and alpha of 0.193 (0.131), the highest ASD_fdm (lowest ASD_mdf) decile portfolio has an excess return of 0.250 (0.280) and alpha of -0.067 (-0.108). The return magnitude similarity holds in the value-weighted sorting portfolios. Nevertheless, we are still interested in whether these two measures combined can generated a larger return difference. Thus, we independently sort funds into 10 portfolios according to ASD_fdm and 10 portfolios according to ASD_mdf in panel C and returns of extreme good dominance ability portfolio (lowest ASD_fdm and highest ASD_mdf) and extreme bad dominance ability portfolio (highest ASD_fdm and lowest ASD_mdf) and the return differences in between is presented. Overall, the return difference is slightly larger when the two measures are combined, with equal-weighted (value-weighted) excess return absolute difference of 0.382 (0.269) and alpha absolute difference of 0.239 (0.151), compared with 0.367 (0.235) and 0.261 (0.145) in univariate ASD_fdm sorting, 0.351 (0.274) and 0.239 (0.165) in univariate ASD_mdf sorting. In conclusion, combining ASD_fdm and ASD_mdf can provide very little additional information and they are almost opposite. From now on, we basically focus on ASD_fdm.

3.2 Fama-MacBeth cross-sectional regressions

We now examine the cross-sectional relation between almost stochastic dominance and future fund return at the individual fund level using Fama-MacBeth (1973) regressions using the following model,

$$Alpha_{i,t+1} = \beta_0 + \beta_1 \cdot ASD\_fdm_{i,t} + \beta_2 \cdot RG_{i,t} + \beta_3 \cdot AS_{i,t} + \beta_4 \cdot SR_{i,t} + \sum_{k=1}^{K} \gamma_k \cdot Fund\ Controls_{k,t} + \varepsilon_{i,t+1}$$

The regression is on the quarter frequency. $Alpha_{i,t+1}$ is the Fama-French-Carhart four-factor in quarter t+1 calculated using the 3 months' daily returns in that quarter. $ASD\_fdm_{i,t}$ is the second-order almost stochastics dominance in quarter t. $RG_{i,t}$ is the return gap in the last month of quarter t. The return gap measure follows Kacperczyk, Sialm and Zheng (2008), which is the monthly difference between net actual fund return and net hypothetical return, with actual annual expense ratio divided by 12 as the monthly expense for hypothetical fund. $AS_{i,t}$ is the active share in the last month of quarter t. The active share measure follows Cremers and Petajisto (2009). $SR_{i,t}$ is the Sharpe ratio in quarter t calculated with previous 12 months fund daily net returns in each quarter end. Fund controls include the natural log of total net asset, fund age, family total net asset, and fund return, expense ratio, turnover ratio, fund flows, all measured as of the last month of quarter t.

[Table 2 about here]

Table 2 presents the average intercepts and slope coefficients from the Fama-MacBeth cross-sectional regressions. The Newey-West (1987) adjusted t-statistics are reported in parentheses. Consistent with our findings in univariate sort, regression (1) show that there is a significant negative relation between ASD_fdm and future fund returns. The average slope on ASD_fdm is -0.0283 with a t-statistic of -2.80. Regression (2)-(5) indicate that the negative relation between ASD_fdm and future fund returns remains significant after controlling for a large set of fund characteristics plus return gap, active share and Sharpe ratio.

The average slope coefficients of fund characteristics are consistent with previous literature, with positive slope on fund alpha, age, family total net asset and negative slope on total net asset, expense ratio, turnover ratio. Although we followed Kacperczyk, Sialm and Zheng (2008) for calculating return gap, the average slope for return gap is not that significant as their findings. There maybe two reasons for the inconsistency. First, while the time period for their paper is from 1984 to 2003, our data is from 2000 to 2015. Second, their research does not use Fama-Macbeth regression to derive the significant positive relation between return gap and future fund return. Doing a similar univariate sorting from 1980 to 2003, we can obtain a significant positive return difference between high and low return gap deciles by using our return gap measure. Active share is positively related to alpha, which is consistent with previous research. While the coefficient of Sharpe ratio is insignificant, the coefficient of ASD_fdm is still significant.

Thus, the regression results confirms that the almost stochastic dominance between fund return and market return is predictive about fund performance, that is if the fund is more capable of dominating the market, its future performance is higher.

4. Stochastic dominance and revealed preference

Given the empirical predictability of second-order almost stochastic dominance measure for future performance of mutual fund and the theoretical superiority of stochastic dominance concept, we further examine whether investors could recognize the importance of this measure. We find the flow response to ASD_fdm is negatively significant, even controlling for return gap and active share measures, but becomes insignificant when controlling Sharpe ratio. In the horse race test, we find that investors care about Sharpe ratio more than ASD_fdm. Despite the empirical and theoretical superiority of second-order stochastic dominance, investors seems to be unaware of this measure.

As mutual fund managers are usually more sophisticated and have more information about their portfolios, they are more likely to be aware of this measure. By showing funds with more manager ownership tend to have lower ASD_fdm in the next period, we confirmed that managers have a preference for lower ASD_fdm. To further differentiate ASD and Sharpe ratio, we decompose ASD_fdm on Sharpe ratio and find manager ownership not only generate higher Sharpe ratio related ASD but also higher Sharpe ratio unrelated ASD. Thus, managers not only value Sharpe ratio, but also value ASD_fdm.

4.1 Investor flow response to almost stochastic dominance

To see whether investors of mutual funds prefer funds with more capability to dominate the market, we take an revealed preference appocah to cross-sectionally compare funds with different stochastic domaince. Sepecifically, we regress future fund flows on ASD_fdm and controlling for other performance measures one by one following the Fama and MacBeth (1973) cross-sectional regression from the model

$$Flow_{i,t+1} = \beta_0 + \beta_1 \cdot ASD\_fmd_{i,t} + \beta_2 \cdot Alpha_{i,t} + \beta_3 \cdot RR_{i,t} + \beta_4 \cdot GR_{i,t} + \beta_5 \cdot RG_{i,t} + \beta_6 \cdot SR_{i,t} + \sum_{k=1}^{K} \gamma_k \cdot Fund\ Controls_{k,t} + \varepsilon_{i,t+1}$$

The regression is on the quarter frequency. $Flow_{i,t+1}$ is the average monthly fund flow in quarter t+1. $ASD\_fdm_{i,t}$ is the second-order almost stochastic dominance in quarter t. $Alpha_{i,t}$ is the Fama-French-Carhart four-factor alpha in quarter t calculated using the 3 months' daily returns in that quarter. $RR_{i,t}$ is the fund raw return in the last month of quarter t. $GR_{i,t}$ is the fund gross return in the last month of quarter t. $RG_{i,t}$ is the return gap in the last month of quarter t. $SR_{i,t}$ is the Sharpe ratio in quarter t calculated with previous 12 months fund daily net returns in each quarter end. Fund controls include the natural log of total net asset, fund age, family total net asset, and fund return, expense ratio, turnover ratio, fund flows, all measured as of the last month of quarter t. Newey-West adjusted t-statistics are used.

[Table 3 about here]

In Table 3, regression (1)-(5) shows the results using ASD_fdm as main independent variable controlling for performance measures like alpha, raw return, gross return, return gap and Sharpe ratio. In regression (1)-(4), fund flow respond to ASD_fdm when controlling alpha, raw return, gross return and return gap, with a average coefficient around -0.0282 to -0.0241, all significant at 1% level. However, when controlling for Sharpe ratio, flow response to ASD_fdm is no longer significant, while the coefficient of Sharpe ratio is still significantly positive. It seems investors prefers funds with higher Sharpe ratio but they are incapable of further recognizing the funds with high dominance ability.

4.2 Horse race of SD and Sharpe ratio

To address the nonlinearity problem, we conduct a horse race that is similar to Baber, Huang ad Odean (2016). In each quarter, we independently sort mutual funds into 10 portfolios according to ASD_fdm and 10 portfolios according to Sharpe ratio. To transform ASD_fdm decile portfolios into an ascending way like Sharpe ratio decile portfolios, we take 11-the ASD_fdm rank as the new rank for ASD_fdm. Thus, the higher the ASD_fdm rank, the lower ASD_fdm, and the fund is more likely to dominate the market. The same is for the Sharpe ratio rank.

Next, we estimate the flow response to the funds' decile ranking based on ASD_fdm and Sharpe ratio by the following regression:

$$Flow_{i,t+1} = \beta_0 + \sum_i \sum_j \beta_{i,j} \cdot D_{i,j,t} + \sum_{k=1}^{K} \gamma_k \cdot Fund\ Controls_{k,t} + \varepsilon_{i,t+1}$$

Where $Flow_{i,t+1}$ is the average monthly fund flow in quarter t+1. $D_{i,j,t}$is a dummy variable that takes on a value of one if the fund in quarter t is in decile I based on ASD_fdm and decile j based on Sharpe ratio. We exclude the dummy variable for i=5 and j=5. Fund controls include the natural log of total net asset, fund age, family total net asset, and fund return, expense ratio, turnover ratio, fund flows, all measured as of the last month of quarter t. the key coefficients of interest are $\beta_{i,j}$, i=1,…,10, and j=1,…,10, which can be interpreted as the flows received by the fund in decile i for ASD_fdm and decile j for Sharpe ratio relative to the fund that ranks fifth decile on both measures.

In figure 1, we present the dummy variables in the horse race. In the regression, the omitted dummy variable (regression constant) is funds with a decile rank of five based on both measures (black square). The gray and black cells represent funds with similar ranks based on both measures. The empirical tests compare the coefficients corresponding to the forty-five lower off-diagonal cells (where funds have better performance based on ASD_fdm) to the forty-five upper-diagonal cells (where funds have better performance based on Sharpe ratio). For example, we compare the coefficient estimate on the dummy variable for funds in the ninth ASD_fdm decile (red cell) and the third Sharpe ratio decile to funds in the third ASD_fdm decile and the nineth Sharpe ratio decile (green cell). To determine whether investors are more sensitive to ASD_fdm or Sharpe ratio, we test the null hypothesis that $\beta_{i,j}= \beta_{j,i}$ for all i$\neq$ j. We calculate a binomial test statistic to test the null hypothesis that the proportion of differences equals 50%. In the binomial test, 84.4% of ASD_fdm coefficient minus Sharpe ratio coefficient is negative, with binomial p-value less than 0.01. Thus, investors seems more sensitive to Sharpe ratio.

In figure 2, we shows the forty-five differences in coefficient estimates on dummy variables that compare funds with similar but opposite rankings based on ASD_fdm and Sharpe ratio. For example, the leftmost bar is the coefficient estimate on the dummy variable for funds in the tenth ASD_fdm decile and the ninth Sharpe ratio decile less coefficient estimate on the dummy variable for fund in the ninth ASD_fdm decile and the tenth Sharpe ratio decile. Obviously, investors weight more on Sharpe ratio than ASD_fdm in most cases.

4.3 Stochastic dominance and manager ownership

Our previous section shows that flows respond to ASD even controlling for some performance measures, which is consistent with investors' preferring funds with higher dominance ability. Besides, fund managers should also prefers such kind of funds. To show this, we regress ASD_fdm on manager ownership measures following the Fama and MacBeth (1973) cross-sectional regression from the model

$$ASD\_fdm_{i,t+1} = \beta_0 + \beta_1 \cdot Own\_dummy_{i,t} + \beta_2 \cdot Log\_own\_mean_{i,t} + \beta_3 \cdot Own\_rank_{i,t} + \beta_4 \cdot Own\_pct_{i,t} + \sum_{k=1}^{K} \gamma_k \cdot Fund\ Controls_{k,t} + \varepsilon_{i,t+1}$$

The regression is on the annual frequency. $ASD\_fdm_{i,t+1}$ is the second-order almost stochastic dominance in year t+1. $Own\_dummy_{i,t}$ is an indicator variable that equals one if portfolio managers have non-zero stakes in the fund, and zero otherwise. $Log\_own\_mean_{i,t}$ is natural logarithm of average dollar value of ownership if there are multiple managers. $Own\_rank_{i,t}$ is a rank variable, which takes a value of one if the ownership is zero, and two to seven, if ownership falls in the range of $1-$10,000, $10,001-$50,000, $50,001-$100,000, $100,001-$500,000, $500,001-$1,000,000, respectively. $Own\_pct_{i,t}$ is the aggregate dollar value of all managers ownership scaled by total net asset. $Alpha_{i,t}$ is the average quarter Fama-French-Carhart four-factor alpha in year t. Fund controls include the natural log of total net asset, fund age, family total net asset, and fund return, expense ratio, turnover ratio, fund flows, all measured as of the last month of year t. Newey-West adjusted t-statistics are used.

[Table 4 about here]

In Table 4, Future ASD_fdm is negatively related to manager ownership in all four measures, all significant at 0.01 level. This means when managers own more stakes in their funds, their portfolios tend to have higher dominance ability in the future.

4.4 Almost stochastic dominance decomposition and manager ownership

In the previous section, we find that fund flow response to ASD is no longer significant when controlling Sharpe ratio. It is likely that investors are not sophisticated enough to recognize ASD. Here we want to see whether fund managers can differentiate ASD from Sharpe ratio. We first decompose ASD_fdm into Sharpe ratio related part and Sharpe ratio unrelated part and then regress these two part on manager ownership measures. The model is

$$ASD\_decom_{i,t+1} = \beta_0 + \beta_1 \cdot Own_{dummy_{i,t}} + \beta_2 \cdot Log_{own_{mean}{}_{i,t}} + \beta_3 \cdot Own_{rank}{}_{i,t} + \beta_4 \cdot Own_{pct}{}_{i,t} + \beta_5 \cdot ASD\_decom_{i,t} + \sum_{k=1}^{K} \gamma_k \cdot Fund\ Controls_{k,t} + \varepsilon_{i,t+1}$$

The regression is on the annual frequency. $ASD\_decom_{i,t+1}$ is the decomposition of second-order almost stochastic dominance on Sharpe ratio in quarter t+1, either Asd_sharpe_related or Asd_sharpe_unrelated. $Own\_dummy_{i,t}$ is an indicator variable that equals one if portfolio managers have non-zero stakes in the fund, and zero otherwise. $Log\_own\_mean_{i,t}$ is natural logarithm of average dollar value of ownership if there are multiple managers. $Own\_rank_{i,t}$ is a rank variable, which takes a value of one if the ownership is zero, and two to seven, if ownership falls in the range of $1-$10,000, $10,001-$50,000, $50,001-$100,000, $100,001-$500,000, $500,001-$1,000,000, respectively. $Own\_pct_{i,t}$ is the aggregate dollar value of all managers ownership scaled by total net asset. $Alpha_{i,t}$ is the average quarter Fama-French-Carhart four-factor alpha in year t. Fund controls include the natural log of total net asset, fund age, family total net asset, and fund return, expense ratio, turnover ratio, fund flows, all measured as of the last month of year t. Newey-West adjusted t-statistics are used.

[Table 5 about here]

In Table 5, Asd_sharpe_related is the dependent variable in regression (1)-(4), Asd_sharpe_unrelated is the dependent variable in regression (5)-(8). Both future Asd_sharpe_related and Asd_sharpe_unrelated are negatively related to manager ownership in all four measures. Thus, managers have preference for ASD even if Sharpe ratio is differentiated.

5. Stochastic dominance and fund strategies

Now that we have shown that fund managers prefer ASD, the question is how do managers achieve such stochastic dominance over the market? Here we present some fund strategies and characteristics that may be related with second-order almost stochastic dominance measure.

First, we regress next period ASD_fdm on dummy variables that comes from mutual fund N-SAR report one by one, using the following Fama-Macbeth regression:

$$ASD\_fdm_{i,t+1} = \beta_0 + \beta_1 \cdot NSAR_{i,t} + \sum_{k=1}^{K} \gamma_k \cdot Fund\ Controls_{k,t} + \varepsilon_{i,t+1}$$

The regression is on the quarter frequency. $ASD\_fdm_{i,t+1}$ is the second-order almost stochastics dominance in quarter t+1. NSAR dummies include strategy dummies like Short-sell perm use/nouse, Repo perm use/nouse, Equity option perm use/nouse, Debt option perm use/nouse, Index option perm use/nouse, Restricted security perm use/nouse, Foreign perm use/nouse, Borrow perm use/nouse, Margin perm use/nouse (perm use stand for the certain strategy is permitted and is used while perm nouse stand for the strategy is permitted but is not used), and characteristic dummies like Multifund, Family, Overdraft, Bankloan, Equityfund, Balancedfund. Fund controls include fund alpha, natural log of total net asset, fund age, family total net asset, and fund return, expense ratio, turnover ratio, fund flows, all measured as of the last month of quarter t. Newey-West adjusted t-statistics are used.

[Table 6 about here]

In table 6, the coefficients are significantly negative for Short-sell use, Equity option use and Index option use, and significantly positive for Repo use, Restricted security use, Foreign use and Borrow use. That means when the fund is having short sales, holding equity options and index options, it tends to have a lower ASD_fdm in the future, which means the fund is more likely to dominate the market. But when the fund is holding Repos, restricted securities, foreign securities and is borrowing, it would have higher ASD_fdm in the next period, that is it is harder for the fund to dominate the market.

Since Sharpe ratio is a traditional performance measure for mutual funds and investors value Sharpe ratio more than our ASD measure, we want to further investigate whether they are different and how does a fund achieve different performance according to these two measures. Here we present the descriptive results for the proportion of funds using certain strategies in each extreme portfolio sorted on ASD_fdm and Sharpe ratio.

[Table 7 about here]

In table 7, we independently sorts funds into quintiles according to ASD_fdm and Sharpe ratio. For each strategy, we report the proportion of funds that exactly use the strategy relative to the funds that are permitted to use the strategy. For each characteristic, we report the proportion of funds that have the certain characteristic relative to the total number of funds. For the portfolio in quintile 1 based on ASD_fdm and in quintile 1 based on Sharpe ratio, it has the best performance according to ASD_fdm and the worst performance according to Sharpe ratio. And for the portfolio in quintile 5 based on ASD_fdm and in quintile 5 based on Sharpe ratio, it has the worst performance according to ASD_fdm and the best performance according to Sharpe ratio. Thus, these two are the divergent portfolios in the sense that their performance ranks according to ASD_fdm and Sharpe ratio are in the opposite extreme. And the other two cross extreme portfolios have the consistent performance ranks in these two measures, which stands for most cases.

For short-sell and index option strategy, the left-up portfolio has a proportion that is substantially higher than all the other portfolios, it seems short sale and index option play an important role in diverging the ASD and Sharpe ratio. Short sale and index option may do good to ASD measure but does no good to Sharpe ratio. The opposite is found for Repo strategy. As we can see, the left-up portfolio has the smallest proportion and the right-down portfolio has the largest proportion, both with substantial difference to the other portfolios. Repo has an obvious opposite relation between ASD and Sharpe ratio, while it hurt the ASD performance, it also improve Sharpe ratio performance. For equity option strategy, both left-up and right-up portfolios have higher proportion than other portfolios, thus, equity option is related to better ASD performance while there is no consistent relation between equity option and Sharpe ratio. Besides, the left-up portfolio has the smallest proportion of foreign security and the right-down portfolio has the largest proportion of borrow. Thus, less foreign security may be associated with the divergence of ASD and Sharpe ratio in the way that ASD is good and Sharpe ratio is bad, more borrow may work in an opposite way, that is lead to a good Sharpe ratio but bad ASD.

6 Conclusions

In this paper, we find conceptually important 2nd-order stochastic dominance of mutual fund (over the market return) is also important empirically for fund managers. However, fund investors tend to response related but simpler concepts such as Sharpe Ratio. Stochastic dominance is highly related with future fund performance and may be related with the genuine skill of fund managers. Managers can adjust their holding especially the non-equity holdings to achieve stochastic dominance.

References

Bali, T. G., Brown, S. J., & Demirtas, K. O. (2013). Do hedge funds outperform stocks and bonds?. Management Science, 59(8), 1887-1903.

Barber, B. M., Huang, X., & Odean, T. (2016). Which factors matter to investors? Evidence from mutual fund flows. The Review of Financial Studies, 29(10), 2600-2642.

Cremers, K. M., & Petajisto, A. (2009). How active is your fund manager? A new measure that predicts performance. The Review of Financial Studies, 22(9), 3329-3365.

Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. Journal of political economy, 81(3), 607-636.

Frazzini, A., & Lamont, O. A. (2008). Dumb money: Mutual fund flows and the cross-section of stock returns. Journal of financial economics, 88(2), 299-322.

Evans, R. B. (2010). Mutual fund incubation. The Journal of Finance, 65(4), 1581-1611.

Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. The Journal of finance, 48(1), 65-91.

Kacperczyk, M., Sialm, C., & Zheng, L. (2008). Unobserved actions of mutual funds. The Review of Financial Studies, 21(6), 2379-2416.

Leshno, M., & Levy, H. (2002). Preferred by "all" and preferred by "most" decision makers: Almost stochastic dominance. Management Science, 48(8), 1074-1085.

Levy, H., Leshno, M., & Leibovitch, B. (2010). Economically relevant preferences for all observed epsilon. Annals of Operations Research, 176(1), 153-178.

Linton, O., Maasoumi, E., & Whang, Y. J. (2005). Consistent testing for stochastic dominance under general sampling schemes. The Review of Economic Studies, 72(3), 735-765.

Maasoumi, E., & Heshmati, A. (2000). Stochastic dominance amongst Swedish income distributions. Econometric Reviews, 19(3), 287-320.

NEWEY, W., & WEST, K. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. Econometrica, 55(3), 703-708.

Figure 1: Horse race dummy variables

This figure shows the 100 dummy variables for the flow regression that compares relative fund flows based on a funds' ASD_fdm and Sharpe ratio. For Sharpe ratio, ten is a top decile fund and one is a bottom decile fund. For ASD_fdm, ten is a bottom decile fund and one is a top decile fund. In the regression, the omitted dummy variable (regression constant) is funds with a decile rank of five based on both measures (black square). The gray and black cells represent funds with similar ranks based on both measures. The empirical tests compare the coefficients corresponding to the forty-five lower off-diagonal cells (where funds have better performance based on ASD_fdm) to the forty-five upper-diagonal cells (where funds have better performance based on Sharpe ratio). For example, we compare the coefficient estimate on the dummy variable for funds in the ninth ASD_fdm decile and the third Sharpe ratio decile to funds in the third ASD_fdm decile and the nineth Sharpe ratio decile.

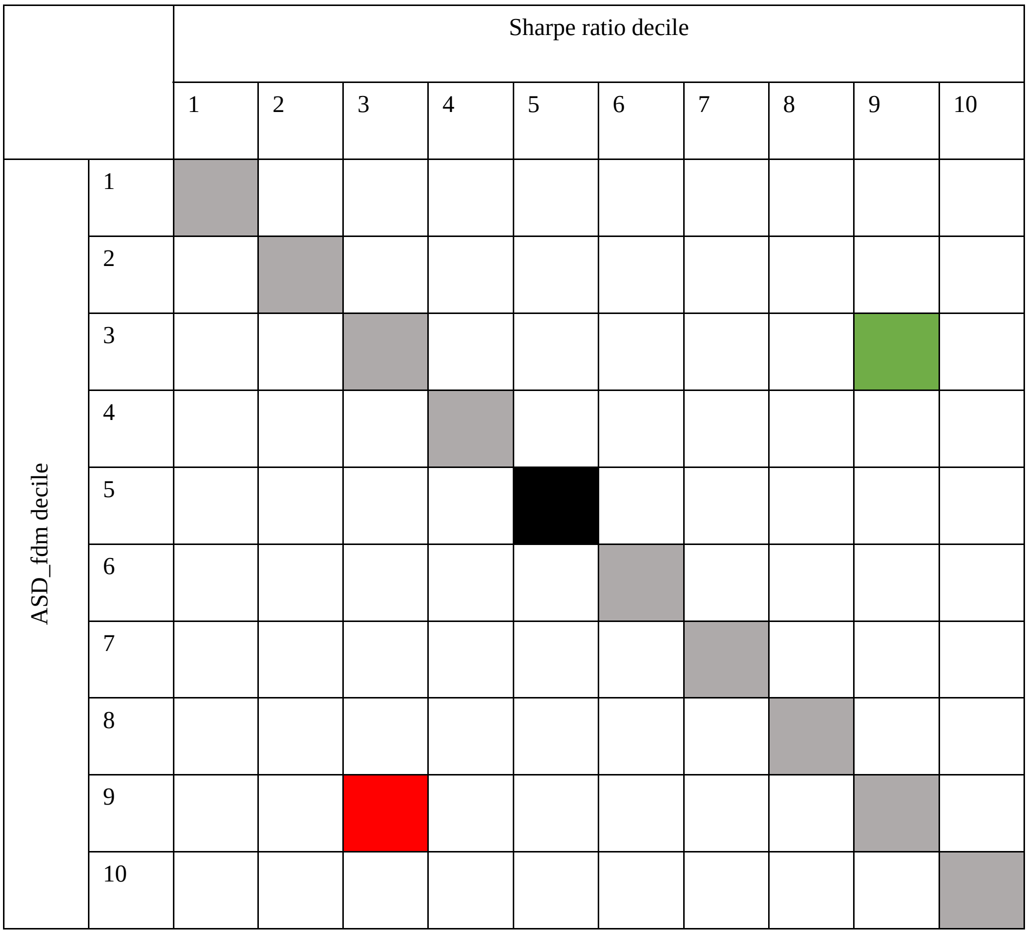

Figure 2: Flow differences for funds with different decile ranks

This figure shows the forty-five differences in coefficient estimates on dummy variables that compare funds with similar but opposite rankings based on ASD_fdm and Sharpe ratio. For example, the leftmost bar is the coefficient estimate on the dummy variable for funds in the tenth ASD_fdm decile and the ninth Sharpe ratio decile less coefficient estimate on the dummy variable for fund in the ninth ASD_fdm decile and the tenth Sharpe ratio decile.

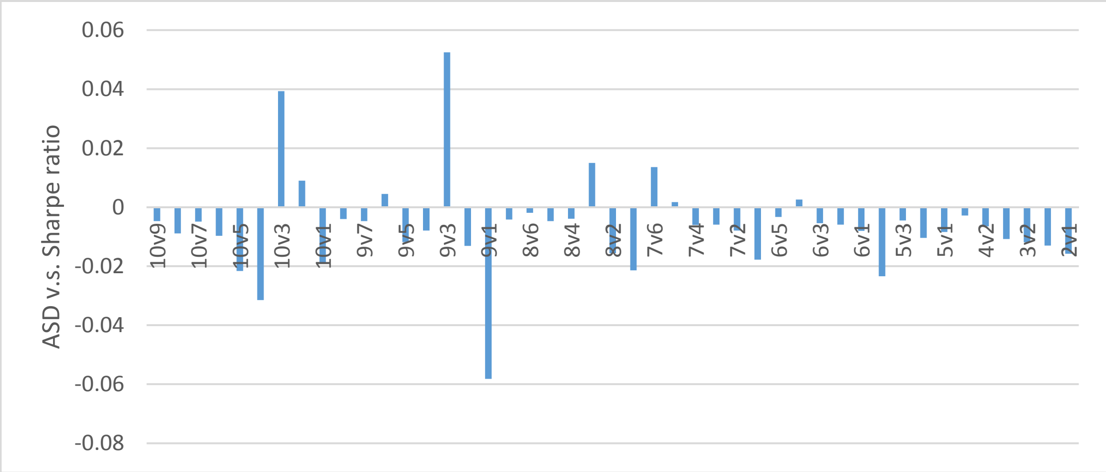

Table 1: Quarter performance of mutual fund sorted on almost stochastic dominance measure

This table reports the excess return and Fama-French-Carhart four-factor alpha on portfolios of mutual fund sorted on ASD_fdm/ASD_mdf. In panel A and B, at the beginning of each quarter, we form deciles portfolios of mutual funds based on their ASD_fdm/ASD_mdf computed using daily fund net returns and daily market return from the previous 12 months. Decile 1 contains funds with the lowest ASD_fdm/ASD_mdf and decile 10 contains funds with the highest ASD_fdm/ASD_mdf. A fund remains in the same portfolio for the whole quarter and then rebalance every quarter. In panel C, we independently sort funds into 10 portfolios according to ASD_fdm and 10 portfolios according to ASD_mdf, showing the return differences between portfolio with highst ASD_fdm and lowest ASD_mdf and portfolio with lowest ASD_fdm and highest ASD_mdf. Portfolios are all updated quarterly. The return and alpha are in monthly percentage. In parentheses are t-statistics. *, **, *** indicate significance at 10%, 5% and 1% levels, respectively.

Panel A: Sorting on ASD_fdm

	Equal-weighted		Value-weighted	
	Excess return	4-factor alpha	Excess return	4-factor alpha
Low ASD_fdm	0.618	0.193**	0.439	0.050
		(2.42)		(1.00)
2	0.560	0.118	0.528	0.063
		(1.35)		(1.15)
3	0.665	0.147	0.535	0.019
		(1.32)		(0.28)
4	0.683	0.122	0.572	0.031
		(0.99)		(0.37)
5	0.624	0.075	0.515	0.016
		(0.73)		(0.21)
6	0.509	-0.038	0.405	-0.036
		(-0.47)		(-0.51)
7	0.448	-0.101	0.367	-0.094
		(-1.51)		(-1.54)
8	0.369	-0.110	0.296	-0.114**
		(-1.43)		(-2.06)
9	0.234	-0.137	0.160	-0.170**
		(-1.50)		(-2.48)
High ASD_fdm	0.250	-0.067	0.204	-0.096*
		(-0.82)		(-1.72)
High-Low	-0.367**	-0.261**	-0.235*	-0.145*
t-statistic	(-2.08)	(-2.46)	(-1.84)	(-1.81)

Panel B: Sorting on ASD_mdf

	Equal-weighted		Value-weighted	
	Excess return	4-factor alpha	Excess return	4-factor alpha
Low ASD_mdf	0.280	-0.108	0.184	-0.156**
		(-1.39)		(-2.59)
2	0.094	-0.063	0.058	-0.039
		(-0.38)		(-0.35)
3	-0.082	-0.133	-0.062	-0.067
		(-1.36)		(-1.01)
4	0.376	-0.071	0.359	0.004
		(-0.94)		(0.06)
5	0.566	0.074	0.417	0.010
		(0.69)		(0.16)
6	0.617	0.160	0.429	0.030
		(1.22)		(0.40)
7	0.555	0.135	0.384	0.007
		(0.99)		(0.09)
8	0.460	0.074	0.384	0.006
		(0.68)		(0.09)
9	0.480	0.080	0.381	-0.005
		(1.13)		(-0.10)
High ASD_mdf	0.631	0.131	0.458	0.010
		(1.60)		(0.17)
High-Low	0.351**	0.239**	0.274*	0.165*
t-statistic	(2.13)	(2.08)	(1.89)	(1.72)

Panel C: Sorting on ASD_fdm and ASD_mdf

	Equal-weighted		Value-weighted	
	Excess return	4-factor alpha	Excess return	4-factor alpha
Low ASD_fdm & High ASD_mdf	0.641	0.163**	0.462	0.032
		(2.10)		(0.54)
High ASD_fdm & Low ASD_mdf	0.258	-0.076	0.193	-0.119**
		(-0.96)		(-2.08)
High ASD_fdm & Low ASD_mdf minus Low ASD_fdm & High ASD_mdf	-0.382**	-0.239**	-0.269*	-0.151
t-statistic	(-2.39)	(-2.23)	(-1.93)	(-1.63)

Table 2: Does second-order almost stochastic dominance measures predict future performance?

This table reports the average slope coefficients from the Fama and MacBeth (1973) cross-sectional regression from the model

$$Alpha_{i,t+1} = \beta_0 + \beta_1 \cdot ASD\_fdm_{i,t} + \beta_2 \cdot RG_{i,t} + \beta_3 \cdot AS_{i,t} + \beta_4 \cdot SR_{i,t} + \sum_{k=1}^{K} \gamma_k \cdot Fund\ Controls_{k,t} + \varepsilon_{i,t+1}$$

The regression is on the quarter frequency. $Alpha_{i,t+1}$ is the Fama-French-Carhart four-factor in quarter t+1 calculated using the 3 months' daily returns in that quarter. $ASD\_fdm_{i,t}$ is the second-order almost stochastics dominance in quarter t. $RG_{i,t}$ is the return gap in the last month of quarter t. The return gap measure follows Kacperczyk, Sialm and Zheng (2008), which is the monthly difference between net actual fund return and net hypothetical return, with actual annual expense ratio divided by 12 as the monthly expense for hypothetical fund. $AS_{i,t}$ is the active share in the last month of quarter t. The active share measure follows Cremers and Petajisto(2009). $SR_{i,t}$ is the Sharpe ratio in quarter t calculated with previous 12 months fund daily net returns in each quarter end. Fund controls include the natural log of total net asset, fund age, family total net asset, and fund return, expense ratio, turnover ratio, fund flows, all measured as of the last month of quarter t. Newey-West adjusted t-statistics are given in parentheses.

	(1)	(2)	(3)	(4)	(5)
ASD_fdm	-0.0283***	-0.0202**	-0.0223***	-0.0213***	-0.0238***
	(-2.80)	(-2.63)	(-2.90)	(-2.77)	(-3.27)
RG			-0.0020		
			(-0.03)		
AS				0.0119	
				(1.64)	
SR					0.0024
					(0.26)
Log(TNA)		-0.0008***	-0.0011***	-0.0010**	-0.0012***
		(-2.69)	(-2.78)	(-2.44)	(-2.94)
Alpha		0.0697***	0.0643***	0.0628**	0.0711***
		(2.90)	(2.62)	(2.42)	(2.76)
Expense ratio		-0.0026	-0.0038**	-0.0047***	-0.0035**
		(-1.23)	(-2.28)	(-3.78)	(-2.30)
Turnover ratio		-0.0000**	-0.0000**	-0.0000***	-0.0000***
		(-2.39)	(-2.45)	(-2.99)	(-3.01)
flow		0.0000	0.0000	0.0000	0.0000
		(0.02)	(0.24)	(0.17)	(0.45)
Log(age)		0.0011	0.0008	0.0008	0.0009
		(1.64)	(1.34)	(1.32)	(1.43)
TNA family		0.0002	0.0002	0.0003*	0.0003**
		(1.66)	(1.66)	(1.75)	(2.27)
Fund-month obs	148,560	145,150	99,183	99,183	99,183
Time periods (quarters)	65	65	54	54	54
Average R-squared	0.051	0.125	0.111	0.122	0.125

Table 3: Almost stochastic dominance and fund flows

Table 3 reports the average slope coefficients from the Fama and MacBeth (1973) cross-sectional regression from the models

$$Flow_{i,t+1} = \beta_0 + \beta_1 \cdot ASD\_fdm_{i,t} + \beta_2 \cdot Alpha_{i,t} + \beta_3 \cdot RR_{i,t} + \beta_4 \cdot GR_{i,t} + \beta_5 \cdot RG_{i,t} + \beta_6 \cdot SR_{i,t} + \sum_{k=1}^{K} \gamma_k \cdot Fund\ Controls_{k,t} + \varepsilon_{i,t+1}$$

The regression is on the quarter frequency. $Flow_{i,t+1}$ is the average monthly fund flow in quarter t+1. $ASD\_fdm_{i,t}$ is the second-order almost stochastic dominance in quarter t. $Alpha_{i,t}$ is the Fama-French-Carhart four-factor alpha in quarter t calculated using the 3 months' daily returns in that quarter. $RR_{i,t}$ is the fund raw return in the last month of quarter t. $GR_{i,t}$ is the fund gross return in the last month of quarter t. $RG_{i,t}$ is the return gap in the last month of quarter t. $SR_{i,t}$ is the Sharpe ratio in quarter t calculated with previous 12 months fund daily net returns in each quarter end. Fund controls include the natural log of total net asset, fund age, family total net asset, and fund return, expense ratio, turnover ratio, fund flows, all measured as of the last month of quarter t. Newey-West adjusted t-statistics are given in parentheses.

Panel A: quarterly flow

	(1)	(2)	(3)	(4)	(5)
ASD_fdm	-0.0241***	-0.0253***	-0.0252***	-0.0282***	-0.0095**
	(-9.95)	(-9.01)	(-8.98)	(-9.69)	(-2.45)
Alpha	0.0690***				
	(4.42)				
RR		0.0022***			
		(4.35)			
GR			0.0022***		
			(4.34)		
RG				-0.0324	
				(-0.34)	
SR					0.0496***
					(10.58)
Log(TNA)	-0.0030***	-0.0031***	-0.0030***	-0.0030**	-0.0032***
	(-3.95)	(-4.08)	(-4.08)	(-4.02)	(-4.27)
Expense ratio	-0.0028	-0.0029	-0.0031	-0.0027	-0.0029
	(-1.09)	(-1.09)	(-1.15)	(-1.09)	(-1.11)
Turnover ratio	0.0000***	0.0000***	0.0000**	0.0000***	0.0000***
	(2.81)	(2.77)	(2.77)	(2.73)	(2.81)
flow	0.0014***	0.0014***	0.0014***	0.0014***	0.0013***
	(9.13)	(9.09)	(9.09)	(9.11)	(8.95)
Log(age)	-0.0075***	-0.0075***	-0.0075***	-0.0075***	-0.0072***
	(-5.51)	(-5.24)	(-5.25)	(-5.44)	(-5.45)
TNA family	0.0007**	0.0008**	0.0008**	0.0008**	0.0008**
	(2.35)	(2.40)	(2.40)	(2.48)	(2.54)
Fund-month obs	99,175	99,175	99,175	99,175	99,175
Time periods (quarters)	54	54	54	54	54
Average R-squared	0.083	0.082	0.082	0.079	0.089

Table 4: Almost stochastic dominance and manager ownership

This table reports the average slope coefficients from the Fama and MacBeth (1973) cross-sectional regression from the model

$$ASD\_fdm_{i,t+1} = \beta_0 + \beta_1 \cdot Own\_dummy_{i,t} + \beta_2 \cdot Log\_own\_mean_{i,t} + \beta_3 \cdot Own\_rank_{i,t} + \beta_4 \cdot Own\_pct_{i,t} + \sum_{k=1}^{K} \gamma_k \cdot Fund\ Controls_{k,t} + \varepsilon_{i,t+1}$$

The regression is on the annual frequency. $ASD\_fdm_{i,t+1}$ is the second-order almost stochastic dominance in year t+1. $Own\_dummy_{i,t}$ is an indicator variable that equals one if portfolio managers have non-zero stakes in the fund, and zero otherwise. $Log\_own\_mean_{i,t}$ is natural logarithm of average dollar value of ownership if there are multiple managers. $Own\_rank_{i,t}$ is a rank variable, which takes a value of one if the ownership is zero, and two to seven, if ownership falls in the range of \$1-\$10,000, \$10,001-\$50,000, \$50,001-\$100,000, \$100,001-\$500,000, \$500,001-\$1,000,000, respectively. $Own\_pct_{i,t}$ is the aggregate dollar value of all managers ownership scaled by total net asset. $Alpha_{i,t}$ is the average quarter Fama-French-Carhart four-factor alpha in year t. Fund controls include the natural log of total net asset, fund age, family total net asset, and fund return, expense ratio, turnover ratio, fund flows, all measured as of the last month of year t. Newey-West adjusted t-statistics are given in parentheses.

	(1)	(2)	(3)	(4)
Own_dummy	-0.0248***			
	(-8.17)			
Log_own_mean		-0.0023***		
		(-9.64)		
Own_rank			-0.0065***	
			(-8.34)	
Own_pct				-0.0000***
				(-9.73)
Alpha	-0.4923	-0.4873	-0.4815	-0.5048
	(-1.15)	(-1.15)	(-1.15)	(-1.19)
Log(TNA)	0.0018	0.0025	0.0032	-0.0018
	(0.85)	(1.18)	(1.49)	(-0.95)
Expense ratio	0.0667**	0.0675**	0.0679**	0.0637**
	(3.49)	(3.56)	(3.61)	(3.38)
Turnover ratio	0.0002**	0.0002**	0.0002**	0.0002**
	(3.40)	(3.40)	(3.39)	(3.54)
flow	-0.0001	-0.0001	-0.0000	-0.0001
	(-0.16)	(-0.12)	(-0.07)	(-0.18)
Log(age)	-0.0077	-0.0075	-0.0079	-0.0098*
	(-1.77)	(-1.72)	(-1.79)	(-2.31)
TNA family	0.0038*	0.0035*	0.0034*	0.0040*
	(2.17)	(2.04)	(1.95)	(2.34)
Fund-month obs	9,832	9,832	9,832	9,832
Time periods (years)	7	7	7	7
Average R-squared	0.080	0.081	0.082	0.078

Table 5: Almost stochastic dominance decomposition and manager ownership

This table reports the average slope coefficients from the Fama and MacBeth (1973) cross-sectional regression from the model

$$ASD\_decom_{i,t+1} = \beta_0 + \beta_1 \cdot Own_{dummy_{i,t}} + \beta_2 \cdot Log_{own_{mean_{i,t}}} + \beta_3 \cdot Own_{rank_{i,t}} + \beta_4 \cdot Own_{pct_{i,t}} + \beta_5 \cdot ASD\_decom_{i,t} + \sum_{k=1}^{K} \gamma_k \cdot Fund\ Controls_{k,t} + \varepsilon_{i,t+1}$$

The regression is on the annual frequency. $ASD\_decom_{i,t+1}$ is the decomposition of second-order almost stochastic dominance on Sharpe ratio in quarter t+1, either Asd_sharpe_related or Asd_sharpe_unrelated. $Own\_dummy_{i,t}$ is an indicator variable that equals one if portfolio managers have non-zero stakes in the fund, and zero otherwise. $Log\_own\_mean_{i,t}$ is natural logarithm of average dollar value of ownership if there are multiple managers. $Own\_rank_{i,t}$ is a rank variable, which takes a value of one if the ownership is zero, and two to seven, if ownership falls in the range of \$1-\$10,000, \$10,001-\$50,000, \$50,001-\$100,000, \$100,001-\$500,000, \$500,001-\$1,000,000, respectively. $Own\_pct_{i,t}$ is the aggregate dollar value of all managers ownership scaled by total net asset. $Alpha_{i,t}$ is the average quarter Fama-French-Carhart four-factor alpha in year t. Fund controls include the natural log of total net asset, fund age, family total net asset, and fund return, expense ratio, turnover ratio, fund flows, all measured as of the last month of year t. Newey-West adjusted t-statistics are given in parentheses.

	Asd_sharpe_related				Asd_sharpe_unrelated			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Own_dummy	-0.0060***				-0.0124***			
	(-8.68)				(-6.11)			
Log_own_mean		-0.0005***				-0.0011***		
		(-6.63)				(-6.68)		
Own_rank			-0.0013***				-0.0030***	
			(-3.72)				(-5.61)	
Own_pct				-0.0000**				-0.0000**
				(-3.83)				(-3.67)
Asd_sharpe_related	0.8212***	0.8212***	0.8218***	0.8206***				
	(12.82)	(12.82)	(12.82)	(12.85)				
Asd_sharpe_unrelated					0.1759***	0.1762***	0.1762***	0.1758***
					(8.50)	(8.55)	(8.59)	(8.44)
Alpha	0.2680***	0.2679***	0.2677***	0.2659***	0.6566*	0.6597*	0.6633*	0.6515*
	(4.53)	(4.55)	(4.60)	(4.55)	(2.04)	(2.06)	(2.10)	(2.03)
Log(TNA)	-0.0001	-0.0000	0.0001	-0.0011	0.0109***	0.0112***	0.0115***	0.0095***
	(-0.08)	(-0.00)	(0.05)	(-0.66)	(7.50)	(7.81)	(7.93)	(7.22)
Expense ratio	0.0146*	0.0148*	0.0147*	0.0137*	0.0301	0.0304	0.0304	0.0288
	(2.31)	(2.35)	(2.38)	(2.16)	(1.28)	(1.30)	(1.31)	(1.24)
Turnover ratio	0.0000**	0.0000**	0.0000**	0.0000**	-0.0000	-0.0000	-0.0000	-0.0000
	(3.27)	(3.26)	(3.31)	(3.23)	(-0.56)	(-0.60)	(-0.65)	(-0.56)
flow	0.0002	0.0002	0.0002	0.0002	0.0005	0.0006	0.0006	0.0006
	(0.97)	(0.99)	(1.01)	(1.03)	(1.40)	(1.41)	(1.43)	(1.41)
Log(age)	-0.0020	-0.0020	-0.0021	-0.0024	-0.0034	-0.0034	-0.0036	-0.0046
	(-0.93)	(-0.90)	(-0.95)	(-1.15)	(-1.15)	(-1.13)	(-1.20)	(-1.48)
TNA family	0.0005	0.0004	0.0004	0.0005	-0.0006	-0.0007	-0.0007	-0.0004
	(0.87)	(0.78)	(0.74)	(0.82)	(-0.58)	(-0.72)	(-0.77)	(-0.36)
Fund-month obs	9,360	9,360	9,360	9,360	9,360	9,360	9,360	9,360
Time periods (years)	7	7	7	7	7	7	7	7
Average R-squared	0.628	0.629	0.629	0.628	0.094	0.095	0.095	0.093

Table 6: Fund strategies and characteristics and ASD and Sharpe ratio

This table reports the Fama-Macbeth regression results for using NSAR dummies as independent variables one by one. The regression model is

$$ASD\_fdm_{i,t+1} = \beta_0 + \beta_1 \cdot NSAR_{i,t} + \sum_{k=1}^{K} \gamma_k \cdot Fund\ Controls_{k,t} + \varepsilon_{i,t+1}$$

The regression is on the quarter frequency. $ASD\_fdm_{i,t+1}$ is the second-order almost stochastics dominance in quarter t+1. NSAR dummies include Short-sell use, Repo use, Equity option use, Debt option use, Index option use, Restricted security use, Foreign use, Borrow use, Margin use, Multifund, Family, Overdraft, Bankloan, Equityfund, Balancedfund. Fund controls include fund alpha, natural log of total net asset, fund age, family total net asset, and fund return, expense ratio, turnover ratio, fund flows, all measured as of the last month of quarter t. Newey-West adjusted t-statistics are given in parentheses.

Panel A: strategy dummies

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Short-sell perm use	-0.0341**								
	(-2.57)								
Short-sell perm	0.0199***								
	(5.57)								
Repo perm use		0.0932***							
		(7.41)							
Repo perm nouse		0.0744***							
		(7.82)							
Equity option perm			0.0345***						
			(3.79)						
Equity option perm			0.0573***						
			(10.33)						
Debt option perm				0.0175					
				(0.97)					
Debt option perm				0.0234***					
				(9.52)					
Index option use					-0.0308				
					(-1.53)				
Index option nouse					0.0625***				
					(11.66)				
Restricted security						0.0427***			
						(7.87)			
Restricted security						0.0428***			
						(5.98)			
Foreign perm use							0.0847***		
							(8.61)		
Foreign perm nouse							0.0779***		
							(6.44)		
Borrow perm use								0.0343***	
								(3.04)	
Borrow perm nouse								0.0165***	
								(3.35)	
Margin perm use									-0.0223
									(-0.72)
Margin perm nouse									-0.0004
									(-0.14)
Fund-month obs	36982	36982	36982	36982	36982	36982	36982	36982	36982
Time periods (years)	28	28	28	28	28	28	28	28	28

Average R-squared	0.116	0.120	0.121	0.115	0.125	0.117	0.121	0.115	0.113

Panel B: characteristic dummies

	(1)	(2)	(3)	(4)	(5)	(6)
multifund	0.0267***					
	(6.54)					
Family		-0.0083*				
		(-1.75)				
Overdraft			0.0222**			
			(2.58)			
Bankloan				0.0284***		
				(4.85)		
Equityfund					0.0083	
					(0.29)	
Balancedfund						-0.0564
						(-1.12)
Fund-month obs	36982	36982	36982	36982	36982	36982
Time periods (years)	28	28	28	28	28	28
Average R-squared	0.113	0.112	0.115	0.113	0.114	0.116

Table 7: Fund strategies and characteristics summary in ASD-Sharpe double sorted portfolios

This table reports the strategies and characteristic of portfolios sorted on ASD and Sharpe ratio. The left half part independently sorts funds into quintiles according to ASD_fdm and Sharpe ratio. The right half part independently sorts funds into quintiles according to Sharpe ratio and into three groups according to whether the fund dominates the market or the fund is dominated by the market or there is no dominance. For each strategy, we report the proportion of funds that exactly use the strategy relative to the funds that are permitted to use the strategy. For each characteristic, we report the proportion of funds that have the certain characteristic relative to the total number of funds.

Short-sell				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	13.99%		5.66%
	2~4		3.34%	
	5	3.93%		0.00%

Repo				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	27.69%		37.42%
	2~4		40.36%	
	5	41.31%		37.14%

Equity option				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	11.57%		10.25%
	2~4		7.56%	
	5	8.40%		3.03%

Debt option				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	0.00%		0.00%
	2~4		0.05%	
	5	0.06%		0.00%

Index option				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	10.19%		2.61%
	2~4		1.30%	
	5	1.44%		2.38%

Restricted security				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	17.42%		20.17%
	2~4		19.27%	
	5	19.83%		17.78%

Foreign				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	63.28%		79.40%
	2~4		76.11%	
	5	78.16%		73.33%

Borrow				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	10.11%		7.69%
	2~4		9.83%	
	5	12.07%		21.95%

Margin

		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	4.23%		0.99%
	2~4		0.97%	
	5	0.75%		0.00%
Multi-fund				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	94.95%		86.58%
	2~4		89.87%	
	5	79.31%		76.09%
Family				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	69.70%		80.26%
	2~4		80.30%	
	5	79.31%		76.09%
Overdraft				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	23.74%		18.75%
	2~4		21.61%	
	5	29.92%		28.26%
Bank loan				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	9.09%		4.92%
	2~4		7.03%	
	5	9.94%		15.22%
Equity fund				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	94.44%		98.19%
	2~4		98.34%	
	5	98.78%		95.65%
Balance fund				
		Sort on Sharpe		
		1	2~4	5
Sort on ASD_fdm	1	5.05%		0.20%
	2~4		0.67%	
	5	0.13%		0.00%